United States Patent [19]

Hoffman et al.

[11] **3,901,186**

[45] **Aug. 26, 1975**

[54] **TRANSFER ROLLER ASSEMBLY**

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[73] Assignee: **Xerox Corporation**, Stamford, Conn.

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[52] **U.S. Cl.** **118/637**; 117/17.5

[51] **Int. Cl.**[2] **G03G 15/16**

[58] **Field of Search** 118/637; 117/17.5

[56] **References Cited**

UNITED STATES PATENTS

3,071,070	1/1963	Matthews et al.	118/637
3,072,026	1/1963	Mackrodt	118/637 X
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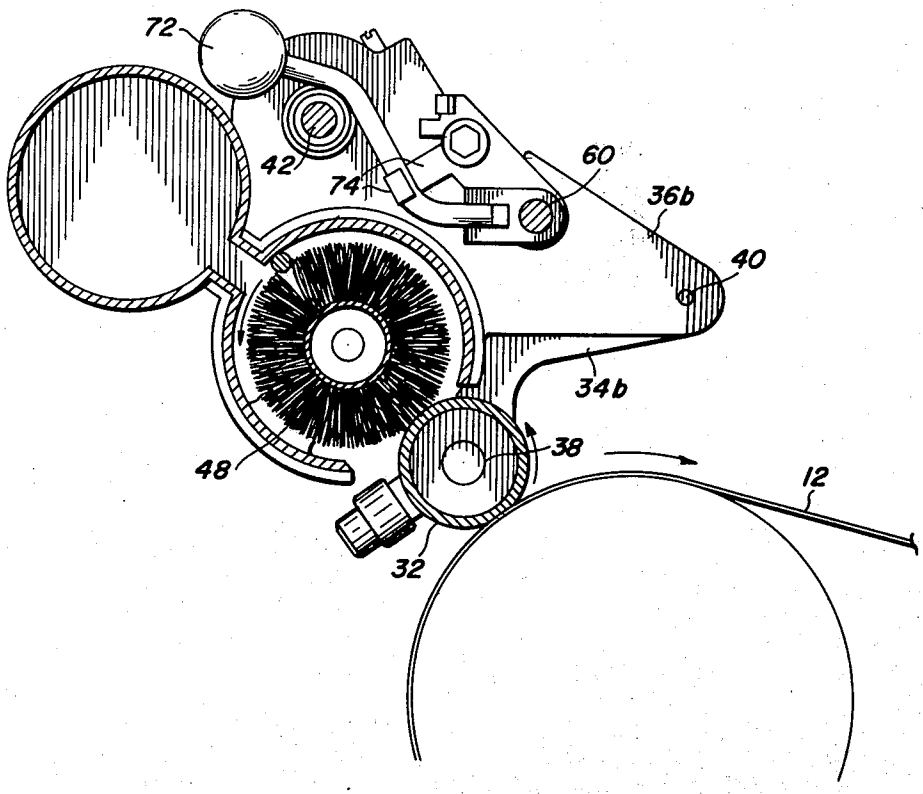
Assistant Examiner—Douglas Salser

[57] **ABSTRACT**

A transfer roller assembly having a transfer roller, is mounted adjacent a curved photoconductive surface of an electrostatographic machine so that the transfer roller is biased into contact with the surface with a minimal force sufficient only to maintain uniform contact therewith during machine operation; the roller is mounted so that it may move in a direction which is at least generally perpendicular to a tangent at the point of contact. The ratio of the radius of the photoconductive surface to that of the roller at the point of contact is not less than 3, and preferably in the range of 3 to 3.5.

2 Claims, 4 Drawing Figures



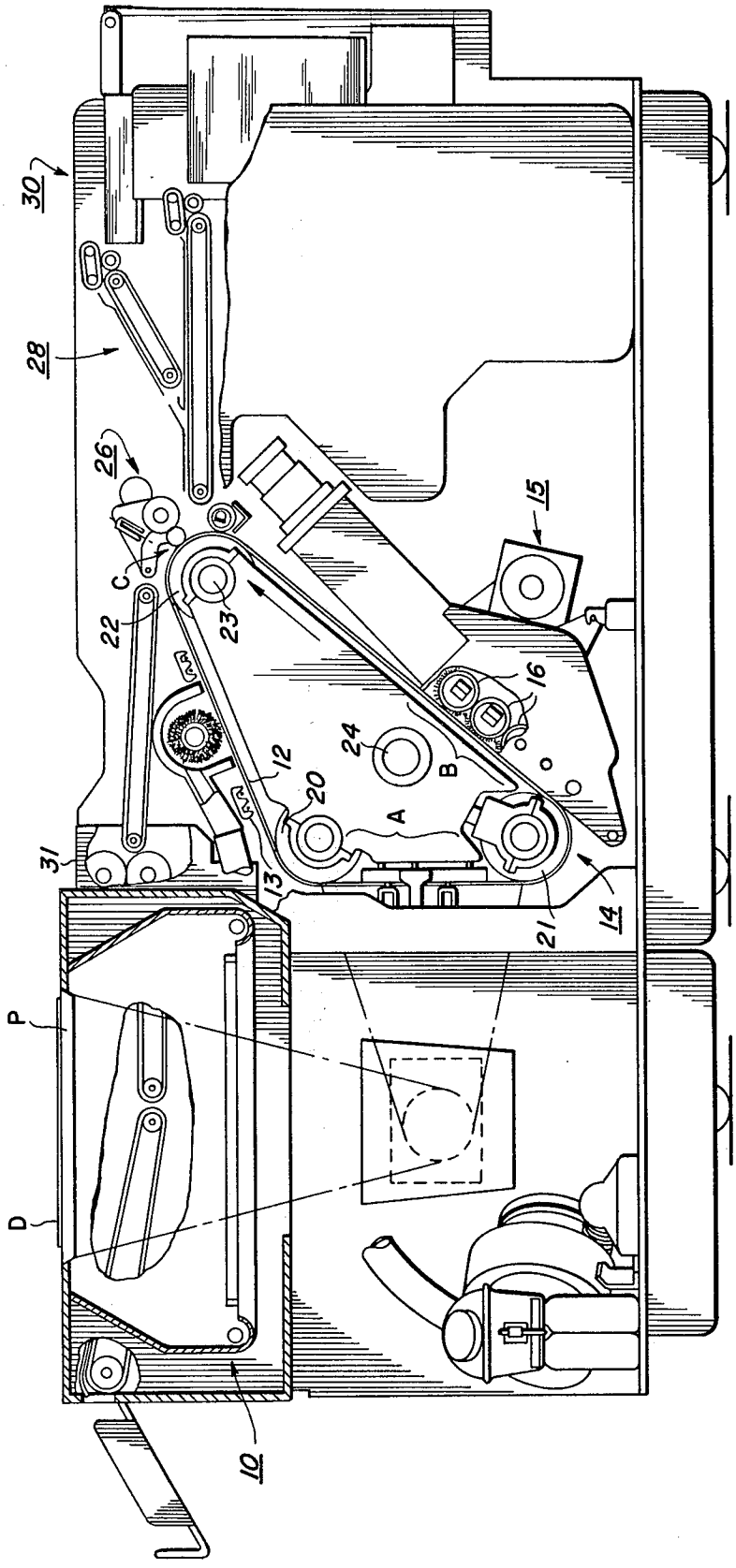


FIG. 1

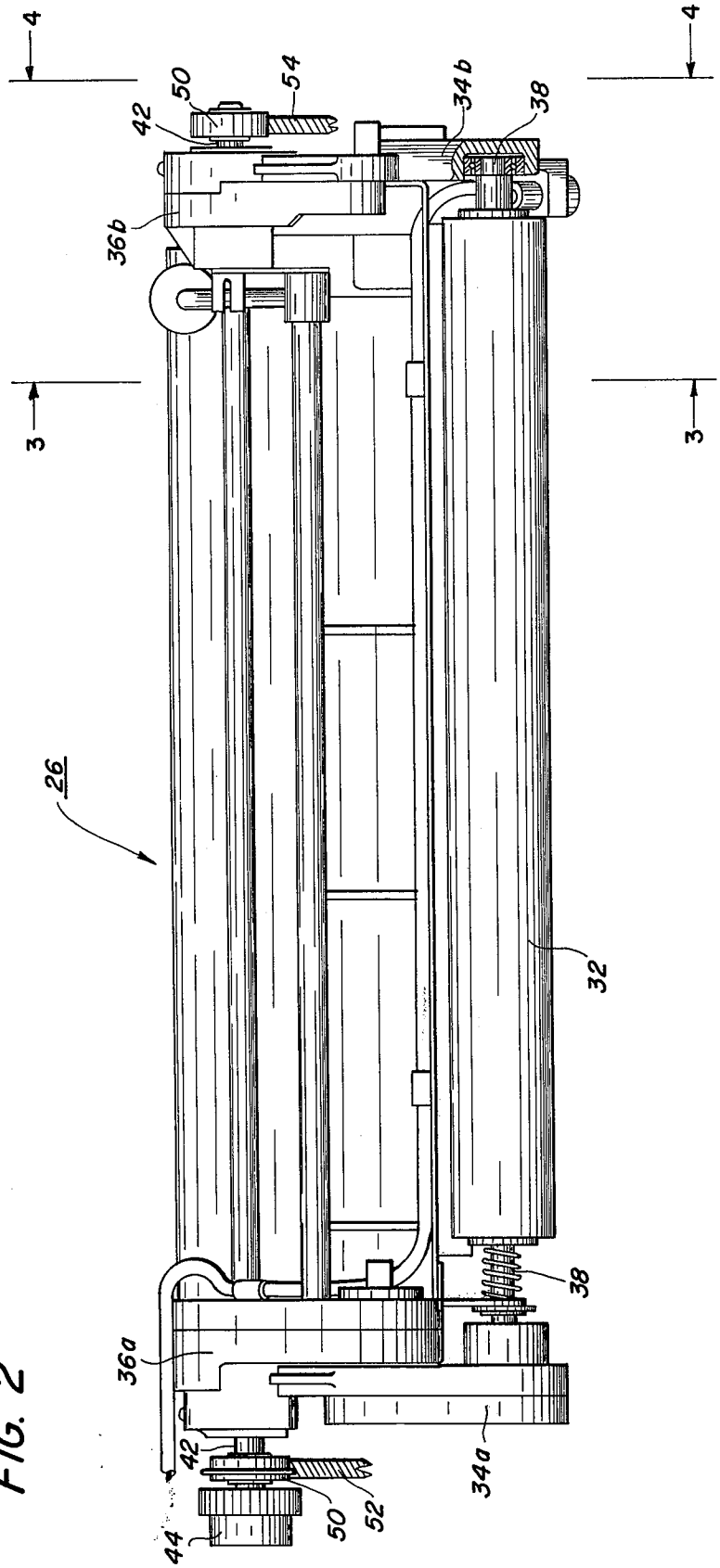


FIG. 2

FIG. 4

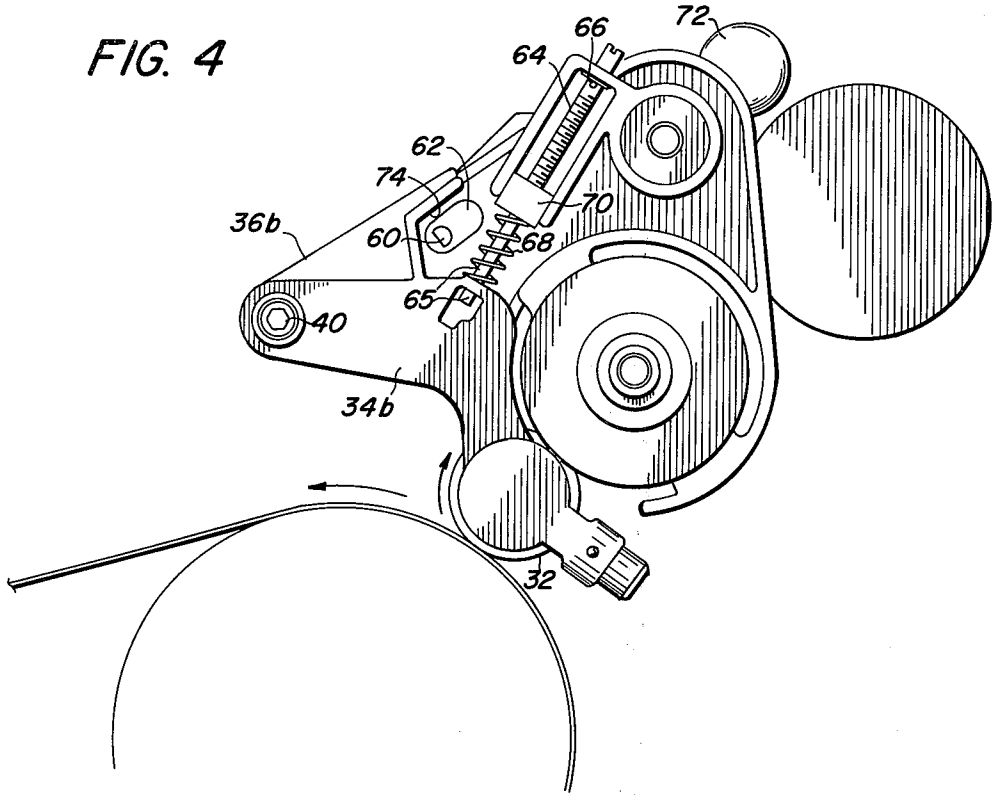
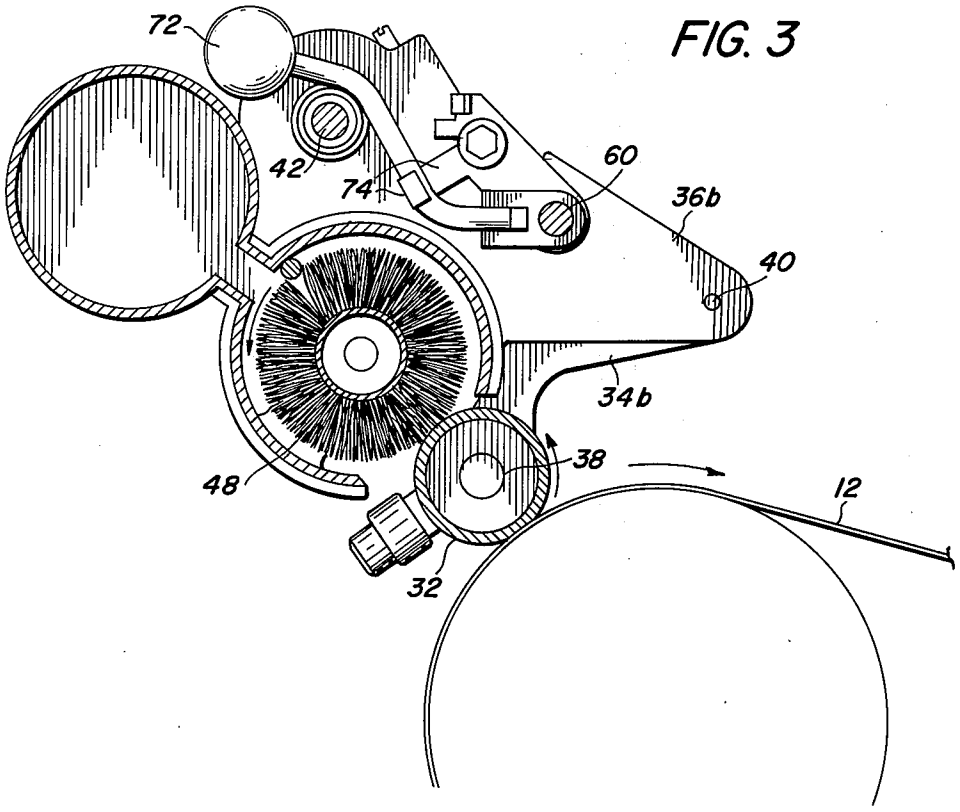

72
66
64
62
74
70
36b
60
68
65
40
34b
32

FIG. 3


72
42
74
60
36b
40
34b
38
48
12
32

TRANSFER ROLLER ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates generally to electrostatography, but more particularly to a novel transfer roller assembly for an electrostatographic machine.

In the practice of xerography as described in U.S. Pat. No. **2,297,691** to Chester F. Carlson, a xerographic surface comprising a layer of photoconductive insulating material affixed to a conductive backing is used to support electrostatic images. In the usual method of carrying out the process, the xerographic plate is electrostatically charged uniformly over its surface and then exposed to a light pattern of the image being reproduced to thereby discharge the charge in the areas where light strikes the layer. The undischarged areas of the layer thus form an electrostatic charge pattern in conformity with the configuration of the original light pattern.

The latent electrostatic image may then be developed by contacting it with a finely divided electrostatically attractable material, such as a resinous powder. The powder is held in the image areas by the electrostatic fields on the layer. Where the field is greatest, the greatest amount of material is deposited; and where the field is least, little or no material is deposited. Thus, a powder image is produced in conformity with the light image of the copy being reproduced. The powder is subsequently transferred to a sheet of paper or other transfer surface, and suitably affixed thereto to thereby form a permanent print.

The toner may be fixed to the paper by passing the latter between a heated roller and a second roller in pressure contact therewith, whereby the toner becomes fused to the sheet of paper.

The image is generally transferred to the image receiving member (e.g. paper) by passing such member between the photoconductive surface including the developed image and a transfer roller in contact therewith.

Roller electrode transfer systems employ DC electric fields to move charged particles such as xerographic toner from first to second supporting surfaces, e.g., from a photoconductive surface to a sheet of paper. The purpose of this is to exert an electrical force on the charged particles that moves them from the first to the second surface. Examples of bias roller transfer systems are described in U.S. Pat. Nos. **2,807,233; 2,068,555; 3,043,684; 3,267,840; 3,598,580; 3,625,146; 3,630,591; 3,691,993; 3,702,482;** and **3,684,364,** French Pat. No. **2,065,390,** German Application OLS **2,102,634** and British Pat. Nos. **2,310,666** and **1,302,922.**

Among the problems that arise in some bias transfer systems is one of the defects in copy quality, e.g., "hollow characters" which may result from a sheet of paper being subjected to an excessive pressure as it passes between the transfer roller and the photoconductive surface during the transfer step or process.

Another copy quality problem which sometimes arises in bias transfer systems relates to undesired nonuniform densities in the transferred image. This results from variations in pressure caused by excessive shift of the transfer nip during the transfer step.

Dimensional variations in the machine and/or the paper affect the dynamic stability of the machine during operation, which in turn affects the operation of the transfer system, thus often resulting in one or more of the above problems.

Also, there is occasionally a problem with the paper wrapping itself around the transfer roller during the transfer step or operation.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to optimize copy quality by providing a transfer roller assembly which minimizes or eliminates any detrimental shift of the transfer nip during machine operation, and wherein the transfer roller is biased toward the photoconductive surface with a minimal force sufficient only to maintain uniform contact with the surface and with the paper during machine operation.

It is also an object of the present invention to provide a transfer roller assembly which minimizes or eliminates wrapping of a support member (e.g., a sheet of paper) around the transfer roller during operation.

These and other objects are obtained by providing a transfer roller assembly which is supported within an electrostatographic machine adjacent a photoconductive surface. The transfer roller assembly is comprised of two rigid frame assemblies rotatably supporting spring loaded pivoting arms in which the transfer roller is journalled for rotation; this structure provides the pressure contact between the transfer roller and the photoconductive surface. The force biasing the transfer roller toward the photoconductive surface is that minimal force sufficient only to maintain uniform contact during operation of the machine. The transfer roller is mounted so that any shift of the transfer roll during operation of the machine is in a direction which is at least generally perpendicular to a tangent at the point of contact. To eliminate or minimize the problem of paper wrapping itself around the transfer roller, the ratio of the radius of the curved photoconductive surface to the radius of the transfer roller at the point of contact is not less than **3,** and preferably in the range of **3** to **3.5.** Electrically, for example, the transfer roller assembly of the present invention may operate as disclosed in U.S. patent application Ser. No. **309,562** filed on Nov. **24, 1972,** or in other suitable conventional manners.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the present invention as well as other objects and further features thereof will become apparent upon consideration of the following detailed disclosure thereof, especially when taken with the accompanying drawings wherein like numerals designate like parts throughout.

FIG. **1** is a schematic sectional view of an electrostatic reproduction machine embodying the principles of the present invention.

FIG. **2** is an elevational view of a transfer roller assembly embodying the principles of the present invention.

FIG. **3** is a sectional view of the transfer roller assembly of FIG. **2** taken along the line **3—3** of FIG. **2.**

FIG. **4** is a side view of the transfer roller assembly taken along the line **4—4** thereof of FIG. **2.**

DETAILED DESCRIPTION OF THE INVENTION

For a general understanding of the illustrated copier/reproduction machine in which the present invention may be incorporated, reference is had to FIG.

1 in which the various system components for the machine are schematically illustrated.

A document D to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly, indicated generally by the reference numeral **10** and 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 **13.**

The belt is journalled for continuous movement upon three rollers **20, 21,** and **22** positioned with their axes in parallel relationship. The photoconductive belt assembly **14** is slidably mounted upon two support shafts **23** and **24** secured to the frame of the apparatus with the roller **22** rotatably supported on the shaft **23,** 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 portion exposed is that portion of the belt running between rollers **20** and **21.** During such movement of the belt **12,** the reflected light images 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 A.

As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly, generally indicated by the reference numeral **15,** and which provides development of the electrostatic image by means of multiple brushes **16** as the same moves through the development zone.

The developed electrostatic image is transported by the belt to a transfer station C wherein the transfer roller assembly **26** of the present invention is positioned and where a sheet of copy paper is moved between the nip formed by the assembly **26** and the belt **12.** The paper is moved at a speed in synchronism with the moving belt, and the transfer of the developed image is accomplished solely by an electrical bias on the transfer roller. There is also provided at station C a sheet transport mechanism generally indicated at **28** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **30** to the developed image on the belt at the station C.

After the sheet is stripped from the belt **12,** it is conveyed into a fuser assembly, generally indicated by the reference numeral **31** 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.

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 Ser. No. **102,312** assigned to the same assignee.

Referring now to FIGs. **2, 3,** and **4,** the transfer roller assembly **26** is illustrated, the assembly being comprised of a transfer roller **32,** pivoting arms **34***a* and **34***b*, and rigid frame assemblies **36***a* and **36***b*. The transfer roller **32** is mounted for rotation about shafts **38** disposed in arms **34***a* and **34***b*, the latter being journalled for rotation about shafts **40** positioned within the assemblies **36***a* and **36***b*, respectively, such that any perturbations of the transfer roller **32** against the photoconductive belt **12** due to dimensional variations will not be deleterious to the image transfer process. A support shaft **42** is mounted for rotation in the assemblies **36***a* and **36***b* above and in parallel alignment with the transfer roller **32,** and a gear **44** is affixed to an end of the shaft **42** for driving a cleaning brush member **48** through a suitable drive means in contact with the transfer roller **32.** Bearings **50** are disposed on the shaft **42** outwardly of the assemblies **36***a* and **36***b*, and are positioned in support assemblies of the machine indicated generally as **52** and **54.**

Shafts **38** are journalled for rotation in the pivoting arms **34***a* and **34***b* as are the shafts **40,** thereby permitting rotation of the transfer roller **32** with respect to the arms **34***a* and **34***b*, and also permitting the transfer roller **32,** and assemblies **34***a* and **34***b* to rotate as a unit about the shafts **40.**

A shaft **60** disposed above and in parallel relationship to the shafts **40,** is journalled for rotation in the assemblies **36***a* and **36***b* and has the portions thereof extending beyond these assemblies provided with cams **62** affixed thereto. A threaded rod member **64** is rotatably mounted by a pin **66** to each of the assemblies **36***a* and **36***b*. The end of the threaded rod member **64** opposite the pin mount is provided with a centrally formed orifice (not shown) into which a rod member **65** is positioned in sliding relationship. A spring **68** is positioned about the rod member **65** between each of the arms **34***a* and **34***b* and a nut **70** threaded on the rod **64.** A lever **72** is connected to the shaft **60** to rotate the latter and is held in operative relationship by a locking arm **74** extending from the assembly **36***b*.

When it is necessary to move the transfer roller **32** into a non-operational mode, i. e., where the roller is not in contact with the photoconductive belt **12,** the lever **72** is moved clockwise as viewed in FIG. **3** (counterclockwise as viewed in FIG. **4**). This would be necessary, for example, when it is desired to change the photoconductive belt **12.** When the lever is so moved, the cams **62** on each side of the assembly **26** are moved against the arms **34***a* and **34***b*. For example, as can be seen in FIG. **4,** cam **62** would rotate counterclockwise against the surface **74** of arm **34***b*. A corresponding action would take place with respect to arm **34***a*. Cams **62** would thus rotate arms **34***a* and **34***b* about the shafts **40.** It should be noted at this point, that because of the location of shafts **40,** the transfer roller **32** moves in a direction which is at least generally perpendicular to a tangent at the point of contact between the transfer roller and the photoconductive belt **12.** Thus, even during the transfer process, any movement of the transfer roller **32** would be in this direction. Heretofore, transfer rollers have been mounted so that any movement of the roller during the transfer process was in a direction generally parallel to a tangent at the point of contact, which resulted in poor copy quality as discussed above. It should also be noted at this point, that the springs **68** bias the transfer roller **32** toward the photoconductive belt **12** with a minimal force which is sufficient only to maintain uniform contact with the belt and the paper

passing between the belt and transfer roller during machine operation.

It will be understood that the transfer roller **32** will contact the photoconductive surface in a manner to provide even contact therebetween similar to the shock absorbing action of the front end of a vehicle and that the compressional forces of the springs **68** are adjustable by rotation of the respective nuts **78.**

Another aspect of the present invention relates to the ratio of A, the radius of photoconductive belt **12** at the point of contact with the transfer roller **32** to B, the radius of the transfer roller at that point. This ratio should not be less than **3,** and preferably is in the range of **3** to **3.5.**

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure which modifications are intended to be included within the scope of this invention.

What is claimed is:

1. Apparatus comprising:

a. means defining a surface adapted to support a developed electrostatic image, the surface being mounted for movement around a closed path;

b. a transfer roller assembly having a transfer roller in contact with the surface, wherein the ratio of (i) the distance from the surface at the point of contact to the center of curvature of the surface at that point to (ii) the radial dimension of the roller, is not less than **3;**

c. means for mounting the transfer roller so that it may move in a direction which is at least generally perpendicular to a tangent at the point of contact between the surface and the roller;

d. means for feeding a support sheet between the surface and the roller; and

e. means for biasing the roller against the support sheet with a minimal force which is sufficient only to keep the roller in contact with the support sheet and the support sheet in contact with the surface during movement of the support sheet between the surface and the rollers during operation of the apparatus so that transfer can be effected solely by an electrical bias applied to the transfer roller.

2. Apparatus as set forth in claim **1** wherein the ratio of (i) to (ii) is in the range of **3** to **3.5.**

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