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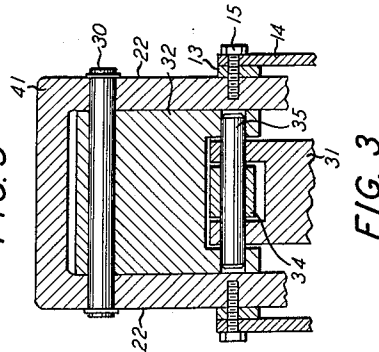
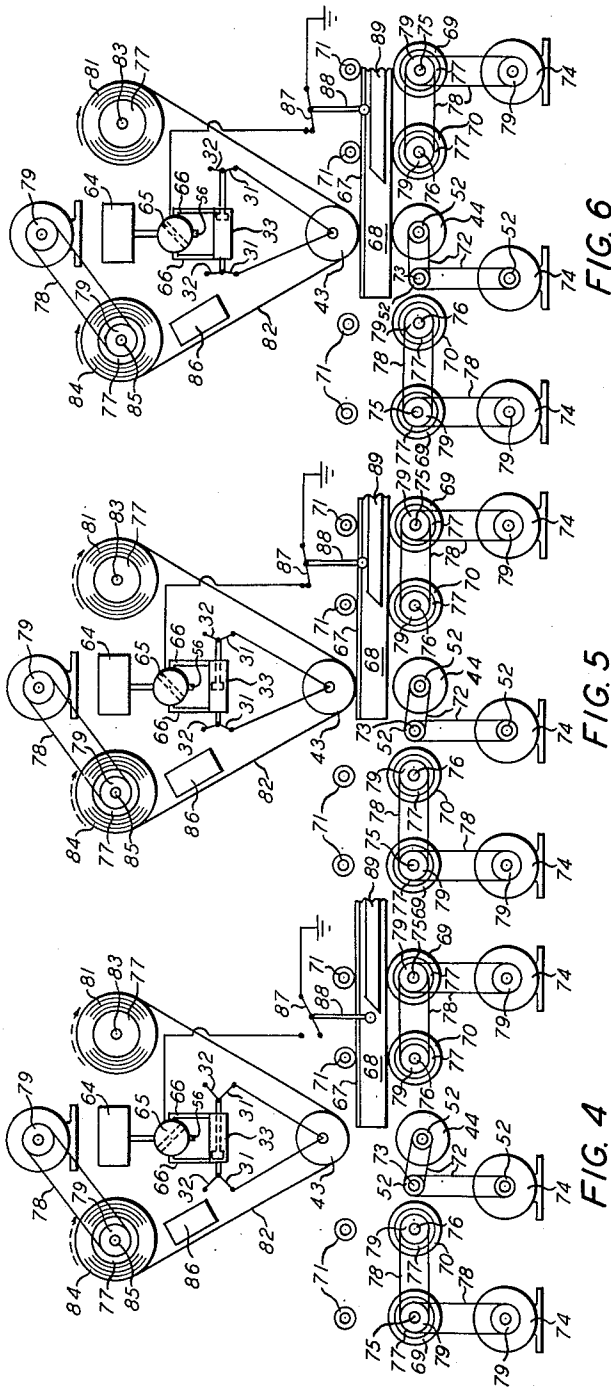
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3,013,526

XEROGRAPHIC IMAGE TRANSFER APPARATUS

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XEROGRAPHIC IMAGE TRANSFER APPARATUS

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This invention relates in general to the field of xerography and particularly to improvements in a transfer apparatus for use in a xerographic device.

In the art of electrostatic electrophotography, otherwise known as xerography, an image of transferable electroscopic material is formed on a surface and transferred to a sheet or web of support material. In practice this transfer has been accomplished by an electrostatic transfer step, although it has been recognized that there might also be used contact transfer to moistened paper or to paper carrying a wax or like soft substance on its surface. The prior methods of transfer have generally been satisfactory where xerography is directed toward reproduction of line copy or in other fields where substantially 100% image transfer is not essential; however, it has been found that many of these methods accomplish transfer of considerably less than all the electroscopic material, with consequent inadequacy for the high requirements of continuous tone xerography.

The purpose of the invention is to provide a pressure transfer apparatus for use with flat xerographic plates whereby essentially all of an electrostatically adhering image on a xerographic plate is transferred to a support material without smearing, smudging or other deformation.

In the field of xerography an image body is developed on a xerographic plate, the image body being secured to the xerographic plate by electrostatic forces only and within the influence of electrostatic forces the image body can very easily be smeared or smudged. Unlike many types of mechanical forces the electrostatic forces binding the image body to the xerographic plate are comparatively weak in preventing lateral motion although they are comparatively strong in preventing motion of the image body away from the xerographic plate surface.

In the case of pressure transfer in a xerographic process, relatively strong pressures between the transfer member and the image surface must be achieved in order to accomplish transfer of the image body from one member to the other. At the same time there is virtually no force securing the image body against smearing or smudging. The situation further becomes complicated by the fact that the image bearing surface itself is fragile and easily broken. According to presently employed embodiments of xerography, the xerographic plate consists of amorphous or vitreous selenium coated on a backing material and this selenium, like the glass which it resembles in appearance, is extremely brittle. Thus, it is necessary to apply a substantial force evenly and without excess. Furthermore, the contact between the transfer member and the image bearing surface must be achieved without the formation of small bubbles or zones in which the proper firm contact is not achieved. This requirement is necessary in order to avoid the production of speckle prints in which the print may give the appearance of freckles through localized improper transfer.

It is, therefore, an object of this invention to provide an image transfer apparatus for transfer of xerographic powder images, the apparatus being simple and compact in use and structure and being efficient in operation.

It is another object of the invention to provide a xerographic image transfer apparatus for pressure con-

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tact transfer of a xerographic powder image to a support material.

It is a further object of the invention to provide apparatus for bringing a support material into uniform pressurized contact with a surface bearing a transferable xerographic powder image for transferring the xerographic powder image from said surface to the support material.

It is a still further object of the invention to provide an image transfer pressure roller apparatus for use in the transfer station of a xerographic machine.

For a better understanding of the invention as well as other objects and further features thereof, reference is had to the following detailed description of the invention to be read in connection with the accompanying drawings, wherein:

FIG. 1 is a front elevation view of a preferred embodiment of an image transfer pressure roller apparatus, partially broken away to illustrate the various elements of the device.

FIG. 2 is a side elevation of the apparatus, partially broken away to illustrate the various elements of the device.

FIG. 3 is a detail vertical sectional view taken along line 3-3 of FIG. 1.

FIG. 4 is a diagrammatic side elevation of the transfer station of a xerographic machine with the image transfer pressure roller apparatus mounted thereon, and

FIGS. 5 and 6 are diagrammatic side elevations of the pertinent elements of FIG. 4, illustrating successive stages in the operation of the image transfer pressure roller apparatus.

Referring now to FIGURES 1 to 3, inclusive, there is disclosed a preferred pressure transfer roller assembly, generally designated 5, for use in a preferred image transfer apparatus illustrated in FIGURES 4 to 6, inclusive.

The pressure transfer roller assembly 5, in the particular arrangement disclosed herein, includes a frame 10 resiliently mounted to support pillars located at the transfer station of a xerographic machine. The frame 10 consists of a left-hand frame member 11 and a right-hand frame member 12 rigidly secured to each other by horizontal tie straps 13 and diagonal tie straps 14 fastened to the left-hand and right-hand frame members 11 and 12, respectively, by screw fasteners 15, the lower ends of the diagonal tie straps being positioned by spacer blocks 26. The left-hand frame member 11 consists of a left-hand hanger 16 which is bifurcated at its lower end to form a fork 17 into which is pivotally fastened a lower roller arm 18 by means of a pin 19 and retainer rings 20. The right-hand frame member 12 also consists of a right-hand hanger 21 also forked at its lower end to receive a lower roller arm 18 secured in a similar manner by a pin 19 and retainer rings 20. Both the left-hand and right-hand hangers 16 and 21, respectively, have spaced side members 22, a top member 41, and a bottom member or leg 42 forming an opening 23 extending transversely of each hanger.

As viewed in FIG. 2, a pair of guides 24 are positioned in the bottom of the openings 23 and are secured by machine screws 25. A pair of sliding bearings or bearing blocks 27 are positioned in the openings 23 of both the left-hand and right-hand hangers 16 and 21, respectively. The sliding bearings or bearing blocks 27 are retained in place by guides 24 at one end, and at the other end by guide blocks 28 positioned in slots 29 formed in side members 22 of each hanger. The sliding bearing or bearings 27 are secured to the guide blocks 28 by means of pivot pins 30 which also pivotally secure the lower knuckles 31, the pivot pins 30 being locked in position by retainer rings 20. A pair of upper knuckles

32 are secured in the openings 23 of the left and right hangers in a similar manner by a second pair of pivot pins 30 and retainer rings 20. A double acting air motor 33 is clevis mounted to the knuckles 31 and 32. The cylinder knuckle 34 on the rear end of the air motor 33 is secured to the upper and lower knuckles 32 and 31, respectively, positioned in the left-hand hanger 16 by means of pivot pin 35. The piston rod 36 of the air motor 33 is threadedly secured to a cylinder rod connector 37 and locked in position by retaining screw 38, the cylinder rod connector 37 in turn being connected to the upper and lower knuckles 32 and 31, respectively, of right-hand hanger 21 by means of a second pivot pin 35. Essentially the upper knuckles 32, lower knuckles 31 and pivot pins 35 form first and second machine toggles in the left-hand hanger 16 and right-hand hanger 21, respectively. Movement of the air motor is limited by stop screws 39 threaded into each of the stop bars 40 secured to the left-hand hanger 16 and right-hand hangers 21.

An upper roller assembly 43 and a lower roller assembly or drive roller 44, each consisting of a rubber 45 covered tubular element or roller 46 secured to stub shafts 47, are rotatably journaled by bearings 48 secured to the stub shafts 47; the upper roller assembly 43 being secured in sliding bearings 27 by retainer rings 20, while lower drive roller assembly 44 is secured in lower roller arms 18 by retainer rings 20. For convenience in assembly, the lower roller arms 18 are pivotally secured to the left-hand and right-hand hangers by pins 19, but are locked in operating position by bolts 49 threaded into the bottom member or leg 42 of the hangers, movement of the lower roller arms being prevented in one direction by the heads of the bolts 49, and movement in the other direction being prevented by the nuts 50 secured to bolts 49.

As viewed in FIG. 1, the left-hand stub shaft 47 of the lower drive roller assembly 44 is of sufficient length to permit the mounting of a thrust washer 51 (see FIG. 2) and a driven sprocket 52 on the stub shaft outboard of the lower roller arm 18, the driven sprocket 52 being secured to the stub shaft by a retainer ring 20 and a woodruff key (not shown), in the well known manner.

As previously set forth, frame 10, carrying the roller assemblies and the air motor, is resiliently mounted to vertical support pillars located at the transfer station of the xerographic machine. As shown, the vertical support pillars consist of a pair of rods 55 threaded at their upper ends; the rods 55 preferably may be an integral part of a xerographic image forming machine or optionally may be separately mounted thereon. The legs 42 of the left-hand and right-hand hangers, 16 and 21, respectively, have apertures 57 through which the rods pass, while the mounting tie bars 58, secured to the hangers by cap screws 59, have passages 60 of sufficient diameter for the passage of the rods 55 and tube elements 61 described below. Secured to the upper portion of each of the rods 55 is a tube element 61 welded to a nut 62 and locked in position by a second nut 62. Springs 63 are telescoped over the tube element 61 and are retained by a second pair of nuts 62.

The springs 63 used to support the assembly provide basic alignment of roller assemblies 43 and 44 with other rollers in the xerographic apparatus, and they serve the function of positioning the lower roller assembly 44 sufficiently close to the bottom of a plate carriage as it moves through the xerographic machine that only a minimum amount of travel will be required to press it against the bottom of a plate carriage during the transfer operation, and at the same time, to effectively balance the whole system to require a minimum of energy to so position the roller assemblies. This structure permits limited vertical movement of the frame member on the rods for reasons explained in more detail in connection with the operation of the device.

Referring now to FIGURES 4 to 6, inclusive, which illustrate diagrammatically a preferred embodiment of the image transfer apparatus of the invention for use in a xerographic machine, the air motor 33 of the pressure transfer roller assembly 5 is supplied with compressed aeriform fluid by compressor 64 or other source of compressed aeriform fluid, connected to one opening of a solenoid-operated, four-way valve 65. The second and third openings of the solenoid-operated four-way valve 65 are connected by flexible conduits 66 to opposite ends of air motor 33, the fourth opening of the valve being connected to an exhaust conduit 56. Operation of the solenoid-operated four-way valve 65 is controlled by a microswitch 87 activated by a cam follower 88 operating on cam 89 connected to plate carriage or carrier block 68.

As previously set forth, the pressure transfer roller assembly 5 is located at the transfer station of the xerographic machine (not shown). A xerographic powder image bearing member in the form of an electrophotographic or xerographic plate 67 including a photoconductive layer on a conductive backing is mounted on a carrier block or plate carriage 68. The plate carriage 68 with the xerographic plate 67 mounted thereon is supported and moved through the transfer station by means of carriage drive rollers 69 and 70, similar to other carriage drive rollers throughout the xerographic machine, and the lower roller assembly 44 of the pressure transfer roller assembly 5, rollers 71 merely acting as guide rollers.

For reasons which will be apparent hereinafter, it is desirable to have the plate carriage 68 and xerographic plate 67 propelled solely by means of the lower roller assembly 44 as they pass through the pressure transfer roller assembly 5. To accomplish this, the driven sprocket 52 of the lower roller assembly 44 is connected by chain drive 72 to the first of two sprockets 52 mounted on shaft 73, the second sprocket being driven by a second chain drive 72 from a motor 74, this arrangement providing a positive drive for lower roller assembly 44.

Since the movement of carriage drive rollers 69 and 70, when either one is in contact with the plate carriage 68, at the same time that the carriage is in contact with the lower roller assembly, must not predominate over the movement of the lower drive roller assembly 44, the carriage drive rollers 69 and 70 are driven by suitable torque responsive devices. Although a number of different torque responsive devices may be used, as, for example, torque motors or over-running clutches, in the embodiment disclosed, over-running clutches are used.

As shown, the carriage drive rollers 69 and 70 are rotatably mounted on shafts 75 and 76, respectively, and are driven by clutches 77 secured to the shafts for rotation therewith. The clutches 77 are of the well known over-running type, commonly referred to as over-running clutches commercially available, for example, from the Formsprag Company of Van Dyke, Michigan. By the use of the over-running clutches 77 to drive the carriage drive rollers 69 and 70, these rollers are free-wheeling relative to the clutches; that is, an over-running clutch allows a driven member to run at greater speed than its driving member. This is true even when the driving member is stopped, reversed or running at slower speed in relation to the driven member.

Each of the shafts 75 is driven by a motor 74 connected by means of a sprocket 79 mounted thereon and chain drive 78 to the first of two sprockets 79 attached to shaft 75. The second sprocket 79 on shaft 75 is the driving sprocket used to transmit power to shaft 76, the units being connected by a second chain drive 78 connected to a sprocket 79, attached to shaft 76.

It is apparent that sprockets 52 and 79 are either driving or driven sprockets, depending on their function as described above.

To provide a support material to which the developed images from a xerographic plate may be transferred, a supply roller or reel 81 carrying a roll or web of support

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material 82 is rotatably mounted on fixed spindle 83, rotation of the supply roller or reel 81 being governed by an over-running clutch 77 of the type previously described. The support material 82 is threaded around upper roller assembly 43 and onto take-up roller or reel 84 rotatably mounted on spindle 85 and driven by an over-running clutch 77 secured to the spindle 85. A power source, such as motor 74, is connected by driven and driving sprockets 79 secured to the spindle 85 and motor 74, respectively, and chain drive 78 for applying torque to the take-up roller or reel 84 via the over-running clutch 77 mounted on spindle 85. With the take-up roller drive motor 74 operating, the over-running clutches 77 for both the take-up roller 84 and the supply roller 81 are adjusted so that balanced tension exists on the web of support material 82 to prevent movement of the support material by take-up roller drive motor 74. As long as the forces acting on the supply roller 81 and the take-up roller 84 are balanced, the support material will not move.

The sequence of operation of the xerographic transfer apparatus of the invention is shown in FIGURES 4 to 6, inclusive, all of the motors 74 being energized through suitable electrical circuits (not shown). The pressure transfer roller assembly 5 is shown in FIG. 4 in its normal position, it being apparent that this device would be supported by springs 63 as shown in FIG. 1. In this position the upper roller assembly 43 and the lower roller assembly 44 are separated due to the piston rod 36 being retracted, compressed aeriform fluid being supplied to the front end of piston rod end of air motor 33 from air compressor 64 through the solenoid-operated four-way valve 65, while the rear end of the air motor 33 is connected by means of the valve to exhaust conduit 56. In this position the lower roller assembly 44 is positioned slightly lower than plate carriage rollers 69 and 70. The movement of the plate carriage 68 in the device illustrated is from right to left as seen in FIGURES 4 to 6, inclusive, movement of the plate carriage 68 to the pressure transfer roller assembly 5 being controlled by the driven carriage drive rollers 69 and 70 on the right-hand side of the machine as shown. As the carrier block 68 is advanced (see FIG. 5), solenoid-operated four-way valve 65 is energized, as by microswitch 87 activated by cam 89 through cam follower 88, whereby the compressor 64 is connected to the rear end of the air motor 33 and the front end of the air motor is connected to exhaust conduit 56. Since the forces acting on the cylinder and piston of the air motor are equal and opposite, the forces acting through the machine toggles on the bearing blocks 27 is equal, causing them to move downward carrying the upper roller assembly 43 into contact with the xerographic plate 67 on plate carriage 68 as illustrated in FIGURE 5. As the power stroke continues, further movement of the upper roller assembly 43 is limited by plate carrier 68 still supported by the right-hand drive rollers 69 and 70, and guide rollers 71, so that the frame 10, itself, is forced to move upward bringing the lower roller assembly 44 into firm contact with the bottom of the plate carriage 68, as illustrated in FIGURE 6. The latter-described movement of the frame is permitted by the resilient mounting means previously described in connection with FIGURES 1 and 2.

By the use of a compressor or other source of compressed aeriform fluid of sufficient capacity to rapidly activate the piston of the air motor, the time interval between the successive stages shown in FIGURES 5 and 6 is negligible.

As the plate carriage 68 is clamped between the upper roller assembly 43 and lower roller assembly 44, the lower roller assembly 44 takes over control of the movement of the plate carriage 68 from carriage drive rollers 69 and 70. This is due to the fact that in this stage of operation the positively driven lower roller assembly 44 is in forced contact with the plate carriage while the carriage drive rollers 69 and 70 are free-wheeling relative to their

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driving members due to the use of the over-running clutches 77, thereby permitting the carriage drive rollers to be frictionally driven by the plate carriage.

Up to this point the web of transfer material or support material 75 has not moved due to the balanced tension existing thereon, but now with the transfer material forced into contact with the xerographic plate on the carrier block, the friction forces developed in the rolling contact between the xerographic plate and the upper roller assembly is sufficient to overcome the balanced tension and cause movement of the support material in the direction of the solid arrow shown in FIGURE 6.

In passing between the roller assemblies, the surface of the electrophotographic plate meets the support material in pressure contact whereby the support material picks up and holds any xerographic powder image or the like on the surface of the electrophotographic plate. When the support material is stripped from this plate, as it passes from the upper roller assembly, it carries such image or powder material in its direct configuration, the image or powder material being permanently bonded to the support material by an image fixing apparatus 86, such as disclosed in Carlson Patent 2,624,652.

Since the support material does not move except when in direct contact with the electrophotographic plate, and then only as a result of the movement of this plate between the roller assemblies, the support material does not move relative to the plate along the line of transfer contact thereby eliminating any smearing or smudging of the xerographic powder image. The line of transfer contact referred to above is the line of contact which the support material, guided by the upper roller assembly, makes with the electrophotographic plate.

As the plate carriage 68 moves through the pressure transfer roller assembly 5, the cam follower 88 will drop off the cam 89 at the end of the plate carriage, thereby opening microswitch 87 with the resultant positioning of the valve element of solenoid-operated four-way valve 65 to permit compressed aeriform fluid to retract the piston of air motor 33. As this happens the upper and lower roller assemblies 43 and 44, respectively, move away from the plate carriage 68 and the movement thereafter of the plate carriage away from these roller assemblies is controlled by the left-hand (as seen in FIGURE 4) carriage drive rollers 69 and 70.

The support material used may be an adhesive support material, such as disclosed in Mayo et al. Patent 2,661,289, or a normally non-adhesive support material such as disclosed in copending applications Serial No. 499,784, filed April 7, 1955, and now Patent No. 2,855,324, and Serial No. 527,354, filed August 9, 1955, and now Patent No. 2,886,464. The pressure capacity of the compressor and the size of the air cylinder should be properly correlated to force the rollers against the xerographic plate with sufficient force to effect transfer of the xerographic powder image to the particular support material used.

In regard to FIGURES 4 to 6, inclusive, it is apparent that the various elements illustrated would be either journaled where necessary or otherwise operatively connected to the structural support elements (not shown) of a xerographic machine in the well-known manner. The structural support elements have been omitted from the drawings since they form no part of the subject invention and since their inclusion in the drawings would only detract from the diagrammatic presentation of the essential elements of the device necessary for a complete disclosure of the invention.

The speed of passage of the xerographic plate through the mechanism may vary over a wide range, merely being slow enough to obtain satisfactory and uniform contact with the particular support material used. When operated under these conditions and with these materials, the mechanism will yield transfers of substantially 100% of the original image material, whereby the full, accurate

reproduction qualities of the xerographic process may be realized.

What is claimed is:

1. An image transfer pressure roller apparatus for use in a xerographic device wherein a flat, xerographic plate, having a xerographic powder image thereon is mounted on a plate holder for movement through the transfer station of the xerographic device, the transfer apparatus including a frame means having two parallel spaced frame members movably supported on the xerographic device, bearing blocks movably mounted in each of said frame members, an upper roller assembly journaled in said bearing blocks for movement with said bearing blocks, a lower drive roller assembly journaled in said frame members in parallel spaced relationship to said upper roller assembly, bearing block moving means connected to said frame members and to said bearing blocks for moving said bearing blocks and therefore said upper roller assembly relative to said lower drive roller assembly and for moving said frame members and therefore said lower drive roller assembly relative to said upper roller assembly, said roller assemblies being movable from a position in which said roller assemblies are in spaced apart relation to receive a xerographic plate to a position wherein said roller assemblies are adapted to support a xerographic plate in pressure contact therebetween, and drive means connected to said lower drive roller assembly for driving said lower drive roller assembly, said roller assemblies thus being adapted to receive a flat xerographic plate and to advance such member in pressure contact therebetween.

2. A transfer apparatus for transferring a xerographic powder image from a xerographic powder image bearing member to a support material, including a structural support element, a pair of support pillars mounted on said structural support element, spring-tensioned mounting means positioned on each of said support pillars, a frame means having two parallel spaced frame members movably mounted on said support pillars and supported by said spring-tensioned mounting means, bearing blocks movably mounted in each of said frame members, a first roller assembly journaled in said bearing blocks for movement with said bearing blocks, a second roller assembly journaled in said frame members in parallel spaced relationship to said first roller assembly, bearing block moving means connected to said bearing blocks and to said frame members for moving said bearing blocks and therefore said first roller assembly relative to said second roller assembly and for moving said frame members and therefore said second roller assembly relative to said first roller assembly from a position in which said roller assemblies are in spaced apart relation to receive a xerographic powder image bearing member to a position wherein said roller assemblies are adapted to support a xerographic

powder image bearing member in pressure contact therebetween, drive means connected to said second roller assembly for driving said second roller assembly, a support material transport means connected to said structural support element, said support material transport means adapted to hold a supply of support material in tension around said first roller assembly, said roller assemblies thus being adapted to receive a xerographic powder image bearing member and to propel such member in pressure contact with a support material therebetween, the forced contact of the xerographic powder image bearing member with the support material causing movement of the support material.

3. A transfer apparatus for transferring a xerographic powder image from a xerographic powder image bearing member to a support material, including a support element, a pair of support rods mounted vertically on said support element, spring-tensioned mounting means connected to each of said support rods, a frame means having two parallel spaced frame members movably mounted on said support rods and supported by said spring-tensioned mounting means, bearing blocks movably mounted in each of said frame members, a first roller assembly journaled in said bearing blocks, a second roller assembly journaled in said frame members in parallel spaced relation to said first roller assembly, a pair of toggle means each connected at one end to one of said bearing blocks, and at its other end to the frame members in which the bearing block is mounted, power means connected to actuate said toggle means for moving said first roller assembly relative to said second roller assembly and for moving said frame members and therefore said second roller assembly relative to said first roller assembly from a position in which said roller assemblies are in spaced apart relation to receive a xerographic powder image bearing member to a position wherein said roller assemblies are adapted to support a xerographic powder image bearing member in pressure contact therebetween, drive means connected to said second roller assembly for rotating said second roller assembly, and a yielding torque-responsive support material transport means operatively connected to said support element for supplying a web of support material in cooperation with said first roller assembly in contact with a xerographic powder image bearing member.

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