United States Patent [19]

Wilson

[11] **3,866,564**

[45] **Feb. 18, 1975**

[54] **MAGNETIC BRUSH DEVELOPING APPARATUS FOR COPIERS**

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[22] Filed: **Apr. 25, 1973**

[21] Appl. No.: **354,416**

[52] **U.S. Cl.** **118/10,** 117/17.5, 118/11, 118/637, 118/4

[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** 118/7, 9, 10, 11, 637; 117/17.5

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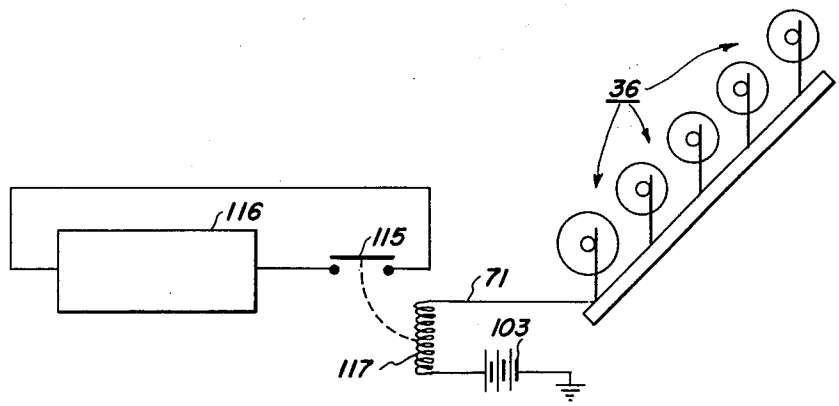
Assistant Examiner—Leo Millstein

[57] **ABSTRACT**

An electrostatic type copier or reproduction machine having one or more magnetic brush devices for developing the latent electrostatic images formed on the copier photoconductive member, such magnetic brush devices ordinarily having a biasing voltage impressed thereon. To enable shorting of the magnetic brush or brushes to be detected, and, where desired, the shorted brush of a multiple brush system to be identified, a short responsive circuit is provided adapted when shorting is detected to actuate a predetermined control. The aforesaid control may comprise an operator signal lamp or a device to shutdown the copier.

7 Claims, 7 Drawing Figures



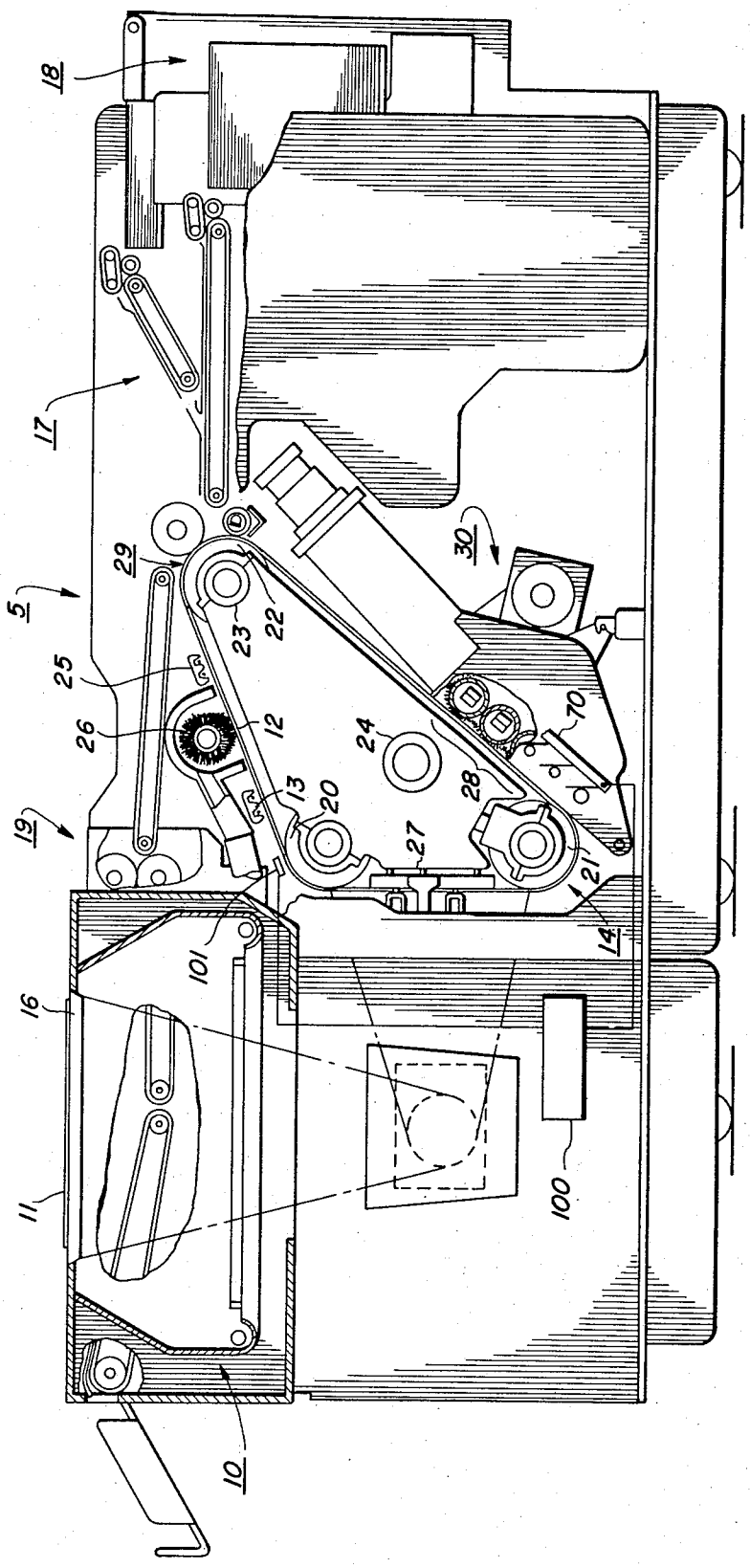


FIG. 1

FIG. 3

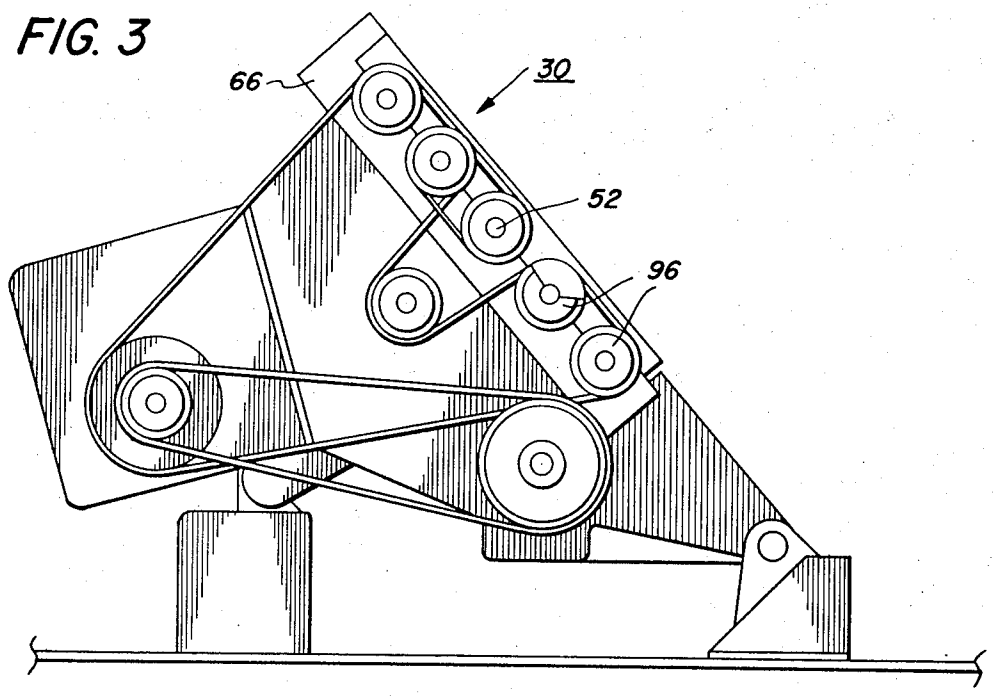


FIG. 2

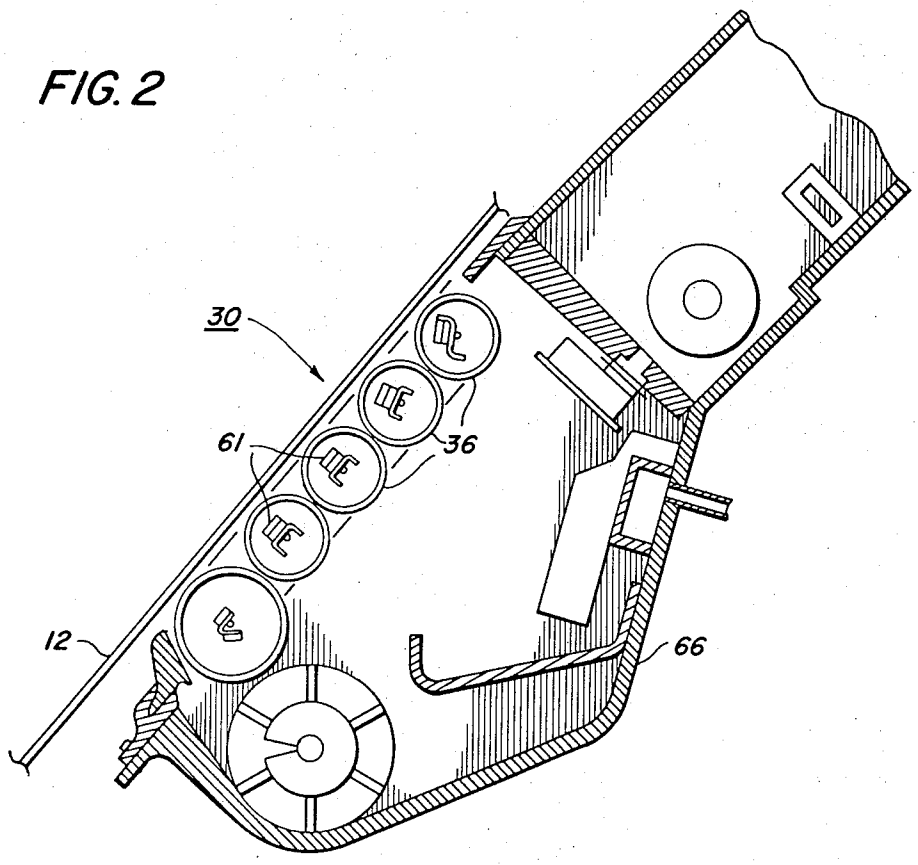
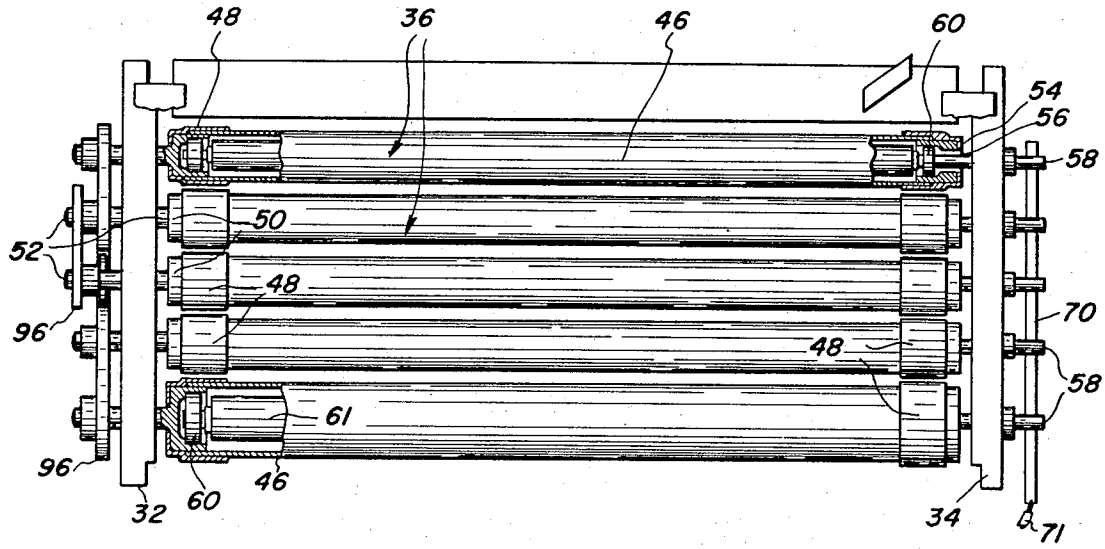


FIG. 4



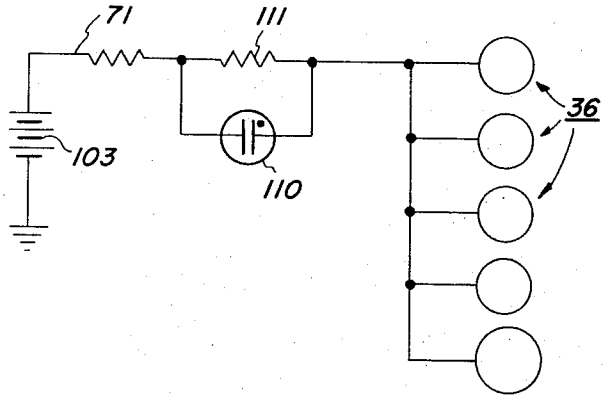


FIG. 5

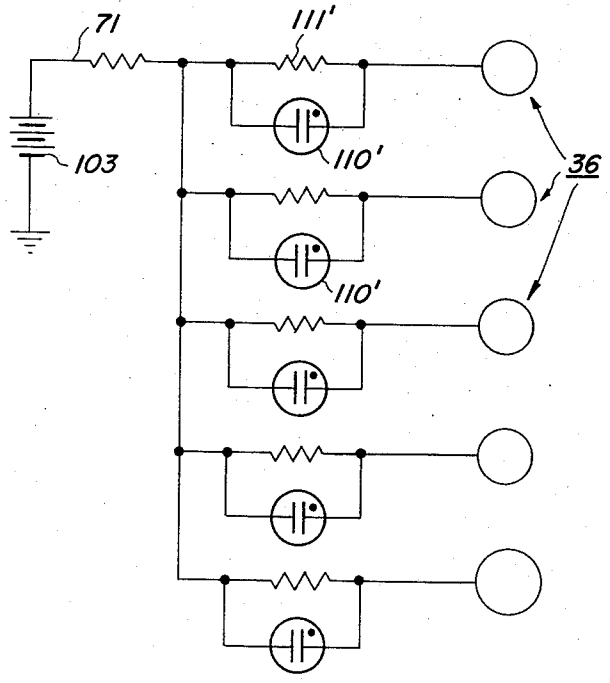


FIG. 6

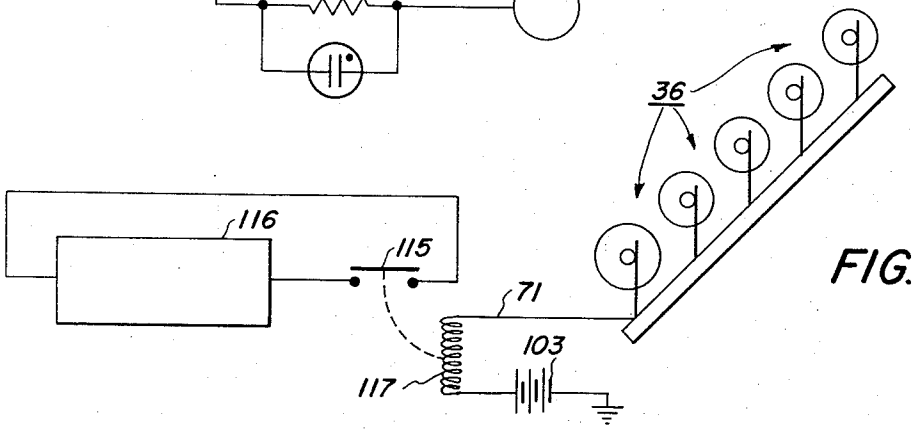


FIG. 7

MAGNETIC BRUSH DEVELOPING APPARATUS FOR COPIERS

This invention relates to a magnetic brush developing system for reproduction machines, and more particularly, to an improved magnetic brush developing system having means for detecting shorting of the system magnetic brush or brushes.

As will be understood by those familiar with electrostatic type reproduction and copier machines, the efficacy of such copiers depends in large measure upon the proper relative charge, i.e. the electrostatic development field, being maintained between the copier photoconductive member and the image developing materia. For, as appreciated, this electrostatic development field is relied upon to attract the ink portion of the developing material, i.e. the toner, to the photoconductive member in conformance with both the outline and density of the electrostatic latent image on the photoconductive member. It will be understood that the electrostatic image was previously formed through exposure of the charged photoconductive member to a light image of the original being copied.

Many copiers employ one or more magnetic brushes to bring the developing material into operative relationship with the photoconductive member. In effectuating this, the magnetic field generated by the brush or brushes serves initially to attract and hold the developing material on the periphery thereof and thereafter, due to the charge relationship between brush and photoconductive member, to release toner attracted to the photoconductive member in conformance with the latent electrostatic image. In this context, the developing material is composed of carrier particles or beads and toner, the toner particles, due to the triboelectric relationship between the carrier and toner materials, being normally attracted to the carrier. It is this carrier bearing toner that is brought by the developing mechanism, i.e. the aforesaid magnetic brushes, into juxtaposition with the photoconductive member to allow the electrostatic charges on the photoconductive member to draw the toner from the carrier beads and onto the photoconductive member in conformance with the latent electrostatic image thereon.

While the aforesaid carrier may comprise various materials and material compositions, in the case of magnetic developing systems, the carrier material must have magnetic properties in order for the magnetic brush or brushes to operate. However, this may give rise to a shorting problem since the magnetic carrier beads, which are normally a ferrite material, can, should they jam or conglomerate between a magnetic brush and the developing material housing, which is normally grounded, short the brush. This condition, which alters the operating bias on the magnetic brush or brushes affected, impairs or destroys developing efficacy.

It is a principal object of the present invention to provide a new and improved magnetic developing system for electrostatic type reproduction machines.

It is an object of the present invention to provide an electrostatic copier with magnetic brush type developer incorporating means to detect faulty operation of the magnetic brushes.

It is a further object of the present invention to provide a magnetic brush type developing apparatus for reproduction machines having means to signal the presence of a short circuit in the magnetic brush developing apparatus.

It is an object of the present invention to provide an improved electrostatic copier having a multiple magnetic brush developer system incorporating means to identify a shorted brush.

It is another object of the present invention to provide an improved reproduction machine with magnetic brush developer having means responsive to a short in the developer to shut down the reproduction machine.

This invention relates to a reproduction machine for producing copies of originals, comprising, in combination, a photoconductive member adapted to be electrostatically charged to permit latent electrostatic images of an original being reproduced to be formed thereon during the reproduction process; developer means to bring developer material into operative relationship with the photoconductive member to develop the latent electrostatic image on the photoconductive member in preparation for transfer thereof to a support material, the developer means including at least one magnetic brush; means to provide a biasing voltage to the magnetic brush; and means adapted on shorting of the magnetic brush to generate a predetermined signal.

Other objects and advantages of the present invention will be apparent from the ensuing description and drawings in which:

FIG. **1** is a schematic sectional view of an electrostatic type reproduction machine incorporating the magnetic brush developing apparatus of the present invention;

FIG. **2** is a side view of the magnetic brush developing apparatus shown in FIG. **1**;

FIG. **3** is an elevational view of the opposite side of the magnetic brush developing apparatus shown in FIG. **2** illustrating the brush drives;

FIG. **4** is a top plan view of the magnetic brush developing apparatus showing details of the brush biasing means;

FIG. **5** is a first circuit embodiment illustrating the magnetic brush short detecting circuit of the present invention;

FIG. **6** is a second circuit embodiment illustrating a magnetic brush short detecting circuit effective to pinpoint the specific brush shorted; and

FIG. **7** is a third circuit embodiment illustrating a magnetic brush short detecting circuit adapted to shut down the reproduction machine in the event shorting of a magnetic brush occurs.

For a general understanding of the illustrated copier/reproduction machine in which the invention may be incorporated, reference is had to FIG. **1** in which the various system components for the machine are schematically illustrated.

A document **11** to be copied is placed upon a transparent support platen **16** fixedly arranged in an illumination assembly, generally indicated by the reference numeral **10**, positioned at the left end of the machine. Light rays from an illumination system are flashed upon the document to produce image rays corresponding to the informational areas. The image rays are projected by means of an optical system onto the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt **12** arranged on a belt assembly, generally indicated by the reference numeral **14**.

The belt **12** comprises a photoconductive layer of selenium which is the light receiving surface and imaging

medium for the apparatus, on a conductive backing. The surface of the photoconductive belt is made photosensitive by a previous step of uniformly charging the same by means of a corona generating device or corotron **13.** Power for corotron **13** is provided by a suitable power source.

The belt is journaled for continuous movement upon three rollers **20, 21** and **22** positioned with their axes in parallel. The photoconductive belt assembly **14** is slidably mounted upon two support shafts **23** and **24,** with the roller **22** rotatably supported on the shaft **23** which is secured to the frame of the apparatus and is rotatably driven by a suitable motor and drive assembly (not shown) in the direction of the arrow at a constant rate. During exposure of the belt **12,** the reflected light image of such original document positioned on the platen is flashed on the surface of the belt to produce an electrostatic latent image thereon at exposure station **27.**

As the belt surface continues its movement, the electrostatic image passes through a developing station **28** in which there is positioned a magnetic brush developing apparatus, generally indicated by the reference numeral **30,** and which provides development of the electrostatic image by means of multiple brushes as the same moves through the development zone, as more fully hereinafter described.

The developed electrostatic image is transported by the belt to a transfer station **29** whereat a sheet of copy paper or transfer member is moved between a transfer roller and the belt at a speed in synchronism with the moving belt in order to accomplish transfer of the developed image solely by an electrical bias on the transfer roller. There is provided at this station a sheet transport mechanism, generally indicated at **17,** adapted to transport sheets of paper from a paper handling mechanism, generally indicated by the reference numeral **18,** to the developed image on the belt at the station **29.**

After the sheet is stripped from belt **12,** it is conveyed into a fuser assembly, generally indicated by the reference numeral **19,** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus. The toner particles remaining as residue on the developed image, background particles and those particles otherwise not transferred are carried by the belt **12** to a cleaning apparatus **26** positioned on the rim of the belt between rollers **20** and **22** adjacent a pre-clean corona generator **25.** Further details regarding the structure of the belt assembly **14** and its relationship with the machine and support therefor may be found in the copending Application Serial No. **102,312,** assigned to the same assignee.

Referring to FIGS. **2** through **4,** there is illustrated a magnetic brush developing assembly, generally indicated as **30,** comprising a series of rollers **36** rotatably supported in frame end plates **32, 34.** The rollers **36** are comprised of a cylindrical sleeve **46** of a roughened surface formed of a non-permeable material and extending almost the length of the housing of the developing apparatus **30.** End sleeves **48,** formed of an insulating material, are shrunk fit on each cylindrical sleeve **46** adjacent the ends thereof. One end of the sleeve **46** is closed by a cap **50** which supports a roller drive shaft **52** in coaxial alignment with the sleeve **46.** The other end of the sleeve **46** is closed by a cap **54** having an orifice **56** through which extends shaft **58** of the internal bar magnets **61.** Suitable bearing means **60** are provided to permit the sleeve **46** to rotate relative to shaft **58.**

The roller drive shafts **52** are suitably mounted in bearings in end plate **32** and carry on their projecting ends drive sprockets **96.** Sprockets **96** are formed of an insulating material.

Referring specifically to FIGS. **2** and **3,** the magnet roller assembly **30** is disposed within a housing, generally indicated as **66,** having a generally rectangular cross section and a length extending beyond the width of the photoconductive belt **12.** Housing **66** is substantially closed except for an opening opposite photoconductive belt **12** whereat development of the latent image on belt **12** is effected. Housing **66** in effect serves as a container for developing material comprising carrier beads from magnetizable material and colored electrostatic toner particles which adhere thereto.

To provide bias potential to rollers **36,** a suitable wiper **70** is provided in electrical contact with magnet shafts **58,** wiper **70** extending along and being supported by side plate **34** to form an electrical path from a suitable power supply, shown schematically by battery **103,** to each of the rollers **36.** As will appear, in the FIG. **5** circuit embodiment the brush short detecting circuit is in series with the voltage line **71** while in the FIG. **6** circuit embodiment brush short detecting circuits are provided in the biasing circuits to individual magnetic brush rollers.

During development, the rollers **36** are rotated in unison in the same direction from a suitable drive source via sprockets **96,** the internal bar magnets **61** remaining stationary. The brush bristles produced by the influence of the magnetic field emanating from the bar magnets **61** acting upon the magnetizable carrier beads in the developing material will form on the upper region of the sleeve **46** between the rollers **36** and the surface of the selenium belt **12.**

This takes the form of a "magnetic blanket" extending continuously over all of the brushes of rollers **36** for the entire width of the development zone **28** wherein the material is disposed or available to some degree for developing purposes. Further details regarding the formation and effect of the "magnetic blanket" are described in the copending application Ser. No. 330,285, assigned to the same assignee.

Rollers **36** are biased to a predetermined voltage by battery **103,** it being understood that the bias applied to magnetic brush rollers **36** cooperates with the electrostatic charge on belt **12** to establish an electrostatic development field in the developing area **28.** The aforesaid electrostatic development field serves to attract toner particles to photoconductor belt **12** in conformance with the latent electrostatic image on belt **12.** As will be understood by those skilled in the art, the aforesaid electrostatic development field is essential if the latent images on belt **12** are to be developed, and must be exactly controlled if optimum development of the latent image on belt **12** is to be attained. Accordingly, any uncontrolled change in the aforesaid electrostatic development field, such as occurs on shorting of one or more of the magnetic brush rollers **36,** may degrade the image developed to a point where it is less than satisfactory.

The developing material normally comprises a carrier, usually small metal beads, and toner or ink particles. The carrier beads and toner are chosen for their triboelectric relationship.

The metal carrier beads may bear a coating of a suitable release material, and this type of bead, so long as the coating is perfect and remains intact and not worn off, is insulated. Other developing materials use uncoated metal beads. Should carrier beads of this type jam or compress together between a magnetic brush roller **36** and the housing **66,** a current or ground path is formed, shorting the brush and changing the brush magnetic force. In addition, metal contaminants may be present in the developing material and this may short out one or more of the magnetic brush rollers **36.**

Referring particularly to the circuit of FIG. **5,** line **71** series connects magnetic brush rollers **36** with one another and with battery **103.** A suitable indicator, which may comprise neon type lamp **110,** is disposed in series with line **71.** A suitable resistor **111** is provided in parallel with lamp **110.** In this embodiment, a ground short in one or more of the magnetic brush rollers **36** increases the current flow through resistor **111** thereby generating sufficient voltage to cause lamp **110** to light. Preferably, lamp **110** is placed where it can be conveniently observed by the operator.

In the circuit embodiment of FIG. **6,** a lamp **110'** is series connected in the biasing circuit to each of the individual magnetic brush rollers **36.** A resistor **111'** parallels each lamp **110'.**

On a short in one of the brush rollers **36,** the lamp **110'** associated therewith lights. By this arrangement, the operator is able to specifically identify the particular magnetic brush roller **36** shorted. Preferably, lamps **110'** are disposed where they may be conveniently seen by the operator.

Instead of visually identifying or signalling the presence of a short in one of the magnetic brush rollers **36,** or as an adjunct thereto, direct control may be exercised over operation of copier **10.** In the schematic circuit representation of FIG. **7** a normally closed control switch **115** is provided in the control circuit **116** of copier **10.** A suitable current sensitive switch relay **117** is arranged in series relationship with the bias line **71** to the magnetic brush rollers **36.**

In the event of a short in any one of the magnetic brush rollers **36,** the change in current through relay **117** energizes relay **117** to open switch **115** and actuate copier shutdown circuit **116.** Circuit **116** stops copier **10,** normally through a cycle out process. For this purpose suitable lock-out means (not shown) may be provided to inhibit restarting of copier **10** until the short condition has been corrected.

Other circuit arrangements for effectuating shutdown of the copier in the event of a short in one or more of the magnetic brush rollers **36** may be contemplated.

While the invention has been described with reference to the structure disclosed, it is not confined to the details set forth, but is intended to cover such modifications or changes as may come within the scope of the following claims.

What is claimed is:

1. In a reproduction machine for producing copies of originals having a photoconductive member on which latent electrostatic images of the original being reproduced are formed, with means for developing said latent electrostatic images in preparation for transfer thereof to support material, said developing means including at least one magnetic brush, together with biasing means to provide a biasing voltage on said magnetic brush, the improvement comprising:

signal indicator means;

energizing means for energizing said signal indicator means to produce a signal; and

brush short responsive means responsive to shorting of said magnetic brush to actuate said energizing means whereby to produce said signal.

2. The reproduction machine according to claim **1** in which said signal indicator means comprises a light.

3. The reproduction machine according to claim **1** in which said signal indicator means comprises means to shut down said reproduction machine on shorting of said magnetic brush.

4. The reproduction machine according to claim **1** in which said developing means includes at least two magnetic brushes, said signal indicator means comprising an indicator element for each of said brushes, said short responsive means responding to a short in one of said brushes to actuate said energizing means to energize the indicator element associated with said one brush.

5. As a control for visually indicating the presence of a short circuit in the magnetic brush developer section of an electrostatic type reproduction machine, said developer section having at least one magnetic developing brush, together with circuit means for imposing an operating bias on said brush, the combination comprising:

signal means in said circuit means in series relationship with said magnetic brush; and

means responsive to a predetermined change in current in said circuit means to actuate said signal means.

6. The control according to claim **5** in which said developer section includes plural magnetic brushes, said circuit means providing an individual bias circuit to each of said magnetic brushes, and

signal means in each of said magnetic brush circuits.

7. In a magnetic brush developing apparatus for reproduction machines, said developing apparatus including a housing within which developing material including bead-like particles of metallic carrier is provided, together with at least one roll-type magnetic brush disposed in operative relationship with said developing material, said magnetic brush being biased whereby to magnetically generate on the surface thereof a blanket-like covering of said developing material for use in developing latent electrostatic images, the combination of:

signal producing means;

energizing means for energizing said signal producing means to produce a signal; and

means responsive to grounding of said magnetic brush through said developing material carrier to actuate said energizing means whereby said signal producing means is energized and a signal reflecting grounding of said brush is produced.

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