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Whited

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[54] **TRANSFER REGULATING APPARATUS**

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[52] **U.S. Cl.** ..... **355/3 R,** 250/325, 96/1.4, 118/7

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** ..... 355/3 R, 3 DD, 4; 250/324–326; 117/17.5; 96/1.4, 1.2; 118/637, 7

[56] **References Cited**

UNITED STATES PATENTS

3,778,146 12/1973 Knapp ..... 355/3 R

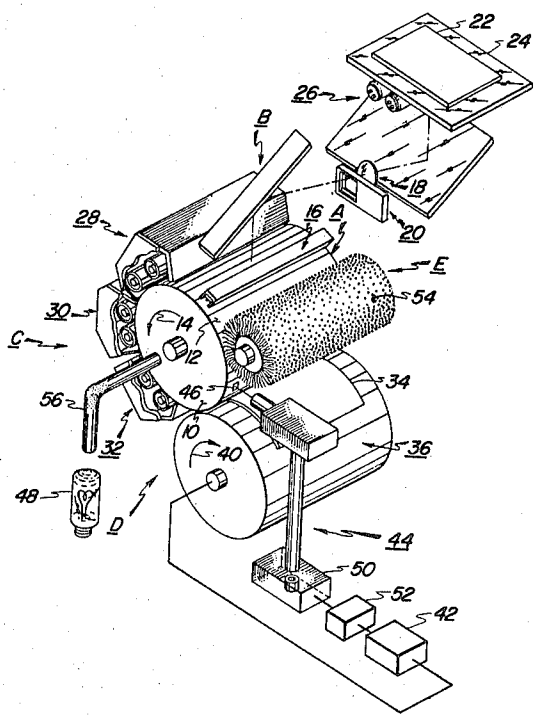
Primary Examiner—Robert P. Greiner

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[57] **ABSTRACT**

An apparatus in which the transfer of charged particles from a support surface to a sheet of support material is regulated. The apparatus electrically attracts the charged particles from the support surface to the sheet of support material. After the charged particles have been transferred to the sheet of support material, a sample density of charged particles corresponding to the density of charged particles remaining on the support surface is detected. In response to the detected sample density of charged particles, the electrical attraction between the support surface and sheet of support material is suitably adjusted.

16 Claims, 4 Drawing Figures



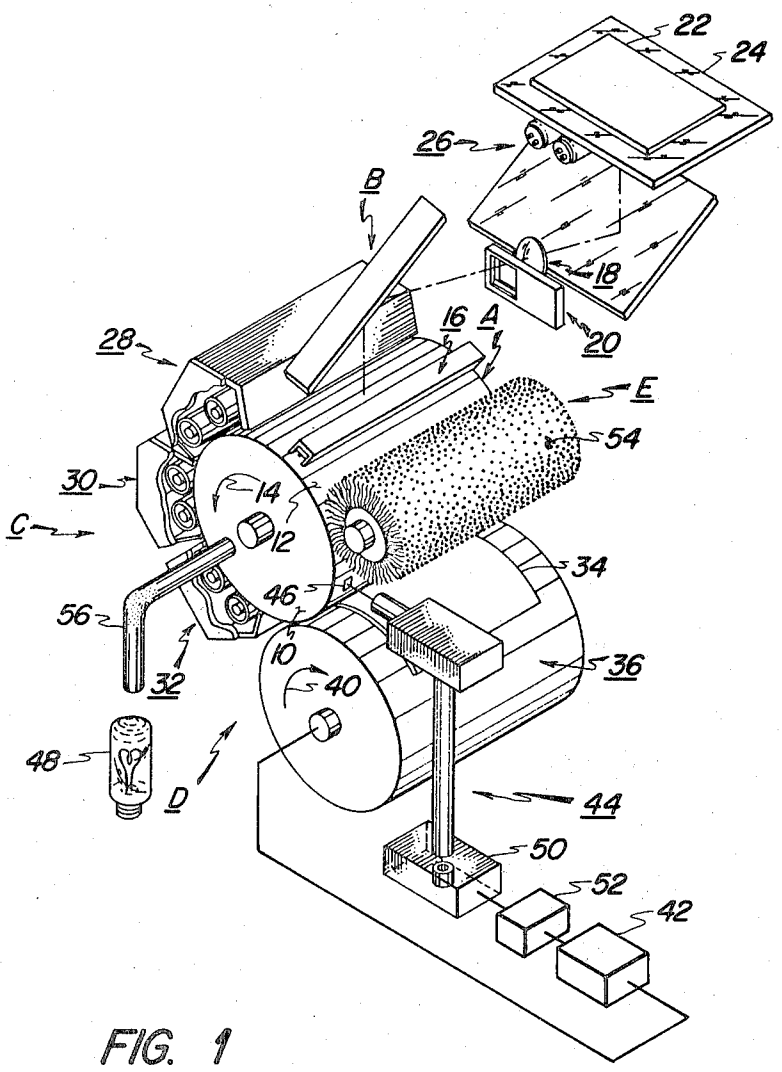

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FIG. 1

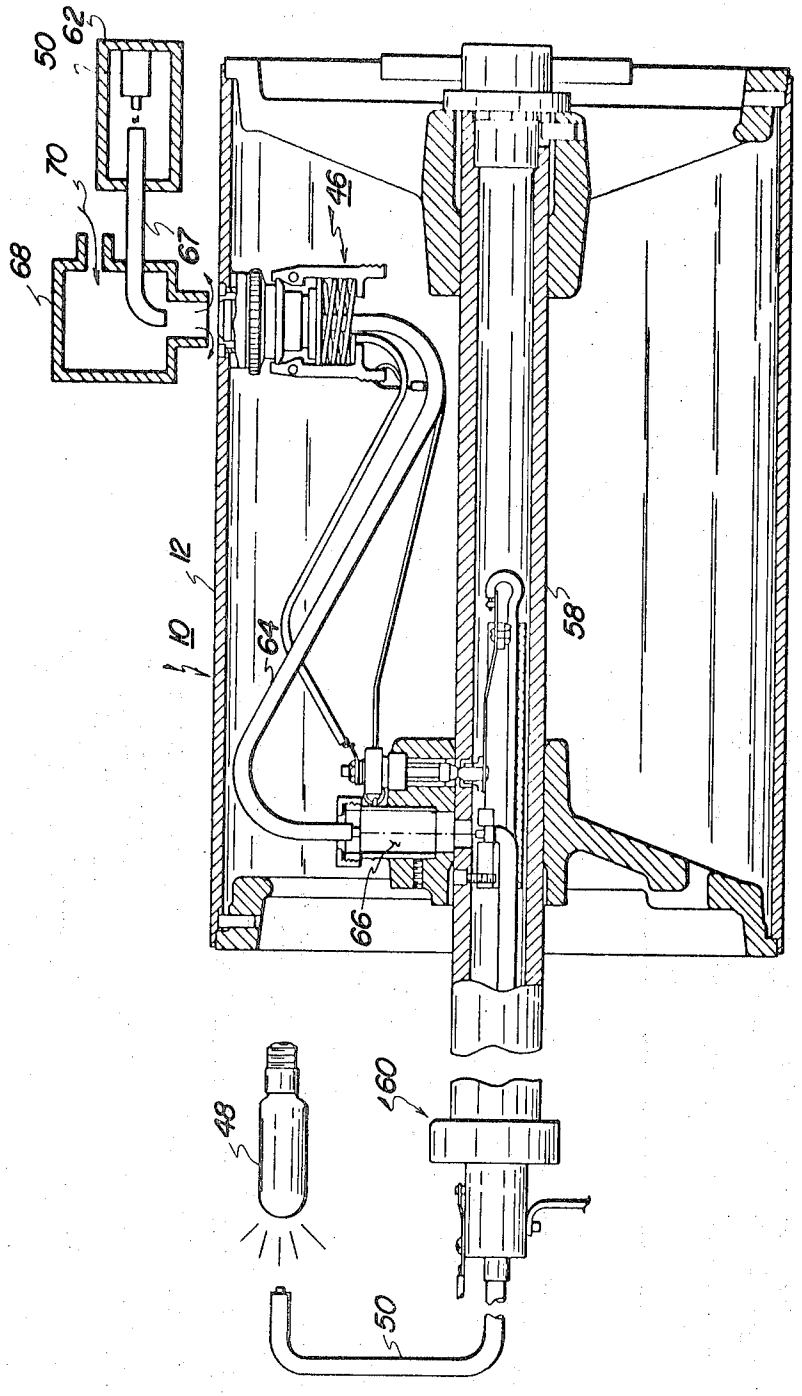


FIG. 2

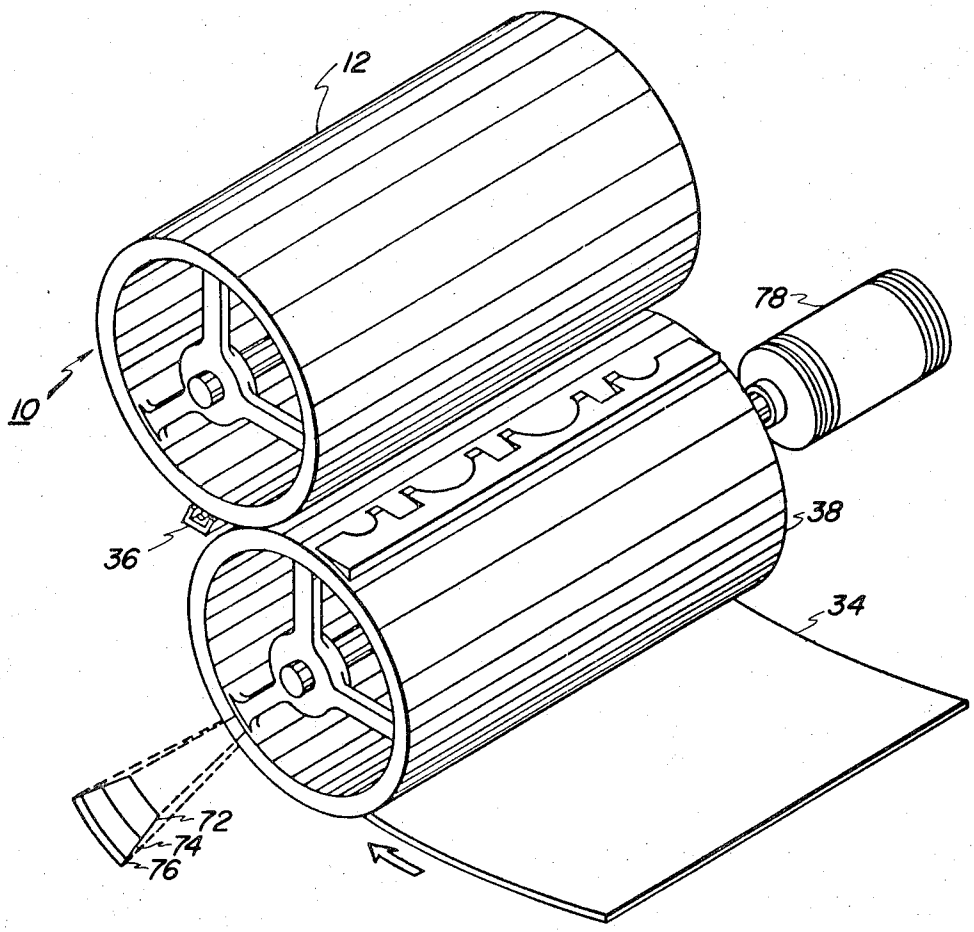


FIG. 3

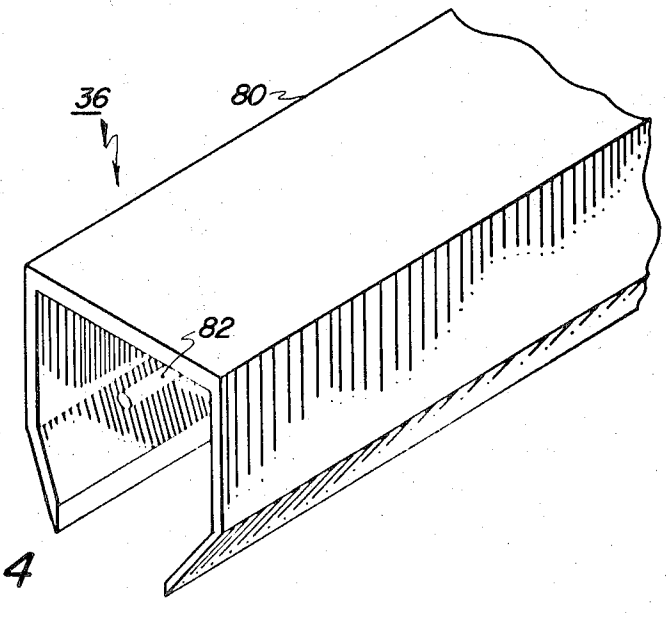


FIG. 4

TRANSFER REGULATING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates generally to an electrophotographic printing machine, and more particularly concerns an improved transfer system for use therein.

In the process of electrophotographic printing, as disclosed in U.S. Pat. No. 2,297,691 issued to Carlson in 1942, an image bearing member having a photoconductive insulating layer is charged to a substantially uniform potential in order to sensitize its surface. This charged photoconductive surface is exposed to a light image of an original document. The charge is selectively dissipated in the irradiated areas in accordance with the light intensity projected onto the photoconductive surface. Development of the electrostatic latent image recorded on the photoconductive surface is attained by bringing a developer mix of carrier granules and toner particles into contact therewith. Typically, the toner particles are heat settable dyed or colored thermoplastic powders, and the carrier granules are ferro-magnetic granules. The developer mix is generally selected such that the toner particles acquire the appropriate charge relative to the electrostatic latent image recorded on the photoconductive surface. As the developer mix is brought into contact with the photoconductive surface, the greater attractive force on the electrostatic latent image causes the toner particles to be transferred from the carrier granules and adhere thereto. Thereafter, the toner powder image, developed on the photoconductive surface, is transferred to a sheet of support material. Subsequently, the toner powder image transferred to the sheet of support material may be permanently affixed thereto by suitable means.

Various techniques have heretofore been utilized for transferring the toner powder image to the sheet of support material. One such technique is the creation of an electrical field by a corona generator such as that disclosed in U.S. Pat. No. 2,836,725 issued to Vyverburg in 1958. A corona generator of this type induces transfer to the sheet of support material by spraying a corona discharge having a polarity opposite to that of the toner particles on the photoconductive surface. This causes the toner particles to be electrically transferred to the sheet of support material. Other techniques utilized have included an electrically biased transfer roll. The biased transfer roll generates a high voltage discharge in the proximity of the surface of the support material or, it may be applied by means of a conductive cylinder in contact with the support material as disclosed in U.S. Pat. No. 2,807,233 issued to Fitch in 1957. As described therein, a sheet of support material is interposed between the conductive roller and a photoconductive surface having the toner powder image adhering thereto. A charge of opposite polarity from the toner particles is deposited on the back side of the sheet of support material. This charge attracts the toner powder image from the photoconductive surface to the sheet of support material.

Many factors influence the quality of the transferred image. The most significant factors are those which affect the uniformity which which the toner powder image is transferred from the photoconductive surface to the sheet of support material. In particular, when a bias transfer roll is utilized to transfer successive toner powder images to a sheet of support material, hollow

characters frequently occur. Hollow characters may be defined as a toner area wherein substantially only the periphery thereof is transferred while the central portion remains devoid of toner particles. The problem of hollow characters is most pronounced for line copy reproductions, however, hollow characters frequently occur in solid area copy as well. It should be noted that when hollow characters are formed residual toner particles will remain on the photoconductive surface after the transfer step. Thus, the untransferred toner particles will adhere electrostatically to the photoconductive surface and may be detected thereon.

Accordingly, it is the primary object of the present invention to improve transferring of the toner powder image from an image bearing member to a sheet of support material by regulating the electrical attractive force therebetween.

SUMMARY OF THE INVENTION

Briefly stated, and in accordance with the present invention, there is provided an apparatus for regulating a system adapted to transfer charged particles from a support surface to a sheet of support material.

Pursuant to the present invention, the apparatus includes electrical transfer means cooperating with the support surface to attract the charged particles from the support surface to the sheet of support material. Means are provided for detecting a sample density of charged particles corresponding to the charged particles remaining on the support surface after the transfer means has attracted the charged particles from the support surface to the sheet of support material. In addition, means are also provided for variably exciting the transfer means. The exciting means is responsive to the detecting means for adjusting the electrical attractive force between the transfer means and the support surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIG. 1 is a schematic perspective view of a multicolor electrophotographic printing machine embodying the features of the present invention therein;

FIG. 2 is a sectional elevational view of the photoconductive drum employed in the FIG. 1 printing machine and showing, in detail, the apparatus of the present invention used for regulating the transfer system thereof;

FIG. 3 is a schematic perspective view of the transfer apparatus utilized in the FIG. 1 printing machine; and

FIG. 4 is a fragmentary perspective view of the corona generator used in the FIG. 3 transfer apparatus.

While the present invention will be described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

With continued reference to the drawings wherein like reference numerals have been used throughout to

designate like elements, FIG. 1 schematically illustrates a multi-color electrophotographic printing machine arranged to create multi-color copies from a colored original document. Although the regulating apparatus of the present invention is particularly well adapted for use in the multi-color electrophotographic printing machine depicted in FIG. 1, it should become evident from the following discussion that it is equally well suited for use in a wide variety of electrostatographic printing machines and is not necessarily limited in its application to the particular embodiment shown herein.

The printing machine depicted in FIG. 1 employs an image bearing member having a drum **10** with a photoconductive surface **12** mounted on and entrained about the exterior circumferential surface thereof. Photoconductive surface **12,** preferably, is formed of a material having a relatively panchromatic response to white light. One type of suitable photoconductive material is disclosed in U.S. Pat. No. 3,655,377 issued to Sechak in 1972. Drum **10** is mounted rotatably within the machine frame and is assigned to rotate in the direction of arrow **14.** A series of processing stations are positioned such that as drum **10** rotates in the direction of arrow **14,** photoconductive surface **12** passes sequentially therethrough. Drum **10** is driven at a predetermined speed by a drive motor (not shown) relative to the various machine operating mechanisms. A timing disc mounted in the region of one end portion of the shaft on which drum **10** is disposed cooperates with the machine logic to coordinate each operation at the respective station so as to produce the proper sequence of events thereat.

First, drum **10** moves photoconductive surface **12** through charging station A. Charging station A has positioned thereat a corona generating device, indicated generally by the reference numeral **16.** Corona generating device **16** extends in a generally transverse direction across photoconductive surface **12.** This readily enables corona generating device **16** to charge photoconductive surface **12** to relatively high substantially uniform potential. A suitable corona generating device is described in U.S. Pat. No. 2,778,946 issued to Mayo in 1957.

After photoconductive surface **12** is charged to a substantially uniform level, drum **10** rotates to exposure station B. At exposure station B, a moving lens system, generally designated by the reference numeral **18,** and a color filter mechanism, shown generally at **20,** create a color filtered light image which irradiates charged photoconductive surface **12.** An original document **22** is stationarily supported upon transparent viewing platen **24.** The original document may be a sheet of paper, book or the like which is placed face down upon viewing platen **24.** Lamp assembly **26,** filter mechanism **20** and lens **18** move in a timed relation with drum **10** to scan successive incremental areas of original document **22** disposed upon platen **24.** During exposure, filter mechanism **20** interposes selected color filters into the optical light path of lens **18.** A selected color filter operates on the light rays passing through lens **18** to create a single color light image. The single color light image irradiates charged photoconductive surface **12** to record an electrostatic latent image thereon corresponding to a preselected spectral region of the electromagnetic wave spectrum, hereinafter referred to as a single color electrostatic latent image.

Subsequent to the recording of the electrostatic latent image on photoconductive surface **12,** drum **10** rotates to development station C. Development station C includes three individual developer units generally designated by the reference numerals **28, 30** and **32,** respectively. A suitable development station employing a plurality of developer units is disclosed in co-pending application Ser. No. 255,259 filed in 1972. The developer units are all of a type generally referred to as magnetic brush development units. A typical magnetic brush developer unit employs a magnetizable developer mix comprising carrier granules and toner particles. The developer mix is continually brought through a directional flux field to form a brush thereof. The developer particles are continually moving to provide the brush consistently with fresh developer material. Development is achieved by bringing the brush into contact with photoconductive surface **12.** Each of the developer units **28, 30** and **32** apply toner particles corresponding to the complement of the specific single color electrostatic latent image recorded on photoconductive surface **12.** The toner particles are adapted to absorb light within a preselected spectral region of the electromagnetic wave spectrum corresponding to the wave length of light transmitted through the filter. For example, a green filtered electrostatic latent image is rendered visible by depositing green absorbing magenta toner particles thereon. Similarly, blue and red latent images are developed with yellow and cyan toner particles, respectively.

Drum **10** is next rotated to transfer station D. At transfer station D, the toner powder image, adhering electrostatically to photoconductive surface **12** is transferred to a sheet of support material **34.** Support material **34** may be plain paper or a sheet of thermoplastic material, amongst others. Transfer station D includes thereat corona generating means, indicated generally at **36** (FIG. 3), and a transfer drum, indicated generally at **38.** Corona generator **36** is excited with an alternating current and arranged to spray ions onto photoconductive surface **12** to pre-condition the toner powder image adhering electrostatically thereto. In this manner, the pre-conditioned toner powder image will more readily be transferred from the electrostatic latent image recorded on photoconductive surface **12** to support material **34** by transfer drum **38.** Transfer drum **38** is adapted to recirculate support material **34** thereon and electrically biased to a potential of sufficient magnitude and polarity to attract electrostatically the preconditioned toner particles from the latent image recorded on photoconductive surface **12** to support material **34.** Transfer drum **38** rotates in the direction of arrow **40,** in synchronism with drum **10,** i.e., at the same angular velocity therewith. Transfer drum **38** is electrically excited by voltage source **42.** Voltage source **42** is a variable high voltage power source. Inasmuch as support material **34** is secured releasably on transfer drum **38** for movement in a recirculating path therewith, successive toner powder images may be transferred thereto, in superimposed registration with one another. Corona generator **36** and transfer drum **38** will be described hereinafter in greater detail with references to FIGS. **3** and **4.**

In accordance with the present invention, the residual toner particles remaining on photoconductive surface **12** are detected after the transfer process. The regulating apparatus of the present invention, indicated

generally at **44**, includes detecting means having a transparent electrode **46**, illuminating means or light source **48**, and sensing means or photosensor **50**. Transparent electrode assembly **46** is mounted on photoconductive surface **12** of drum **10**. Light source **48**, in cooperation with fiber optics **52**, transmits light rays through transparent electrode assembly **46**. During development, toner particles are deposited on transparent electrode **46**. This creates a sample density of charged particles corresponding to the charged particles on photoconductive surface **12**. The toner particles deposited thereon are then transferred to support material **34** as photoconductive surface **12** passes through transfer station D. Thereafter, the intensity of the light rays passing through transparent electrode **46** is detected by photosensor **50**. The intensity of the light rays passing therethrough is indicative of the density of toner particles remaining thereon after the transfer process. This creates a sample density of charged particles corresponding to the untransferred toner particles remaining on photoconductive surface **12**. Photosensor **50** is adapted to receive the light rays transmitted through transparent electrode **46** and develops an electrical output signal corresponding to the intensity of the light rays passing therethrough. Comparing means **52**, e.g. suitable logic circuitry, compares the electrical output signal from photosensor **50** to a reference signal and generates a control signal for adjusting the voltage excitation furnished by voltage source **42**. Thus, the voltage exciting transfer drum **38** may be varied so as to substantially optimize transfer.

Prior to proceeding with the remainder of the processes in the electrophotographic printing machine, the sheet feeding arrangement will be briefly discussed. Support material **34** is advanced from a stack thereof, A feed roll, in operative communication with a retard roll, advances and separates the uppermost sheet from the stack. The advancing sheet moves into a chute which directs it into the nip between a pair of register rolls. Thereafter, gripper fingers, mounted on transfer roll **38**, secure releasably thereon support material **34** for movement in a recirculating path therewith.

After a plurality of toner powder images have been transferred to support material **34**, the gripper fingers on transfer roll **38** to release support material **34** and space it therefrom. A stripper bar is then interposed therebetween to separate support material **34** from transfer roll **38**. Thereafter, an endless belt conveyor advances support material **34** to fixing station E.

At fixing station E, a fuser coalesces the transferred multi-layered toner powder image to support material **34**. One type of suitable fuser is described in U.S. Pat. No. 3,498,592 issued to Moser et al. in 1970. After the fusing process, support material **34** is advanced by a plurality of endless belt conveyors to a catch tray for subsequent removal from the machine by an operator.

The last processing station in the direction of drum rotation, as indicated by arrow **14**, is cleaning station E. Although a preponderance of the toner particles are transferred to support material **34**, residual toner particles remain on photoconductive surface **12** after the transfer of the powder image therefrom and the detection of the remaining toner particles thereon by regulating apparatus **44**. The residual toner particles are removed from photoconductive surface **12** as it passes through cleaning station E. Here, the residual toner particles are first brought under the influence of a cleaning corona generating device (not shown) adapted to neutralize the electrostatic charge remaining on photoconductive surface **12** and the residual toner particles. The neutralized toner particles are then cleaned from photoconductive surface **12** and transparent electrode assembly **46** by a rotatably mounted fibrous brush **54** in contact therewith. A suitable brush cleaning device is described in U.S. Pat. No. 3,590,412 issued to Gerbasi in 1971. Rotatably mounted brush **54** is positioned at cleaning station E and maintained in contact with photoconductive surface **12** and transparent electrode **46**. In this manner, residual toner particles remaining on photoconductive surface **12** and transparent electrode **46** are readily removed therefrom.

It is believed that the foregoing description is sufficient for purposes of the present application to depict the operation of the multi-color electrophotographic printing machine and the regulating apparatus incorporated therein.

Referring now to the specific subject matter of the present invention, FIG. 2 depicts drum **10** with transparent electrode assembly **46** mounted thereon. Electrode assembly **46** is located in a non-image portion of photoconductive surface **12**. As electrode assembly **46** passes through the development zone, the conductive surface thereof is biased with an electrical potential simulating the electrostatic latent image on photoconductive surface **12** of drum **10**. Preferably, the electrode is biased to about 200 volts above developer bias, normal developer bias being about 500 volts. However, the electrode may be biased from about 100 volts to about 600 volts above the developer bias. The density of toner particles on transparent electrode assembly **46** after the transfer process is sensed by photosensor **50**. The output signal from photosensor **50** is processed by suitable logic elements **52** and, depending upon the density of the toner particles remaining on electrode assembly **46**, the electrical excitation of voltage source **42** may be suitably adjusted. Photosensor **50** is mounted exterior to photoconductive surface **12** of drum **10** and positioned to sense the intensity of light rays passing through transparent electrode **46** just prior to the cleaning of photoconductive surface **12**, i.e. before drum **10** is rotated to cleaning station E since electrode assembly **46** undergoes a regular photoconductive drum cleaning process. Light source **48** may be inside drum **10**, or as shown in FIG. 2, external to drum **10** with the light rays conducted therein by means of fiber optics **56**. Shaft **58**, supporting drum **10**, is a tubular member and permits fiber optics **52** to pass through the hollow central core thereof and out therefrom to photoconductive surface **12** to direct light rays from light source **48** to transparent electrode assembly **46**.

In order to apply the appropriate voltage corresponding to the electrostatic latent image recorded on photoconductive surface **12** of drum **10**, transparent electrode assembly **46** must be biased to a suitable voltage level. This is achieved, preferably, by mounting a commutator assembly, indicated generally at **60**, in the region of the end bell of drum **10**. A suitable slip ring assembly may be used in lieu of commutator assembly **60**. Timing for the application of the bias voltage to electrode assembly **46** may be controlled by suitable electronic switching or by the use of a split commutator ring, i.e. the electrode being biased over one portion of

the commutator and not over the remaining portion. The bias voltage is removed from transparent electrode assembly **46** during the cleaning process. In lieu of applying a bias voltage to transparent electrode assembly **46,** a suitable bias may be applied thereto by electrical charging.

Light source **48** is preferably a derated tungsten lamp with a regulated voltage, e.g. a 7 volt tungsten filament lamp operating from a 5 volt source.

Photosensor **50** is a commercially available silicon phototransistor such as is produced by the General Electric Company, Model No. L14B. Preferably, photosensor **50** is maintained in a controlled thermal environment to minimize the effects of its temperature sensitivity. Oven **62** maintains the thermal environment at 50° ± 1° C, or at any other appropriate temperature suitable for photosensor **50.** Fiber optics **64** transmits the light rays transmitted from light source **48** to transparent electrode assembly **46.** The light rays are transmitted through transparent electrode assembly **46** and the intensity thereof is measured by photosensor **50.** Preferably, glass fiber optics are used to obtain good transmittance. Glass fiber optics do not attenuate the radiant energy in the most sensitive region of the silicon phototransistor which is the preferred photosensor. As shown in FIG. **2,** fiber optics **50** extends from light source **48** through the core of drum shaft **58** to a suitable fiber optic connector **66** and fiber optic light pipe **64** extends radially outwardly therefrom to photoconductive surface **12,** where it is secured to transparent electrode assembly **46.** In this manner, light rays are transmitted from light source **48** to transparent electrode assembly **46.**

Logic element **52** processes the electrical output signal from photosensor **50.** The logic elements, preferably include a suitable discriminator circuit for comparing a reference with the electrical output signal from photosensor **50.** The discriminating circuit may utilize a silicon control switch which turns and effectively locks in after an electrical output signal has been obtained having a magnitude greater than the reference level, i.e. set point. The signal from the discriminator circuit adjusts the electrical voltage level being generated by voltage source **42.** Duplicate logic elements may be utilized for each transfer process step, i.e. a yellow transfer process step, a cyan transfer process step and a magenta process step. Hence, there may be three separate independent logic channels, each channel being adapted to adjust voltage source **42** for the toner powder image being transferred. The light rays transmitted through transparent electrode assembly **46** are conducted by fiber optics light pipe **67** to photosensor **50.** Fiber optic light pipe **67** is mounted in plenum chamber **68** which is adapted to move air in the direction of arrow **70** to prevent the accumulation of dirt particles on the surface of fiber optic light pipe **67.** The detailed structural arrangement of the regulating apparatus is disclosed in U.S. Pat. No. 3,754,821 issued to Whited in 1973, the disclosure of which is hereby incorporated into the present application.

Referring now to FIG. **2,** the electrical transfer means including corona generating means **36** and transfer drum **38** is described herein in detail. Transfer drum **38** includes an aluminum tube **72,** preferably, having about a one-fourth inch thick layer of urethane **74** cast thereabout. A polyurethane coating **74,** preferably of about 1 mil thick is sprayed over the layer of cast urethane **74.** Preferably, transfer drum **38** has a durometer hardness ranging from about **10** units to about **30** units on the Shore A scale. The resistivity of transfer drum **38,** preferably, ranges from about 10^8 to about 10^{11} ohm-cms. Voltage source **42** applies a direct current bias voltage to aluminum tube **72** via suitable means such as a carbon brush and brass ring assembly (not shown). The transfer voltage may range from about 1,500 to about 4,500 volts. This voltage is suitably adjusted depending upon the density of toner particles remaining on transparent electrode assembly **46** of regulating apparatus **44** after the transfer step. This density is detected by regulating apparatus **44,** which, in turn, adjusts the voltage exciting transfer drum **38.** Transfer drum **38** is substantially the same diameter as drum **10** and is driven at substantially the same speed. Contact between photoconductive surface **12** of drum **10** and transfer drum **38** with support material **34** interposed therebetween is, preferably, limited to a maximum of about 1 pound linear force. A synchronous speed main drive motor rotates transfer drum **38.** This drive is coupled directly to transfer drum **38** by flexible metal bellows **78** which permits the lowering and raising of transfer drum **38.** Synchronization of transfer drum **38** and drum **10** is accomplished by precision gears (not shown) coupling the main drive motor to both transfer drum **38** and drum **10.**

Turning now to FIG. **4,** corona generator **36** is shown therein in detail. Corona generator **36** includes an elongated shield **80** preferably made from a conductive material such as an aluminum extrusion. Elongated shield **80** is substantially U-shaped and may be grounded or, in lieu thereof, biased to a suitable electrical voltage level. A discharge electrode **82** is mounted in the chamber defined by U-shaped shield **80.** Discharge electrode **82** is, preferably, a coronode wire approximately 0.0035 inches in diameter and extends longitudinally along the length of shield **80.** Coronode wire **82** is made preferably from platinum. Coronode wire **82** is excited to produce a flow of ions therefrom. The ion flow is adapted to pre-condition the toner particles deposited on the electrostatic latent image of photoconductive surface **12.** In this way, the efficiency of attracting the toner powder image from the electrostatic latent image recorded on photoconductive surface **12** to support material **34** secured to transfer drum **38** is enhanced. Preferably, coronode wire **82** is excited at about 110 micro-amperes and at about 4,400 volts rms, the range being from about 80 micro-amperes at about 3,000 volts rms to about 200 micro-amperes at about 5,000 volts rms. The alternating current output from coronode wire **82** to photoconductive surface **12** with the toner powder image thereon ranges from about 3.0 to about 5.0 micro-amperes and is preferably about 4.0 micro-amperes. The detailed structural configuration of transfer drum **38** and corona generating device **36** is more fully described in co-pending application Ser. No. 335,968, filed in 1973, the disclosure of which is hereby incorporated into the present application.

In recapitulation, the regulating apparatus of the present invention improves transfer of a toner powder image from a photoconductive surface to a sheet of support material. This is achieved by detecting a sample density of toner particles corresponding to the untransferred toner particles remaining on the photoconductive surface. An electrical output signal is developed corresponding to the sample density of toner par-

ticles, this electrical signal being compared to a reference to develop an error signal. The error signal controls the voltage source exciting the transfer drum which electrostatically attracts toner particles from the photoconductive surface to the sheet of support material. In this manner, the regulating apparatus insures that the transfer of the toner powder image from the photoconductive surface to the sheet of support material 34 is substantially optimized, thereby minimizing the formation of hollow characters and providing a substantially uniform high quality color image on the sheet of support material.

It is, therefore, apparent that there has been provided, in accordance with the present invention, an apparatus for regulating the transfer system of an electrophotographic printing machine that fully satisfies the objects, aims and advantages set forth above. While this invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

What is claimed is:

1. Apparatus for regulating a system adapted to transfer charged particles from a support surface to a sheet of support material, including:

electrical transfer means cooperating with the support surface to attract the charged particles from the support surface to the sheet of support material;

means for detecting sample charged particles corresponding to the charged particles remaining on the support surface after said transfer means has attracted the charged particles from the support surface to the sheet of support material; and

means, responsive to said detecting means, for variably exciting said transfer means to adjust the electrical attractive force between said transfer means and the support surface.

2. An apparatus as recited in claim 1, wherein said detecting means includes:

transparent electrode means electricaly biased to attract the charged particles thereto, said transparent electrode means being mounted on the support surface;

means for illuminating said electrode means after said transfer means attracts the charged particles therefrom to the sheet of support material; and

means for sensing the intensity of light rays transmitted through said electrode means to produce an electrical output signal indicative of the density of charged particles remaining on said electrode means.

3. An apparatus as recited in claim 2, wherein said detecting means further includes means for comparing the electrical output signal with an adjustable reference to produce a control signal corresponding to the deviation between the actual density of charged particles remaining on said electrode means and the desired density thereof.

4. An apparatus as recited in claim 3, wherein said detecting means further includes means for adjusting the reference to achieve the desired level of charged particles remaining on said electrode means.

5. An apparatus as recited in claim 4, wherein said illuminating means includes a light source.

6. An apparatus as recited in claim 5, wherein said sensing means includes a photosensor positioned in a light receiving relation with the light rays transmitted through said electrode means.

7. An apparatus as recited in claim 6, wherein said transfer means includes:

a cylindrical core of electrical conductive material; and

a plurality of resilient layers entrained about said cylindrical core with at least one of the layers in contact therewith and the sheet of support material being secured releasably to the outermost resilient layer.

8. An apparatus as recited in claim 7, wherein said transfer means includes corona generating means disposed adjacent the support surface for applying an alternating charged potential to the support surface preconditioning the charged particles thereon to readily facilitate the transfer therefrom.

9. An electrostatographic printing machine of the type wherein toner particles are transferred to a sheet of support material forming thereon a copy of an original document being reproduced, including:

an image bearing member having toner particles deposited thereon;

electrical transfer means cooperating with said image bearing means to attract the toner particles from said image bearing member to the sheet of support material;

means for detecting sample toner particles corresponding to the toner particles remaining on said image bearing member after said transfer means has attracted the toner particles from said image bearing member to the sheet of support material; and

means, responsive to said detecting means, for variably exciting said transfer means to adjust the electrical attractive force between said transfer means and said image bearing member.

10. A printing machine as recited in claim 9, wherein said detecting means includes:

transparent electrode means electrically biased to attract toner particles thereto, said transparent electrode means being mounted on said image bearing member;

means for illuminating said electrode means after said transfer means attracts the toner particles therefrom to the sheet of support material; and

means for sensing the intensity of light rays transmitted through said electrode means to produce an electrical output signal indicative of the density of toner particles remaining on said electrode means.

11. A printing machine as recited in claim 10, wherein said detecting means further includes means for comparing the electrical output signal with an adjustable reference to produce a control signal corresponding to the deviation between the actual density of toner particles remaining on said electrode means and the desired density thereof.

12. A printing machine as recited in claim 11, wherein said detecting means further includes means for adjusting the reference to achieve the desired level of toner particles remaining on said electrode means.

13. A printing machine as recited in claim 12, wherein said illuminating means includes a light source.

14. A printing machine as recited in claim 13, wherein said sensing means includes a photosensor positioned in light receiving relation with the light rays transmitted through said electrode means.

15. A printing machine as recited in claim 14, wherein said transfer means includes:

a cylindrical core of electrically conductive material; and

a plurality of resilient layers entrained about said cylindrical core with at least one layer in contact therewith and the sheet of support material being secured releasably to the outermost resilient layer.

16. A printing machine as recited in claim 15, wherein said transfer means includes corona generating means disposed adjacent said image bearing member for applying an alternating charged potential to said image bearing member pre-conditioning the toner particles thereon to readily facilitate the transfer therefrom.

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