United States Patent

Kaupp

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[45] **Aug. 22, 1972**

[54] **DUPLICATING METHOD AND APPARATUS**

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[21] Appl. No.: **75,897**

Related U.S. Application Data

[62] Division of Ser. No. 595,752, Nov. 21, 1966, Pat. No. 3,592,642.

[52] **U.S. Cl.** **355/3**

[51] **Int. Cl.** **G03q 13/16**

[58] **Field of Search** 355/10, 12; 219/216; 355/3, 355/4, 5, 6, 7, 8, 9, 11, 17

[56] **References Cited**

UNITED STATES PATENTS

3,549,251	12/1970	Olden	355/12 X
3,249,738	5/1966	Simm et al.	219/216
3,359,404	12/1967	Limberger	219/216

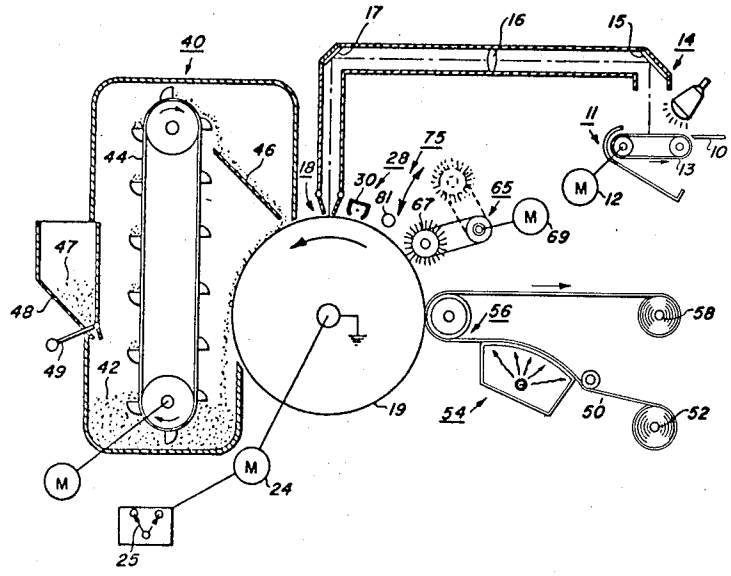
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[57] **ABSTRACT**

Apparatus for producing multiple copies of electrostatically formed image by first developing the image and then transferring the developed image to copy paper by the application of heat and pressure to permanently affix the developed image to the copy paper leaving a reusable latent electrostatic image. In one embodiment the copy paper is moved past a heat source and then immediately urged into pressure contact with the developed image. In a second embodiment the copy paper is heated simultaneously while in pressure contact with the image by a centrally heated roller.

5 Claims, 7 Drawing Figures



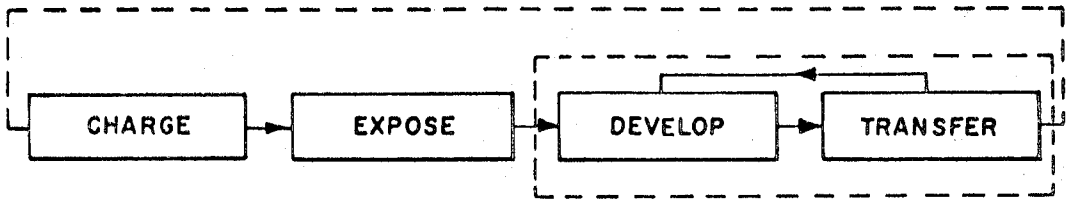


FIG. 1

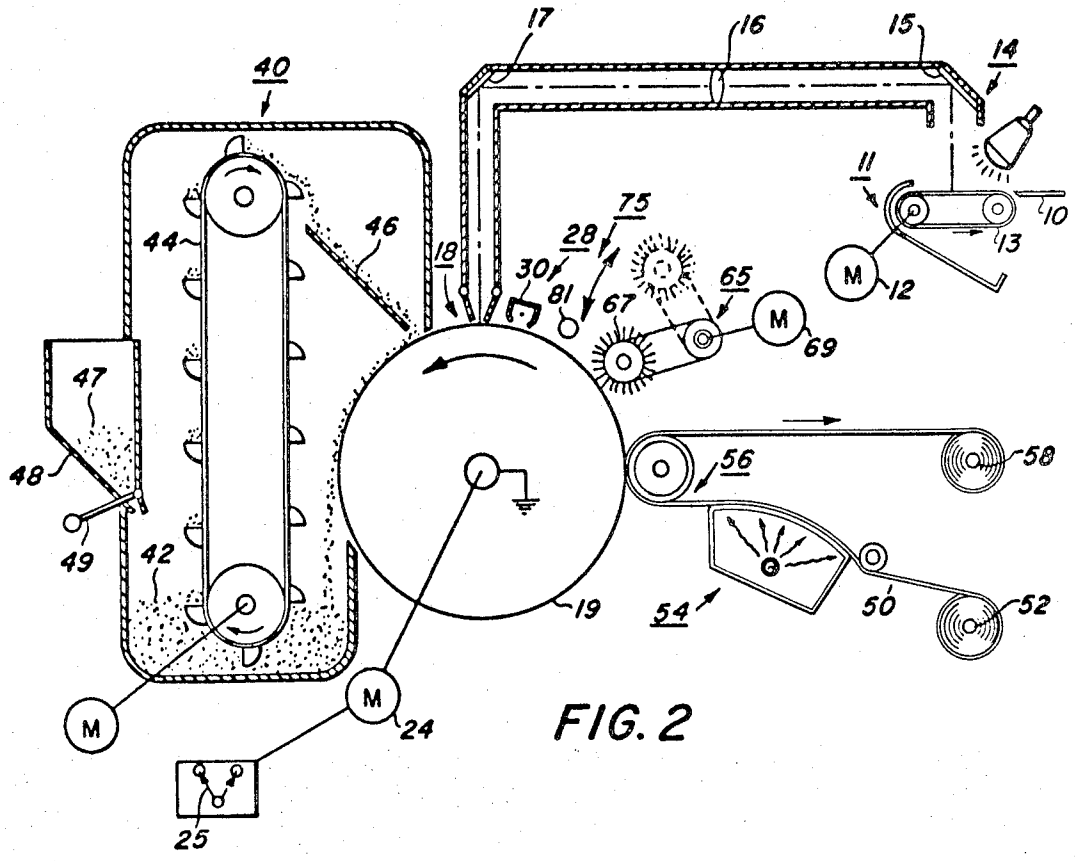


FIG. 2

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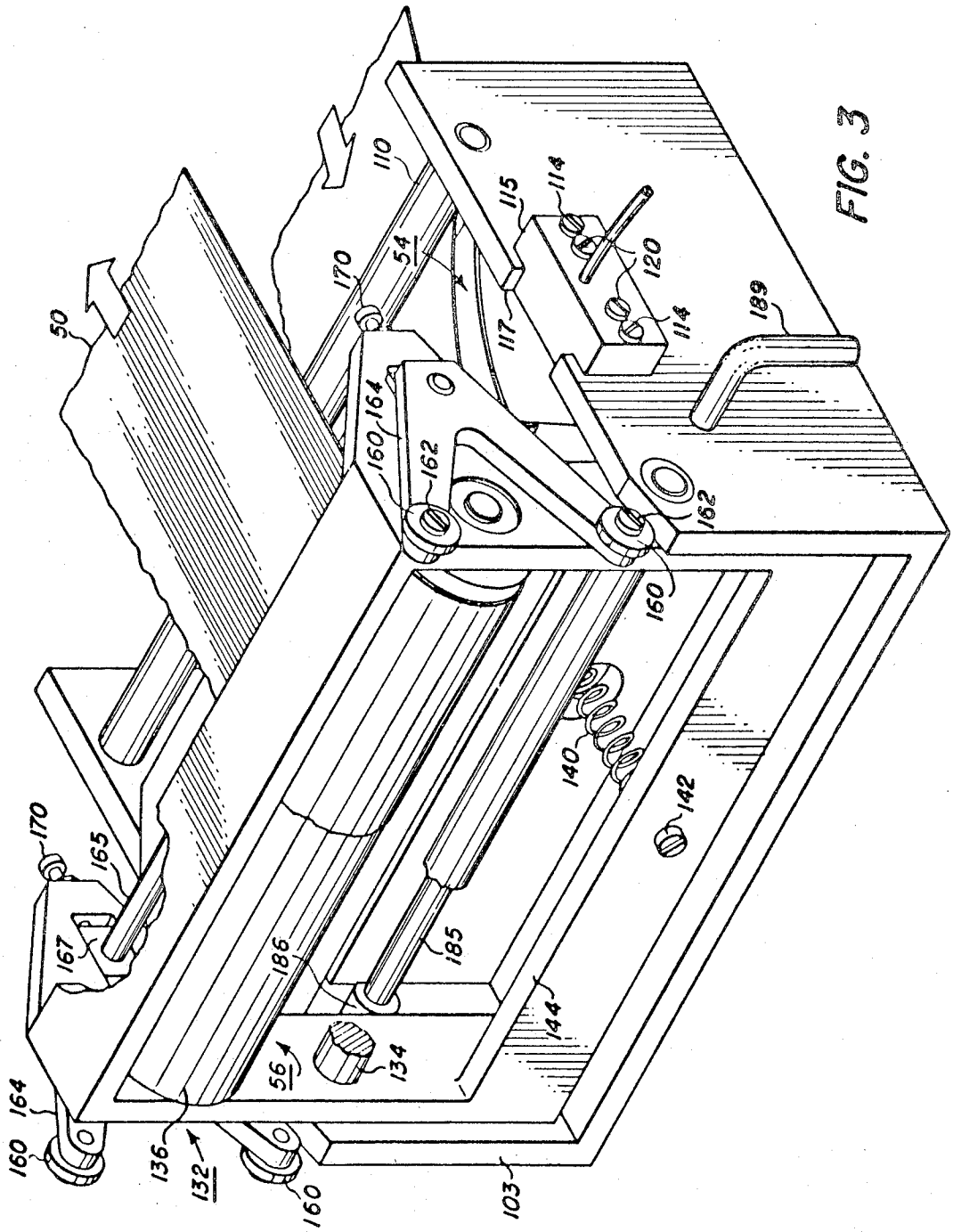

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FIG. 3

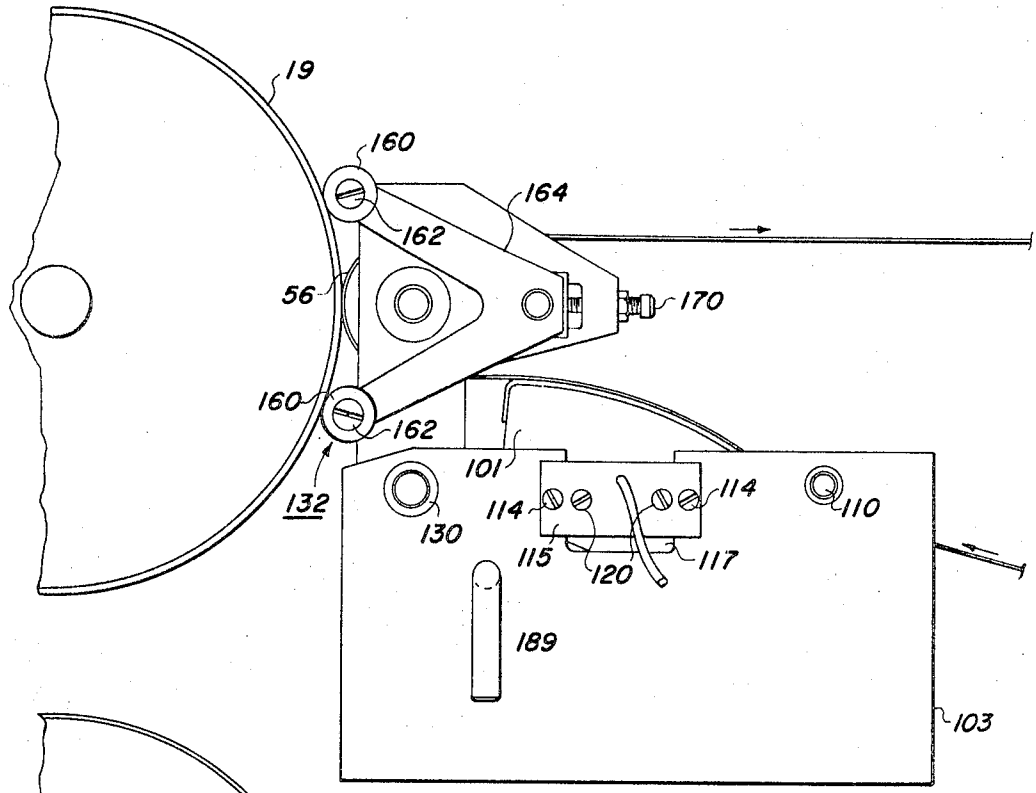

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FIG. 4

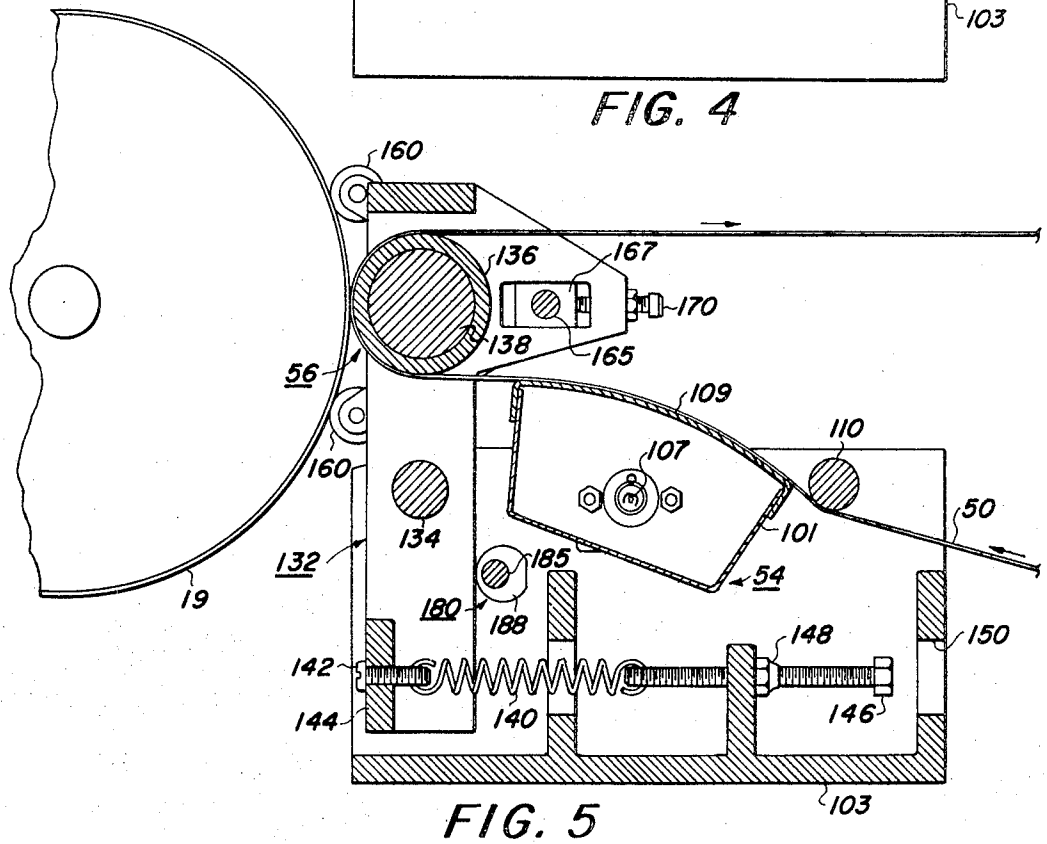

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FIG. 5

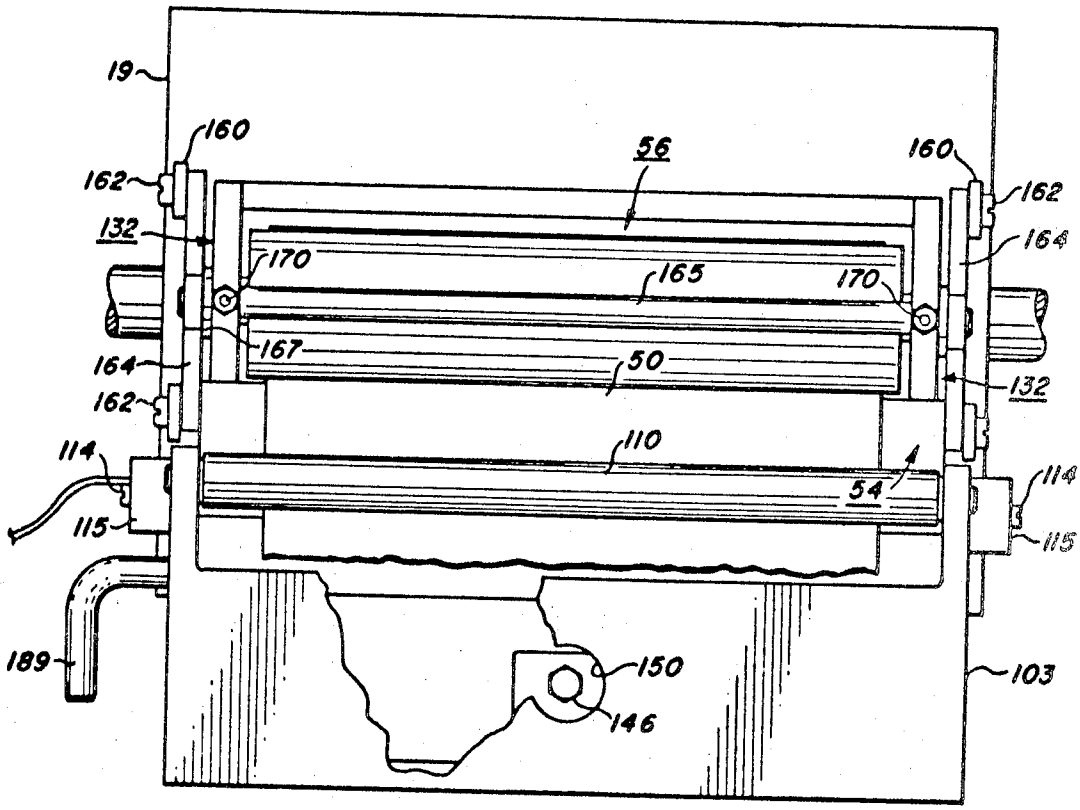

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FIG. 6

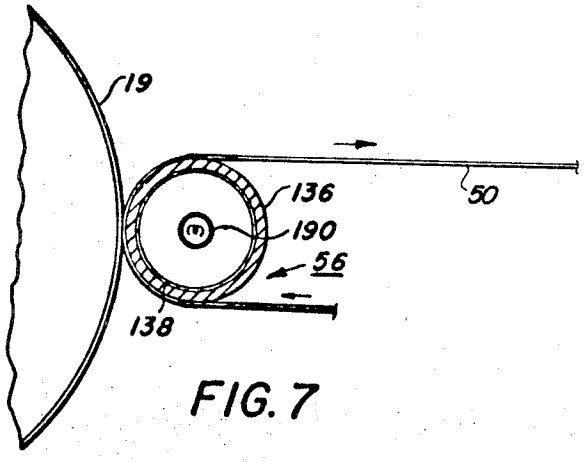

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FIG. 7

DUPLICATING METHOD AND APPARATUS

This application is a division of application, Ser. No. 595,752 filed Nov. 21, 1966, now U.S. Pat. No. 3,592,642.

This invention relates to electrophotography and, more particularly, to method and apparatus for producing multiple copies from a single exposure of an original document to be reproduced.

In xerography, as disclosed, for example, in Carlson U.S. Pat. No. 2,297,691, a xerographic plate comprising a layer of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional projection techniques. This exposure discharges the plate areas in accordance with the light intensity that reaches them, and thereby creates an electrostatic latent image on or in the photoconductive layer. Development of the latent image is effected with an electrostatically charged, finely divided material, such as an electroscopic powder, which is brought into surface contact with the photoconductive layer and is held thereon electrostatically in a xerographic powder image pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic powder image is transferred to a support surface, such as, a sheet of paper, to which it may be fixed by heat or vapor. This cycle is repeated in its entirety for each xerographic print reproduced.

Since the disclosure in Carlson, many improvements have been made in xerographic devices and techniques, and as a result both manual and automatic machines for carrying out xerographic reproduction processes are in wide commercial use. The present invention constitutes a further improvement in xerographic systems adapted for automatic operation to further extend such systems to duplicating a large number of copies cheaply and rapidly from what in effect is a master latent image.

Heretofore, one exposure of the original has been necessary for every copy produced from a xerographic machine. The reason for this briefly stated, is that with conventional transfer, which is by electrostatics, corona air breakdown occurs between the charged paper and the low potential background areas of the xerographic plate causing a drastic reduction in the electrostatic contrast between image and background. Hence the image cannot be reused as an offset master. Moreover, after separation of the developed image from the plate onto a charged support surface, it is necessary to advance the drum past a series of cleaning stations to remove the residual developer powder not transferred from the drum surface and any electrostatic charge that may remain on the drum before commencing another cycle. Needless to say the elimination of repeated exposure and cleaning steps in the reproduction process would greatly enhance machine operation.

In accordance with the present invention, as described herein, the latent electrostatic image produced from a single exposure of the xerographic plate is preserved as a master and multiple copies made therefrom by continuously developing the latent image and transferring the developer to a copy sheet. More than this, the developed image transferred is simultaneously fused to the copy rendering a permanently fixed image thereon. After forming an initial latent image, development and transfer are effected in rapid

sequence as in a duplicating system. Generally speaking, this is accomplished by transferring substantially all of the developed image from the xerographic plate onto the support surface by utilizing heat and pressure so as not to significantly alter the electrostatic contrast on the plate surface. Since electrostatic contrast is not altered, the latent image can be redeveloped again and again as a master image until the desired number of copies are produced.

It is therefore an object of this invention to improve xerographic method and apparatus for duplicating.

Another object of this invention is to transfer developer material from an electrostatic image in such a manner as to preserve the electrostatic contrast after transfer whereby the image can be redeveloped over and over as a master.

It is another object of the invention to reduce wear on a xerographic plate resulting in substantially longer drum life.

It is a further object of the invention to facilitate stripping copy paper from a photoreceptor bearing a developed image.

It is another object of the invention to improve the efficiency of transfer of a developed image from a xerographic plate to a support surface whereby high quality images are formed at a reduced developer consumption.

It is still a further object of this invention to achieve simultaneous transfer and fusion of a developed xerographic image.

The above objects as well as additional features and advantages will become more apparent from the following description as best understood in conjunction with the drawings in which:

FIG. 1 is a block diagram of a new and improved xerographic method according to the present invention;

FIG. 2 is a schematic representation of a xerographic machine, for practicing the present invention;

FIG. 3 is a perspective view of the image transfer assembly shown in the embodiment of FIG. 2;

FIGS. 4 and 5 are side elevation views of the transfer assembly shown in FIG. 3, FIG. 5 containing parts in section to illustrate details therein;

FIG. 6 is an end view of the transfer assembly; and,

FIG. 7 is a side sectional view illustrating a second embodiment for the transfer assembly.

The new and improved method as diagrammatically set forth in FIG. 1 comprises four basic steps of charging, exposure, development, and transfer. The two last steps are repeated to make multiple prints in what hereinafter is referred to as the duplicating mode.

As in the usual xerographic process, a charging step comprises the formation of an electrostatic charge across the surface of the xerographic plate, and exposure occurs when the charged xerographic plate is exposed to a light pattern or optical image thereby forming an electrostatic charge pattern.

Next is the development or image body formation step wherein the electrostatic latent image is transformed into the image body by the deposition of finely divided electroscopic material. The electroscopic material desirably bears a charge opposite to the charge on the electrostatic latent image whereby it is selectively deposited on the image portions. Various

methods of deposition may be employed, such as, deposition by bringing into contact with the image surface a carrier bead having charged electroscopic particles thereon as described, for example, in U.S. Pat. No. Re. 25,136.

With the presently existing xerographic techniques transfer of the electroscopic material to paper is effected by electrostatics such as, by applying a corona charge to the back side of the paper causing the paper to tack to the plate and the electroscopic material to adhere electrostatically to the paper. It is then necessary to strip the paper from the plate and fix the electroscopic material to the paper to render a permanent print. As previously discussed transfer by electrostatics causes a deterioration of the electrostatic contrast of the image remaining on the plate which must now be cleaned for another print cycle.

In accordance with the present invention, the final step in the cycle for producing a single print is the step of transfer of the image body to a support surface, such as, a paper sheet, web or the like. This transfer step combines heat and pressure to remove substantially all of the developer particles from the image bearing surface onto a support surface. As a result the electrostatic latent image is not altered. Thereafter the xerographic plate is recycled through the development and transfer steps to make additional copies of the original latent image which now serves as a master.

At the time of transfer the developer particles become "tackified" and are removed onto a support surface to which they become permanently affixed as will become more apparent hereinafter. The term "-tackified" or "melt" and the several variant forms thereof used throughout the specification, is employed to define the condition of the powder particles that form the copy pattern when treated in a manner such that the individual powder particles soften and coalesce, and in which state they become sticky and readily adhere to other surfaces. Although the condition necessarily requires a flowing together of the powder particles to effect a thorough fusion thereof, it is to be understood that the extent of such flowing is not sufficient to extend beyond the boundary of the pattern in which the particles were formed.

The temperatures used to tackify or melt the developer particles at the time of transfer depend upon the melting point of the developer particles. Any suitable developer particles may be used. It has been found that conventional toner particles such as described in the patent above, melt at about 75° C.

The xerographic plate may be any suitable photoconductive material formed on an insulating backing member. Suitable photoconductive materials are formulations of vitreous selenium with arsenic, tellurium, sulphur and mixtures thereof.

Since electrostatic contrast is not altered by the heat and pressure at the time of transfer, the initial latent image is preserved and can be redeveloped until the desired number of copies are reproduced or depletion of the electrostatic contrast occurs. This depletion takes place independent of the transer and is a function of the photoconductive drum dark decay rate and the neutralization effect that takes place when a charged toner particle adheres to an oppositely charged image area on the photoconductive surface. In this manner, it is possible to duplicate as many as several hundred copies or more in a relatively brief period depending upon the rate at which the xerographic drum can move without detracting from the quality of development and transfer.

Referring now to FIG. 2, there is shown various components of a xerographic system for practicing the present invention in schematic fashion. A document to be reproduced is placed on a transport tray **10** from which it is fed onto a transport mechanism generally designated **11**. Suitable drive means are provided for the transport mechanism from motor **12** to endless belt **13** whereby the document is moved past the optical axis of a projection lens assembly **14** that is illuminated by a projection lamp. The image of the copy is reflected by mirror **15** through an adjustable objective lens **16** and then reflected by mirror **17** downwardly through a variable aperture assembly **18** and onto the surface of the xerographic plate in the form of a drum **19**.

Xerographic drum **19** comprises a cylindrical member having photoconductive material as previously described on the surface and mounted on suitable bearings set in a frame. Drum **19** is driven in a counterclockwise direction by a motor **24** at two rates, an image forming rate and duplicating rate, as determined by the two positions on a selector switch **25**. The first position serves to drive drum **19** as a rate proportional to the transport rate of the document whereby the peripheral speed of the drum surface is identical to the rate of movement of the reflected light image. Movement of the selector switch **25** to the second position as shown by the dotted portion speeds up drum **19** for operation in the duplicating mode incorporating only the development and transfer stations.

A charging station generally designated **28** serves to direct a uniform electrostatic charge onto the photoconductive layer of xerographic drum **19** by means of a corona genrally device **30** containing one or more corona wires energized from a suitable potential source.

Exposure of the drum to the light pattern previously described discharges the photoconductive layer in the areas struck by light whereby there remains on the drum a latent electrostatic image in image configuration corresponding to the light image projected from the document. As the drum surface continues its movement the electrostatic latent image passes through a developing station **40** in which a two-component developing material **42**, as previously described, is cascaded over the drum surface by means of a developing apparatus **43**.

In the developing apparatus, developing material is carried upwardly by conveyor **44** being driven by a suitable drive means from motor **45** and is released onto chute **46** from where it cascades down over the drum surface. Toner component **47** of the developer which is consumed in developing is stored in dispenser **48** and is released in amounts controlled by gate **49**.

To transfer the developed image onto a support surface, a web **50** is advanced from a supply spool **52** first over a heating unit **54** and then over a pressure roller **56** which urges the heated web into contact with the developed image on the drum. The toner particles in contact with the hot paper tackify or melt causing them to adhesively adhere to the support web. As the support

web is advanced onto a take-up spool **58**, the toner cools resulting in the toner being permanently affixed to the web.

Since the latent electrostatic image is preserved on the drum, multiple copies can be made without additional exposures. The charging and exposure stations are de-energized so as to permit the xerographic drum to pass only the development station and transfer station previously described. In this manner multiple copies are made of the same image. During the duplicating mode in which only development and transfer are effected, motor **24** is preferably run at the higher speed setting to enable multiple copies to be reproduced most rapidly.

After the desired number of copies has been made motor **24** is reset to its reduced speed setting and the drum advanced past a cleaning station **65** in which a cleaning brush **67** hitherto retracted from the surface of the drum is moved into contact with the drum as shown by the dotted portion. Although substantially all of the developer powder is removed at the transfer station, the cleaning brush which is rotated by a motor **69** conveniently serves to remove any residual powder on the drum.

The drum also passes through a discharge station **75** which has likewise been inactivated during the duplicating mode, where it is illuminated by a fluorescent lamp **81** to remove any remaining electrostatic charge remaining thereon. The drum is now ready to pass the charging and exposure stations which are now activated for the start of another duplicating cycle in which another document is reproduced.

Referring now to the FIGS. **3–6** there is shown in greater detail the xerographic transfer assembly generally designated **101** by which the image is transferred to the support web. Transfer assembly **101** comprises a base frame **103** on which is mounted both heating unit **54** and pressure roller **56**. Heating unit **54** comprises a housing **105** enclosing a heating lamp **107**, such as, an infrared lamp. Housing **105** has a curved upper wall **109** over which the support web is directed by a guide roller **110** journaled in base frame **103**. Side walls of housing **105** are supported by screws **114** secured in insulating blocks **115** which are received within recesses **117** in the side walls of the base frame. A pair of bolts **120** secured in the insulating blocks serve to support heating lamp **107** which extends longitudinally and centrally along the interior of the housing.

Pressure roller **56** is rotatably supported in ball bearings **130** set in a pivotable support frame **132** which is pivotable on a pivot shaft **134** journaled in the side walls of base frame **103**. The outer surface of pressure roller **56** comprises a resilient layer **136** which is knurled on a core **138** made of metal, such as, aluminum. Resilient layer **136** may be made from any suitable material, such as, siliconized rubber. To urge the pressure roller against the drum surface a coil spring **140** is secured at one end by an anchor screw **142** to a tie bar **144** on support frame **132** and at the other end to a tensioning screw **146** on base frame **103**. Tensioning screw **146** is treadingly received by stop nut **148** supported by a raised portion **149** of the base frame. An access port **150** is provided through which the tensioning screw can be turned to vary the tension on the coil spring thereby controlling the force exerted by the pressure roller on drum **19**. A 40 durometer roller at 30 lbs. pressure provides ⅜ inches contact arc which has been found to work well. It should be understood that the contact arc may be varied by changing the durometer of the roller or the pressure exerted or both.

To ensure proper contact of the pressure roller with the surface of xerographic drum alignment rollers **160** are mounted by shoulder bolts **162** on yoke members **164** which are movably supported on support frame **132**. Yoke members **164** are connected by a tie rod **165** secured to bearing blocks **167** which are slidable within openings **169** formed in support frame **132**. Positioning screws **170** are provided for positioning the bearing blocks within within the support frame.

A release assembly **180** is provided so that when the drum is removed while there is tension on spring **140** the pressure roller may be restrained from movement about pivot shaft **134**. Release assembly **180** comprises a shaft **185** which is journaled in base frame **101**. Cam shaft **185** has a pair of cam members **186** having a flattened portion **188** which is urged in contact with support frame **132** upon turning a cam shaft handle **189** locking the support frame against further movement about the pivot shaft **134**.

FIG. **7** shows another embodiment by which heating of the support web may be effected. With this embodiment, pressure roller **56** is tubular and houses a heating lamp **190** which is similar to heating lamp **107** previously described in the embodiment of FIGS. **2–6**. Obviously a combination of the heated roller with the preheating unit of FIGS. **2–6** can be used. This combination is particularly advantageous where higher temperatures are desired for the transfer and fusion of the image to the support web.

By the invention described above, the latent electrostatic image is preserved enabling recycling through only the development and transfer stations thereby making duplicating possible. In addition, since substantially all of the developer particles are removed at the time of transfer, plate cleaning is eliminated with consequent extension of the life of the xerographic plate. Also the fact that such a large quantity of developer is transferred renders a high quality print with reduced toner consumption. Moreover, since the developed image is permanently affixed onto the final support surface at the time of transfer, it is possible to make multiple copies in a rapid and simplified manner without the necessity of additional components, such as, a fuser.

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

What is claimed is:

1. In an electrostatic copying apparatus having a photosensitive plate mounted for movement to pass a series of processing stations including an exposure station to form light images on said photosensitive plate for producing a latent image thereon, a development station for developing the latent image with electrostatically attractable powder to form a powder image body on the plate and transfer station at which the powder image body is transferred from the plate to a support material, the improvement comprising

drive means operatively associated with said plate for moving the same relative to the series of processing stations,

a strip of support material arranged for movement past said plate at the transfer station,

means for imparting movement to said support material,

heating means arranged in the path of said support material immediately before the transfer station and having a heating capacity sufficient to raise the temperature of said support material to a temperature which will tackify said powder on said plate when placed into intimate contact therewith, and

roller means closely positioned adjacent said plate at the transfer station and arranged to urge said support material into pressure contact with the moving plate to effect transfer and fixing of the developed tackified powder image to the support material.

2. Apparatus according to claim 1 wherein said roller means includes a base, a support frame pivotally mounted on said base, a cylindrical member supported at its ends by said support frame and having a resilient layer on its exterior surface, and pressure loading means operatively associated with said support frame for exerting a force on same to effect movement about its pivot axis causing said cylindrical member to abut against said photosensitive plate and including adjustment means to vary the surface contact between said resilient layer and said plate.

3. Apparatus according to claim 1 wherein said photosensitive plate is in the shape of a drum rotated past development and transfer stations for repeated development and transfer.

4. Apparatus according to claim 3 wherein said heating means comprises a lamp disposed inside of said cylindrical member.

5. Apparatus according to claim 3 wherein said heating means comprises a lamp disposed in a housing positioned adjacent said cylindrical member.

* * * * *