RESERVE COPY.

PATENT SPECIFICATION

DRAWINGS ATTACHED

1,032,951

1,032,951

Date of Application and filing Complete Specification Dec. 28, 1962.

No. 48954/62.

Application made in United States of America (No. 162779) on Dec. 28, 1961.

Complete Specification Published June 15, 1966.

© Crown Copyright 1966.

Index at acceptance: —G2 H; G2 A(1E1G, 1E1J, 1E1L, 1E1X, 1E2, 1E4)

Int. Cl.:—G 03 g//G 03 b

COMPLETE SPECIFICATION

Improvements in Xerographic Reproducing Apparatus

We, RANK XEROX LIMITED, a British Company of Mortimer House, 37/41 Mortimer Street, London, W.1, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates in general to xerography and, in particular, to an improved xerographic reproducing apparatus.

More specifically, the invention relates to an improved automatic xerographic apparatus for use in producing xerographic reproductions from a moving document or original.

In the process of xerography, for example, as disclosed in either British patent specification 672,767, or in British patent specification 679,533, 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 radiation intensity which reaches them and thereby creates an electrostatic latent image on or in the plate coating.

Development of the image is effected with developer material or developers which comprise, in general, a mixture of a suitable pigmented or dyed electroscopic powder, hereinafter referred to as toner, and a granular carrier material, which later functions to carry and to generate triboelectric charges on the toner. More exactly, the function of the granular material is to provide the mechanical control to the powder, or to carry the powder to an image surface and, simultaneously, to provide almost complete homogeneity of charge polarity. In the development of the image, the toner powder is brought into contact with the plate and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Thereafter, the developed xerographic image is usually transferred to a support of transfer material to which it may be fixed by any suitable means.

According to the present invention, there is provided a xerographic copying machine comprising a drum having a photoconductive surface upon which for production of an electrostatic latent image there is projected an optical image of an original to be copied and the surface of which drum when being rotated to effect a copying cycle passes through a number of processing stations which act on the drum, an original carrier connected for rotation in synchronism with the drum, controllable grippers associated with the original carrier, a control system which in a first position permits the grippers to grip an original on the carrier and which in a second position permits the actuation of the grippers to release the original, the system including a counter responsive to the number of copying cycles effected by the drum, which counter for the production of multiple copies is set in accordance with the number of copies to be made and which causes the control system to assume the first position until the drum has completed a number of copying cycles one less than the number of copies set on the counter and subsequently to assume the second position.

An example of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic illustration of the apparatus of the invention;

Figure 2 is a top view of the apparatus of the invention, with the cabinet covers removed;

Figure 3 is a top view of the apparatus

[*Price 4s. 6d.*]

similar to Fig. 2, but with the optical projection mechanism removed;

Figure 4 is a vertical transverse section through the apparatus;

Figure 5 is a sectional view taken along lines 5—5 of Figure 2;

Figure 6 is a sectional view taken along lines 6—6 of Figure 3, illustrating a document stop;

Figure 7 is a sectional view taken along lines 7—7 of Figure 3, illustrating a document retainer and pressure finger;

Figure 8 is a sectional view taken along lines 8—8 of Figure 3, illustrating the document lever;

Figure 9 is a sectional view taken along lines 9—9 of Figure 3, illustrating the document latch stop mechanism;

Figures 10, 11, 12 and 13 are views similar to Figures 6, 7, 8, and 9, respectively, showing the position of the respective elements as a document is picked up by the gripper bars of the copy drum;

Figure 14 is a left-hand perspective view of the mechanical control mechanism of the apparatus;

Figure 15 is a right-hand perspective view of the programmer mechanism of the apparatus;

Figure 16 is a right-hand perspective view of the programmer mechanism and document handling mechanism set for reproducing single copies;

Figure 17 is a right-hand perspective view of the programmer mechanism and document handling mechanism set for making multiple copies;

Figure 18 is a front view of the time out cam and time out latch assembly;

Figure 19 is a sectional view taken along lines 19—19 of Figure 18;

Figure 20 is a right-hand perspective view of the time out cam assembly viewed from the back of the machine; and

Figure 21 is a schematic electrical circuit wiring diagram of the apparatus.

Referring now to the drawings, there is shown in the figures a xerographic reproducing apparatus used for producing xerographic reproductions from a moving original.

The xerographic reproducing apparatus is adapted for installation with a suitable light-tight housing or cabinet of a size so that the entire unit may be mounted on an office desk or table.

General

As shown, the xerographic apparatus comprises a xerographic plate including a photoconductive layer or light-receiving surface on a conductive backing and formed in the shape of a drum, generally designated by numeral 20, which is journalled in a frame to rotate in the direction indicated by the arrow to cause the drum surface sequentially to pass a plurality of xerographic processing stations.

For the purpose of the present disclosure, the several xerographic processing stations in the path of movement of the drum surface may be described functionally, as follows:

A charging station, at which a uniform electrostatic charge is deposited on the photoconductive layer of the xerographic drum;

An exposure station, at which a light or radiation pattern of copy to be reproduced is projected onto the drum surface to dissipate the drum charge in the exposed areas thereof and thereby form a latent electrostatic image of the copy to be reproduced;

A developing station, at which a xerographic developing material including toner particles having an electrostatic charge opposite to that of the electrostatic latent image are cascaded over the drum surface, whereby the toner particles adhere to the electrostatic latent image to form a xerographic powder image in the configuration of the copy to be reproduced;

A transfer station, at which the xerographic powder image is electrostatically transferred from the drum surface to a transfer material or support surface; and,

A drum cleaning station, at which the drum surface is first charged and then brushed or wiped to remove residual toner particles remaining thereon after image transfer, and at which the drum surface is exposed to a relatively bright light source to effect substantially complete discharge of any residual electrostatic charge remaining thereon.

The charging station is preferably located as indicated by reference character A in the schematic illustration of the apparatus. In general, the charging apparatus or corona charging device 21 includes a corona discharge array of one or more discharge electrodes that extend transversely across the drum surface and are energised from a high potential source and are substantially enclosed within a shielding member.

Next subsequent thereto in the path of motion of the xerographic drum is an exposure station B. This exposure station may be one of a number of types of mechanisms or members such as desirably an optical scanning or projection system, or the like, designed to project a line copy image onto the surface of the photoconductive xerographic drum from a suitable original.

The optical scanning or projection assembly consists of a copyboard in the shape of a drum, hereinafter referred to as copy drum 30, which is adapted to support copy to be reproduced and arranged to rotate in light projection relation to the moving light-receiving surface of the xerographic plate. Uniform lighting is provided by suitable lamps 31 attached to a slotted light reflector 32 mounted adjacent to the copy drum.

A slotted light shield 33, adapted to protect the xerographic plate from extraneous light, is positioned adjacent to the surface of the xerographic plate. A slot aperture in the light shield extends transversely to the path of movement of the light-receiving surface of the xerographic drum 20 to permit reflected rays from the copy drum to be directed against a limited transverse area of the light-receiving surface as it passes thereunder.

To enable the optical system to be enclosed within a relatively small cabinet, a folded optical system including an object mirror 34, a lens 35, and an image mirror 36, is used.

A document fed through document guides 37 to the copy drum is removably secured thereon by a suitable gripper mechanism for movement therewith in timed relation to the movement of the xerographic drum whereby a flowing image copy is projected onto the xerographic drum. The copy is held against the surface of the copy drum until gripped by means of document retaining guides 38. Pressure guides 39 and document guard 41 retain and guide the trailing edge of the document on the copy drum. After the copy is scanned it is released from the copy drum to be transported out of the machine by the copy drum and document feed out rollers 42 through document feed out guide 43.

Adjacent to the exposure station is a developing station C in which there is positioned a developer apparatus 50 including a developer housing having a lower or sump portion for accumulating developer material 51. Mounted within the developer housing is a driven bucket-type conveyor 52 used to carry the developer material previously supplied to the developer housing to the upper portion of the developer housing from where the developer material is cascaded over a hopper chute 53 onto the drum.

As the developer material cascades over the drum, toner particles of the developer material adhere electrostatically to the previously formed electrostatic latent image areas on the drum to form a visible xerographic powder image; the remaining developer material falling off the peripheral surface of the drum into the bottom of the developer housing. Toner particles consumed during the developing operation to form the xerographic powder images are replenished by a toner dispenser 54, of the type disclosed in British patent specification 938,501 mounted within the developer housing.

Positioned next adjacent to the developing station is the image transfer station D which includes suitable sheet feeding mechanism adapted to feed sheets of paper successively to the xerograpic drum in coordination with the presentation of the developed image on the drum at the transfer station. The sheet feeding mechanism includes a sheet source such as paper tray 60 for a plurality of sheets of a suitable support material, that is, sheets of paper or the like, separator rollers 61 adapted to feed the top sheet of the stack of support material through a guide 67 to a sheet conveyor mechanism 62 having paper grippers 63 thereon which carry the sheet support material into contact with the rotating xerographic drum in coordination with the appearance of a developed image at the transfer station.

The transfer of the xerographic powder image from the drum surface to the support material is effected by means of a corona transfer device 64 that is located at or immediately after the point of contact between the support material and the rotating xerographic drum. The corona transfer device 64 is substantially similar to the corona discharge device that is employed at the charging station in that it also includes an array of one or more corona discharge electrodes that are energized from a suitable high potential source and extend transversely across the drum surface and are substantially enclosed with a shielding member. In operation, the electrostatic field created by the corona transfer device is effective to tack the transfer material electrostatically to the drum surface and simultaneously with the tacking action, the electrostatic field is effective to attract the toner particles comprising the xerographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the support material.

As the paper gripper mechanism continues to move forward in its closed circuit, it will strip the support material from the xerographic drum and carry it to a fixing device, such as, for example, heat fuser 70, whereat the developed and transferred xerographic powder image on the support material is permanently fixed thereto.

After fusing, the finished copy is preferably discharged from the apparatus at a suitable point for collection externally of the apparatus. To accomplish this, there is provided a pair of delivery rolls 65 and 66 by means of which the copy is delivered from the machine after it is released by the gripper mechanism. Suitable cam means 68 and 69 are provided at the receiving and delivery stations of the conveyor mechanism, respectively, to actuate the paper grippers at these stations to receive or discharge a sheet of support material.

The next and final station in the device is a drum cleaning station E whereat any powder remaining on the xerographic drum after the transfer step is removed and whereat the xerographic drum is flooded with light to cause dissipation of any residual electrical charge remaining on the xerographic drum.

To aid in the removal of any residual powder remaining on the xerographic drum

there is provided a corona precleaning device 84 that is substantially similar to the corona discharge device that is employed at charging station A. Removal of residual powder from the xerographic drum is effected by means of a web cleaner device 80 adapted to continuously feed a clean fibrous web material into wiping contact with the xerographic drum. As shown, the web material 55 is taken from a supply roll 81 and transported around a cleaning or pressure roll 82, preferably made of rubber, onto a take-up or rewind roll 83.

Any residual electrical charge remaining on the xerographic drum is dissipated by light from a fluorescent lamp 85 mounted in a suitable bracket above the xerographic drum, a suitable starter and ballast being provided for energising the fluorescent lamp.

Suitable drive means drive the xerographic drum, the copy drum, the sheet conveyor mechanism at predetermined speeds relative to each other, and to effect operation of the paper separator roll, and the web cleaner mechanism, the latter being driven at a speed or speeds whereby relative movement between the xerographic drum and the web material is effected. Suitable drive means are also provided for effecting operation of the conveyor mechanism and toner dispenser of the developing apparatus assembly.

Components of the apparatus are further described and claimed in copending applications which have been divided from the present application. Copending application No. 43029/65 (Serial No. 1,032,955) describes and claims the heat fuser 70. The sheet feeding mechanism is described and claimed in copending applications Nos. 43030/65 (Serial No. 1,032,956) and 43032/65 (Serial No. 1,032,958). The drum cleaning apparatus is described and claimed in copending application No. 43031/65 (Serial No. 1,032,957).

Referring now to Figure 2 of the drawings, there is provided a frame for supporting the components of the apparatus formed by left-hand plate 10, intermediate plate 11 and right-hand plate 12, connected together and maintained rigidly in spaced relation to each other by suitable tie rods 13 and 14.

The xerographic drum 20, having a layer of photoconductive insulating material on a conductive backing, is mounted on horizontal driven shaft SH1 that rotates in bearing 22 and 23 mounted in plates 11 and 12, respectively. The free end of shaft SH1, as seen in Figure 3, is threaded to receive nut 24. Spring 25, encircling the free end of the shaft, forces the drum to the left into driven engagement with a pin (not shown) extending from the hub portion of sprocket 27 secured to shaft SH1. The left-hand end of the drum is provided with a suitable aperture, to receive this pin.

Exposure Mechanism

The exposure mechanism of the xerographic reproducing apparatus is designed to use an optical projection or scanning mechanism adapted to scan a document or copy wrapped around a rotating copy drum and to project a flowing image of the document or copy onto the photoconductive surface of the rotating xerographic drum.

As shown, the scanning mechanism includes a feeding station, a copy station, an exposure station, and means for moving the document through the copying station in synchronism with the movement of the xerographic drum.

The feeding station includes a document guide 37 extending between frame plates 10 and 11, through which a document or copy to be reproduced is moved forward into engagement with the copy drum 30 and the document stops of the document retaining guide 38, the latter orientating and holding the document in position to be gripped by the gripper fingers of the copy drum.

Document retaining guide 38 includes shaft 101 journalled in bearings 102 and 103 (Figure 3) positioned in frame plates 10 and 11, respectively. Axial alignment of the shaft is maintained by retaining rings 104 positioned in suitable grooves formed in the shaft adjacent opposite sides of bearing 103.

A spacer plate 105 (Figs. 3 and 6 to 13) is fixed to the shaft 101. Mounted in spaced relation to each other on the spacer plate are a series of pressure fingers 106 (Figures 3, 7 and 11) adapted to be brought into contact with the peripheral surface of the copy drum or a document sandwiched therebetween to hold the trailing edge of a document against the copy drum. A series of document stops 107 and document retainers 108 are loosely mounted on the shaft 101 in alignment with the notched out portion of the spacer plate. As shown in Figure 6, the document stops 107 are normally biased into engagement with the peripheral surface of the copy drum by means of leaf springs 111 fixed to the spacer plate.

A document inserted into the document guide 37, by an operator, is forced into contact with the copy drum by the document retainers 108 and its forward progress is arrested by the document stops which also serve to align the leading edge of the document in parallel relation to the axis of the copy drum. Each document retainer is loosely journalled on the shaft 101, in an off centre position, so that the document retainer will normally rotate by its own weight into contact with the copy drum or into contact with a document sandwiched therebetween with sufficient force to hold the document against the peripheral surface of the copy drum. The weight of the document retainers is such that the force asserted by the document retainers against the copy drum is of such a

limited magnitude that although the document retainers will hold a document against the copy drum, the document retainers will move when contacted by the leading edge of a document to permit a document to be inserted between the document retainers and the copy drum.

Secured to the right-hand end of the spacer plate, as seen in Figure 3 is an actuator lever 114 which extends beyond the end of the copy drum, and mounted on the right-hand end of shaft 101 is a latchstop 115, for reasons described in detail hereinafter.

The shaft 101 is normally biased in a counter-clockwise direction, as seen in Figure 1, by a spring to normally urge the document stops and pressure fingers into engagement with the peripheral surface of the copy drum. The spring is connected at one end to a pin 113 fixed in frame plate 10, and at its other end to the spacer plate 105, a suitable aperture being provided in the spacer plate for attaching the bent end of the spring.

The copy drum 30 is fixed on shaft SH2 rotatably supported in bearings 121 and 122 mounted in frame plates 10 and 11, respectively.

Shaft SH2 is maintained in axial alignment by means of retaining rings 123 (Figure 4) positioned in suitable grooves formed in shaft SH2 adjacent the bearings 121 and 122.

The hub 124, fixed to shaft SH2, is provided with an axial hub pin 125 adapted to extend into a suitable aperture in the right-hand end plate of the copy drum by means of which the copy drum is secured for rotation with the shaft. The copy drum is normally biased into driven engagement with the hub pin by spring 126 encircling left-hand end of shaft SH2, as seen in Figure 4.

The copy drum is driven in timed relation with the xerographic drum by means of chain 131 which runs on sprockets 132 and 133, fixedly mounted on shafts SH1 and SH2, respectively. As shown in Figure 5, the chain 131 extends from sprocket 132, under sprocket 134 journalled on shaft SH13, around sprocket 133, over idler sprocket 135 journalled on stud shaft SH18, then back around sprocket 132.

The peripheral surface of the copy drum 30 is provided with slots 141 parallel and in line with each other through which gripper fingers 142 extend to grip the leading edge of a document against the peripheral surface of the copy drum. The gripper fingers are secured to rocker shaft 143 which is rotatably journalled in bearings 138, mounted in the end plates of the copy drum, in such a manner that upon rotation of the rocker shaft the gripper fingers are moved in unison into and out of operative pressure relationship with the peripheral surface of the copy drum. Axial alignment of the rocker shaft is maintained by retaining rings 139 positioned in suitable grooves formed in the rock shaft.

The gripper fingers are normally biased into operative pressure relationship against the peripheral surface of the copy drum by means of a spring 144 secured at one end to a stud 145, extending from the left-hand end plate of the copy drum, as seen in Figure 4, and connected at its other end to pin 146 extending from lever 147 secured to the left-hand end of the rocker shaft 143. A cam lever 148 is secured to the right-hand end of the rocker shaft, as seen in Figure 4, in position to be engaged by the interposer pin 151 for opening the gripper mechanism to receive a document or to release a document.

The interposer pin for opening the gripper mechanism is adapted to be moved manually either into position for operative engagement with the cam lever 148 on the rocker shaft as the copy drum rotates, or alternatively, into an inoperative position so as to clear the cam lever for the purpose described in greater detail hereinafter. When the interposer pin 151 is in its operative position, as shown in Figure 3, the rocker shaft is automatically actuated during each revolution of the copy drum so that a document retained by the gripper fingers is released for delivery from the machine and the gripper fingers remain open sufficiently long enough to receive a new or second document. Rotational movement of the rocker shaft is limited by means of stop studs 149 secured to the left-hand end plate of the copy drum in position to be engaged by lever 147.

To permit multiple scanning of a document the interposer pin 151 is moved to the right, to the position shown in Figure 4, out of interference relation with cam lever 148, by an operator through the manipulation of control knob 6, as described in greater detail hereinafter.

The interposer pin 151 is slidably mounted in a housing 153 and housing cap 154 secured to frame plate 11 by means of screws 155 threaded therein. The interposer pin 151 is normally biased into interference relation with cam lever 148 by means of spring 156 encircling the interposer pin and butting at opposite ends against the housing cap 154 and the retaining ring 157 positioned in a suitable groove formed in the interposer pin.

An actuator lever 161, journalled on pin 162 positioned in bracket 163 secured to frame plate 11, is used to move the interposer pin out of interference relation to cam lever 148. The forked end of the actuator lever encircles the interposer pin behind the interposer stop 158 secured at one end thereon, and at its other end the actuator lever is positioned to be actuated by a cam 602 of the programmer mechanism described in detail hereinafter.

To permit a document retained by the document stops to be gripped by the gripper

fingers of the copy drum, the actuator lever 114 of document retaining guide 38 is positioned on shaft 101 so that it extends beyond the right-hand edge of the copy drum in interference relation with the rocker shaft 143 whereby shaft 101 is rotated to move the document stops carried thereon out of engagement with the leading edge of the document in timed relation with the gripping of the leading edge of the document by the gripper fingers 142.

As the document, gripped at its leading edge between the gripper fingers and the peripheral surface of the copy drum, is transported thereby through the copying station, as defined by the slotted light reflector 32, successive portions of the document are uniformly illuminated by lamps 31. As shown in the electrical wiring diagram, four lamps are used to illuminate the copy, that is, a pair of fluorescent lamps LMP2 and LMP3 and a pair of incandescent lamps LMP4 and LMP5.

To receive the image of the document reflected through the light reflector, there is provided an object mirror 34 which reflects the image through lens 35. An image mirror 36 is positioned in the light path from the lens to reflect the image onto the xerographic drum through the slot aperture of the light shield 33. The lens 35 and two mirrors are suitably secured to an optical mounting bracket 171 supported by tie rods 14 extending between plates 10 and 11. The mounting bracket is held in position on the tie rods by means of springs 172, secured to the mounting bracket and at the opposite end to the tie rods. Suitable light baffles, not shown, are secured to the underside of the optical mounting bracket 171 to shield the lens 35 from extraneous light.

The slotted light shield 33 is simply an open elongated box, the bottom wall of which has a narrow slot aperture extending across its length. The light shield is suitably mounted, by clamp assembly 173 on a tie rod 14 extending between plates 10 and 11, directly above and in close proximity to the peripheral surface of the xerographic drum with the centre line of the slot aperture parallel to the axis of shaft SH1.

As a document is conveyed through the copying station, the trailing portion of the document is retained against the peripheral surface of the copy drum by pressure fingers 106 on shaft 101 and then, as it leaves the copying station, by pressure guides 39. The pressure fingers 106 and pressure guides 39 also perform the function of holding creased or wrinkled documents flat in the illumination region. The pressure guides 39 and the curved document guard 41 are secured at opposite ends to brackets fastened to plates 10 and 11.

After a document has been scanned, the rocker shaft 143, is actuated to release the document whereby it is forwarded by feed-out rollers 42, coacting with the peripheral surface of the copy drum, through the document feed-out guides 43.

The feed-out rollers 42 are rotatably mounted on arms 181 journalled on shaft SH20 secured against rotation between the plates 10 and 11. Each of the arms 181 is biased by means of a torsion spring 182 to yieldingly force the feed-out roller carried thereby against the peripheral surface of the copy drum or against a document sandwiched therebetween. One end of each torsion spring is secured to a radial pin 183 extending from the shaft SH20 and the other end of each spring is secured to the arm 181 with which it coacts.

Machine Operation

The xerographic drum is rotated at a constant speed by compound gear 91 fixed to the drum shaft SH1 carrying the xerographic drum, by a main drive motor MOT3. Compound gear 91 engages compound idler gear 92 which is driven by gear 93 fixed to the shaft of the main drive motor MOT3. The bucket-type conveyor and the toner dispenser of the developing apparatus 50 are suitably driven by a motor MOT2, shown schematically in Figure 21. Suitable blowers, not shown, driven by motors MOT1 and MOT4 are used to dissipate heat, generated by the fuser and projection lamps, from the machine.

In the average office, it is generally necessary to make, at random intervals through the day, a single reproduction of an original, multiple reproductions of an original, or successive reproductions from successive originals.

To make a single reproduction, a copy is inserted into the machine through document guide 37 into contact with the copy drum 30. The copy is advanced through the document guide 37 until its forward progress is stopped by the document stops 107 and in this position the document is maintained against the peripheral surface of the copy drum by document retainer 108, whereby the operator can release the copy.

As the document is inserted in the document guide, its leading edge will actuate a limit switch 6LS, positioned beneath the document guide with its actuator 701 extending through a suitable aperture in the document guide, to thereby close its contact to complete a circuit through other switches normally closed, as will be described hereinafter, to initiate operation of the machine. That is, at this time the main drive motor MOT3 is energised to rotate the xerographic drum 20, the copy drum 30 and the sheet conveyor mechanism 62. Motor MOT2 is also energised to effect operation of the developer mechanism 50 and toner dispenser 54. Solenoid SOL2 is energised to open the gate 541 of the heat fuser 70.

At the illuminating station, the exposure lamps 31 are energised; that is, fluorescent lamps LMP2 and LMP3 are energised through their circuits, consisting of ballast L1, L2 and L3, L4, and starters S1 and S2, respectively. Incandescent lamps LMP4 and LMP5 connected in series with each other are energised through the conductor line connected to the primary winding T2-A of a transformer also energised at this time. The residual charge dissipating lamp 85, a fluorescent lamp LMP6 as shown in the circuit drawing is energised through its circuit consisting of ballast L5 and starter switch S3. Power is also supplied to the high voltage power supply PS1 to effect operation of the corona charging device 21, the corona transfer device 64 and the corona pre-cleaning device 84.

Now as the xerographic drum 20 rotates under corona charging device 21, a uniform electrostatic charge is deposited on the photoconductive layer of the drum. As the xerographic drum rotates through the exposure station a light or radiation pattern of the copy carried on the rotating copy drum 30 is projected, by means of the mirror and lens assembly previously described, onto the surface of the drum to dissipate the charge on the drum in accordance with the light or radiation pattern of the copy, thereby forming a latent electrostatic image of the copy on said xerographic drum.

The exposed portion of the drum then rotates to the developing station C, where a xerographic developing material including toner particles having an electrostatic charge are cascaded over the drum surface whereby the toner particles adhere to the electrostatic latent image to form a xerographic powder image in the configuration of the copy. The exposed and developed portion of the xerographic drum then advances to the image transfer station D where it receives a sheet of support material advanced by the separator rollers 61 and transported into contact with the drum by the sheet conveyor 62. As the drum surface and sheet of support material pass over the corona transfer device 64, the developed powder image is transferred electrostatically from the xerographic drum surface to the sheet of support material. The xerographic drum then continues to rotate past the pre-cleaning corona device 84, then to the web cleaning device whereat any residual powder on the drum surface is removed by the web, and then under the discharge lamp whereat any residual charge on the drum is dissipated by radiation from this lamp.

In the meantime, the copy drum has rotated at a corresponding speed whereby it will have ejected any copy, if the interposer pin is in position to cause the ejection of copy, and the copy drum is then ready to receive a second copy, or if the copy is to be retained on the copy drum, it is ready to be advanced through the exposure station again. Assuming that only a single reproduction of a single copy is being made, the copy will have been ejected from the machine and the xerographic powder image will be transferred to the sheet of support material during the one cycle of rotation of the xerographic drum and copy drum. However, at this point in the operation of the apparatus the sheet of support material, with the powder image transferred thereto, has not been ejected from the machine.

The operating cycle of the apparatus disclosed is such that it requires three cycles of rotation of the xerographic drum and the copy drum to effect one and one-half cycles of rotation of the sheet conveyor mechanism. In the embodiment of the apparatus shown, the length of the chain of the sheet conveyor is twice the circumference of the xerographic drum, so for three revolutions of the xerographic drum the chain makes one and one-half revolutions.

Thus, after the transfer step, even though a second reproduction is not to be made, the xerographic drum and the copy drum must rotate through a second and third revolution to permit the sheet conveyor mechanism to eject a sheet of support material from the machine. However, during the second and third revolution of the xerographic drum and the copy drum, still assuming that only a single reproduction is being made, the optical system will, in effect, scan a blank copy drum and project a radiation image from the copy drum onto the xerographic drum, to expose the xerographic drum to this image of the copy drum. The xerographic drum will then again pass through the developing station and through the transfer station; however, a latch mechanism has now engaged a cam lever 277 to prevent advancement of a sheet of transfer material from the paper tray to the xerographic drum. As the xerographic drum continues to rotate through the second and third cycle it will again be cleaned as it passes through the cleaning station E and thus made ready for an actual reproducing cycle.

The continued operation of the sheet conveyor, copy drum and xerographic drum is effected by means of a time out cam which, when actuated by the latch mechanism, operates in time sequence to the rotation of the xerographic drum so that sufficient time is allowed to permit the xerographic drum to rotate through the required cycles before the main drive motor is de-energised, thereby enabling the sheet conveyor mechanism and the delivery rollers to eject the reproduction from the machine.

As shown in Figures 14, 18, 19 and 20, the time out cam 630 is mounted on shaft SH11 journalled in frame plates 11 and 12.

The time out cam is journalled on shaft SH11 for rotation relative to the shaft and is maintained axially thereon by a retaining ring 645 positioned in a suitable groove formed on the shaft. Shaft SH11 is operatively connected to the drum shaft SH1 by belt 96, which runs on pulleys 95 and 94, fixedly mounted on shaft SH11 and SH1, respectively, whereby the shaft SH11 is rotated at approximately one-third the speed of shaft SH1.

The time out cam is provided on one face thereof with cam surfaces 631 and 632 formed concentric with each other, these cam surfaces being used to actuate a multi-copy delivery limit switch 12LS and a main drive limit switch 9LS, respectively. On its peripheral surface adjacent to these cam surfaces the time out cam is provided with a cam surface 633 adapted to actuate a limit switch 8LS for a purpose to be described hereinafter. Limit switches 9LS and 12LS are mounted on support 646 and limit switch 8LS is mounted on support 647, both supports being secured to frame plate 11.

The time out cam is rotated, during the timing out cycle, in the same direction and in synchronism with the drum shaft by the clutch slide 640 mounted on shaft SH11. The time out cam and the clutch slide form a dog clutch, that is, the clutch slide is provided with a lug 641 adapted to engage one of the slots 634 formed on the raised annular inner portion of the time out cam, and the clutch slide is slidable axially on shaft SH11 for engaging the time out cam.

The clutch slide 640 is secured for rotation with shaft 11 by engagement of radial pin 644, carried by the shaft, with the longitudinal slot 642 provided in the hub end of the clutch slide. Clutch slide 640 is provided with an annular groove 643 adapted to receive the latch lever of the latch mechanism, described hereinafter, whereby the clutch slide may be selectively moved into or out of engagement with the time out cam.

To effect rotation of the time out cam in the opposite direction, there is provided a return spring 651 encircling the hub of the time out cam. One end of the return spring is received by an opening in frame plate 11 and the opposite end portion of the return spring is received by a suitable opening in the time out cam.

It is noted that the size of the return spring is such that, when the spring is in its normal expanded condition, it may be contracted when the time out cam is rotated in a counterclockwise direction, as seen in Figure 5, whereby sufficient energy is stored up by the spring to rotate the time out cam in a clockwise direction when the drive force, i.e., the clutch slide 640, rotating the return spring in a counterclockwise direction is released.

The rotation of the time out cam in a clockwise direction, as seen in Figures 5 and 19, is limited by engagement of the stop lug 635 extending axially from a cam 636 for operating a copy counter which cam is also formed on the time out cam, with the bumper 652 on the end of the cam stop lever 653. The cam stop lever is journalled on stub shaft 654 secured to frame plate 11 and is normally biased by spring 655 in a counterclockwise direction, as seen in the above Figures, into contact with the stop pin 656 fixed to frame plate 11. To retard the motion of the time out cam as it is rotated in a clockwise direction by the return spring, there is provided on the time out cam a toothed escapement wheel portion 637, the teeth of which cooperate with an oscillating member 656 pivotally supported on spindle 657. With this arrangement, the inertia of the time out cam as it is returned to its home position, as determined by the engagement of the stop lug against the bumper, is partly absorbed by the oscillating member, and not entirely by the stop lug 635 as it strikes the bumper 652.

The latch mechanism used to prevent advancement of sheet transfer material during the timing out cycle of the machine and to effect operation of the time out cam includes a clutch lever bracket 661 fastened to a U-shaped bracket 662 secured to frame plate 12. A forked actuator lever which consists of two L-shaped levers 663 held in spaced relation to each other by spacer 664 and by rods 665, is pivotally mounted on pivot pin 666 positioned in the clutch lever bracket 661. As shown, spacer 664 encircles pivot pin 666.

The levers 663, at one end, engage the annular groove 643 in clutch slide 640, and at the other end are engaged by pivot 667 positioned in the link 668. Link 668 is connected at one end to the bifurcated plunger of the normally open, cam release solenoid SOL1 fastened to bracket 662.

At its other end, link 668 is provided with an opening to receive one end of spring 671, the opposite end of the spring being secured to spring pin 672 extending from one leg of bracket 662, whereby the levers are normally biased in a counterclockwise direction, as seen in Figure 18, to force the clutch slide into engagement with the time out cam.

A latch 673 is fixed to the forked actuator lever in position to engage the latch portion 279 (Fig. 18) of cam lever 277 whereby when the cam release solenoid SOL1 is de-energised as shown in Figure 5, 18, and 19, the latch 673 engages the latch portion 279 of cam lever 277 to lock this lever in an inoperative position. When the cam lever 277 is in its inoperative position, the roller 278, thereon, is raised out of engagement with the roller control cam 281 on drum shaft SH1 thereby preventing the separator rollers

61 (Figures 1, 14) from being dropped into contact with the stack of support material in the paper tray. In this manner, although the separator rollers are rotated to advance a sheet during each rotative cycle of the xerographic drum, sheet material is not advanced as the xerographic drum is rotated during the timing out cycle of the machine.

To permit an operator to determine the number of reproductions made during a period of time, for example a day, there is provided a conventional mechanically actuated counter 674 (Figure 14) mounted on bracket 675, secured to frame plate 11 at the rear of the machine, in position to be accessible to an operator.

Since the number of revolutions of the xerographic drum and the elements related thereto will vary, depending on the number of reproductions made, because of the two additional rotative cycles of the xerographic drum while the machine is timing out, it is apparent that a count of the number of revolutions made by the xerographic drum in a period of time would not be a true indication of the number of reproductions made during the period of time.

The only accurate indication of the number of reproductions made during a period of time, is the number of sheets of support material advanced into transfer contact with the drum in the specified period.

To count the number of sheets advanced, there is provided a lever mechanism to actuate the counter only during an actual feeding cycle or reproducing cycle, but not during the timing out cycle.

As shown in Figures 5 and 14, there is provided a counter lever 681 pivotally mounted on stub shaft 682 secured to frame plate 11.

A pair of cam followers 683 and 684 are journalled on the counter lever on opposite sides of its pivot axis, cam follower 683 being adapted to be actuated by counter cam 636 formed on time out cam 630 and cam follower 684 being adapted to be actuated by counter cam 685 fixed to the drum shaft SH1.

A spring 686 is connected at one end to the counter lever 681 and at its other end to a stud 687 extending from frame plate 11 to force the cam followers 683 and 684 toward the respective cooperating cams.

A drive pin 688, secured to the end of counter lever 681 remote from cam follower 683, is engaged in a suitable aperture in the actuating lever of the counter 674 whereby the counter is actuated as the counter lever is oscillated.

During a reproducing cycle, as a sheet is advanced by the paper feed mechanism previously described, the cam follower 684 by engagement with counter cam 685 will cause the counter lever to be rotated in a clockwise direction, as seen in Figure 5, to actuate the counter. During the reproducing cycle, the time out cam 630, which has previously been released, is in its home position with the fall of the counter cam 636 adjacent the cam follower 683 on the counter lever.

When the time out cam is rotated during the timing out cycle, to the position shown in Figure 5, the rise of the counter cam 636 will engage the cam follower 683 on the counter lever to raise cam follower 684 out of engagement with the counter cam 685 thereby preventing actuation of the counter during the period of time when the separator rollers are prevented from contacting the stack for advancing a sheet, as previously described.

As previously described, when the interposer pin 151 is in its operative position, as shown in Figure 3, the rocker shaft 143 carrying the gripper fingers 142 is automatically actuated during each revolution of the copy drum so that a document retained by the gripper fingers is released for delivery from the machine and the gripper fingers remain open sufficiently long enough to receive a new or second document. This is the mode of operation when the machine is set to make a single reproduction of an original or when making successive reproductions from successive originals.

When making multiple reproductions, of an original, it is desirable to retain the original on the copy drum during successive reproducing cycles, rather than requiring the operator to insert the original into the machine for each reproduction. To permit the document to be retained on the copy drum while making multiple reproductions, the interposer pin is moved out of operative relation with respect to the rocker shaft by an operator through the manipulation of control knob 6 of a programmer mechanism.

The programmer mechanism includes a control knob 6, secured to a control shaft 601 rotatably and slideably supported in a bracket 603 secured to the frame plate 11. The control knob is provided with a numbered scale so that the operator can dial the number of copies desired, for example, in the embodiment shown, the operator can set or programme the machine to make one to ten copies from an original.

Fixed by means of pin 604 and retainer 605 to one end of the control shaft 601 is the interposer cam 602, which is used to effect operation of the interposer pin 151, the latter effecting operation of the gripper fingers on the copy drum 30 as previously described. The interposer cam 602 is positioned on the control shaft so that the rise of the cam is in position to actuate the actuator lever 161 when the control knob 6 is turned to make multiple copies, that is, when the control

knob is set to make two to ten copies. With the interposer cam thus positioned on the control shaft, the fall of the cam is adjacent the actuator lever when the control knob is positioned to make single copies, that is, when number one on the dial is at the 12 o'clock position.

A ratchet 606 is fixed to the control shaft between the control knob and the front leg of bracket 603. A pawl plate 607 is loosely mounted on the control shaft between the ratchet 606 and a retaining ring positioned in a suitable groove formed in the control shaft.

A step by step rotary motion is imparted to the ratchet by cam 609 fixed on shaft SH2 supporting the copy drum, this cam operating on a roller 611 carried by a lever 612. The lever 612 is pivotably journalled on the stud shaft 613 fixed to the rearwardly extending ear of the rear leg of bracket 603, and is provided with a drive pin 614 which is slideably received in the slotted end of pawl plate 607. A spring 615 is attached at one end to the lever, and its other end to a stud 616 fixed to frame plate 12, and the arrangement is such that the lever is rocked by the cam 609 in one direction during each revolution of the copy drum to drive the ratchet and the return movement of the lever and ratchet in the opposite direction is produced by the spring 615 when the roller 611 engages the flat on the cam 609. The pawl plate 607, which is pivoted concentrically with the ratchet 606, carries a drive pawl 618 loaded by spring 617 which pawl is adapted to engage the teeth of the ratchet 606 so that as the pawl plate is rocked it turns the ratchet with a step by step motion.

The pawl 618 on its return stroke strikes a pawl retract pin 619 and is thereby raised out of engagement with the ratchet. When the machine is at rest, the pawl is in position out of engagement with the ratchet whereby the operator may rotate the control knob 6 to set the machine to produce the number of copies desired.

The control shaft 601 is normally biased to the front of the machine, to the left as seen in Figure 15, by coil spring 621 encircling the control shaft. One end of the coil spring butts against the rear leg of the bracket 603 and the opposite end of the coil spring butts against a thrust washer 622 retained axially on the control shaft by pin 604*a*.

A stop detent 623 (see Figures 15 to 17) is fixed to the rear leg of the bracket opposite the coil spring. The stop detent is provided with a large notched or detent portion defining a zero position and a series of angularly displaced small notches or detents, the latter numbering one less than the maximum number on the number scale on control knob 6. Thus in the embodiment shown, the stop detent is provided with nine small notches or detents. A detent pin 624 extends radially from the control shaft to cooperate with the stop detent, as described hereinafter.

The number of teeth on ratchet 606 is also one less than the highest number on the numbered scale on control knob 6. Thus, in the embodiment shown, wherein the control knob is calibrated with a number scale running from one through ten, the ratchet 606 is provided with nine teeth.

When it is desired to make more than one reproduction from an original, the mechanism is set by pushing inward on the control knob 6 against the action of spring 621 and simultaneously rotating the control knob to indicate the number of reproductions desired. When the control knob is pushed in and rotated in a clockwise manner, as shown in Figure 15, the detent pin 624 on the control shaft will be rotated to engage a small detent on the stop detent corresponding to the number dialled on the control knob minus one. The ratchet is also rotated upon rotation of the control shaft in corresponding relationship with the numbered scale on the control knob. At the same time the interposer cam 602 is rotated to actuate lever 161 to withdraw the interposer pin from its operative position and the interposer cam is moved to the rear out of engagement with multi-copy limit switch 7LS mounted on bracket 603, for a purpose to be described.

As the machine is actuated, the copy drum will be rotated and during each revolution of the copy drum, the ratchet will be indexed one step, in a counterclockwise direction, as seen in Figure 15. When the pawl engages the last tooth on the ratchet, it will rotate the control shaft sufficiently to allow the detent pin to ride off the shoulder on the stop detent to fall into the large detent or zero position thereon. When this occurs, the biasing action of the coiled spring 621 will force the control shaft forward locking the detent pin 624 in the zero position on the stop detent 623 and causing the interposer cam to move into contact with the multi-copy limit switch 7LS.

Referring to Figures 16 and 17, it is noted that when the interposer pin 151 is in its operative position with respect to the lever cam 148 on the rocker shaft 143, the latch stop 115, on shaft 101, carrying the document stops 107 and pressure fingers 106, will clear the end of the interposer pin 151 whereby the rocker shaft and elements attached thereto will operate in the manner previously described.

When the interposer pin 151 is moved out of operative relation to the rocker shaft, when making multiple reproductions, it is positioned in interference relation with the latch stop 115.

As a document is inserted into the machine, the elements on the shaft 101 will retain and

guide the document as previously described, but as soon as the shaft 101 is rotated to release the document, the latch stop will be rotated sufficiently to engage the interposer pin, that is, it will move from the position shown in Figure 9 to the position shown in Figures 13 and 17.

The latch stop 115 includes an arm 116 fixed to shaft 101. A latch 118 biased by spring 117 is pivotally secured to the arm 116 whereby as the shaft 101 and therefore arm 116 is moved in a counterclockwise direction, as seen in Figure 9, the latch 118 will be rocked about its pivot to ride past the interposer pin 151. Return movement of the shaft 101 and arm 116 in a clockwise direction is prevented by the latch 118 at one end striking the interposer pin, the opposite end of the latch striking an ear 119 on arm 116, whereby the document stops 107 and pressure fingers 106 are held out of interference relation with a document on the copy drum.

A clearer understanding of the operation of the apparatus can best be obtained by reference to the schematic wiring diagram and by reference back to the operating characteristics of the machine elements, as previously described.

Before the xerographic apparatus may be actuated, the removable panels of the cabinet enclosing the apparatus must be placed in closed position to actuate the interlock switches 1LS, 2LS and 4LS, mounted on the cabinet frame, not shown. These interlock switches are used, so that the machine may be operated only when the removable panels of the cabinet are in position. This provision is made, not only from the standpoint of safety, but also to ensure proper air circulation within the cabinet to dissipate heat generated by the projection lamps and the fuser. In addition, the paper tray and the developer apparatus must be positioned in operative relation to the other elements of the machine to close switches 3LS and 13LS, respectively.

The entire assembly of the apparatus is energised by closure of switch SW1 connecting the assembly through the switches 1LS, 2LS, 3LS and 4LS to a suitable source of power, such as a commercial 120 volt, 60 cycle alternating current outlet.

With the closure of switch SW1, the machine is placed in a stand-by condition as indicated by a stand-by lamp LMP1 which is energised through transformer T1. The resistance heating elements R1 and R2 of the heat fuser 70 are energised through the normally closed thermostat THS2. The machine is maintained in the stand-by condition for a period of time to permit the heat fuser to come up to its normal operating temperature. It is noted that motors MOT1 and MOT4 operating blowers, not shown, are connected in series with normally open thermostat THS1 directly across the line, whereby these motors may be energised upon a rise in temperature within the cabinet.

Referring now to Figure 5, the physical relationship of the control components of the machine and some of the electrical components involved in timing the machine are shown in the machine stand-by condition. The drum pulse switch 5LS is actuated by a cam 164 fastened to the copy drum shaft SH2. The cam 164 is arranged on the shaft so that the drum pulse switch 5LS is open at the time the machine shuts down, therefore, this switch is open when the machine is in a stand-by condition. The drum pulse switch is, in fact, an interlock which permits the solenoid SOL1 to be actuated to release time-out cam 630 when making successive copies as described hereinafter.

In the machine stand-by condition, the cam release solenoid SOL1 is de-energised thereby permitting the spring 671 to bias the levers 663 in position to maintain the clutch slide 640 in engagement with the time out cam 630, and to hold the separator rollers 61 out of contact with the support material stack through the linkage previously described.

In the stand-by condition the time out cam 630 actuates the limit switches 8LS, 9LS and 12LS. When the limit switch 8LS is actuated by the time out cam, its normally open contact 8LS-A is closed, and its normally closed contact 8LS-B is opened. In this position, of the time out cam, the normally open contact 9LS-A of limit switch 9LS is closed, and the normally closed contact 9LS-B is open. Also the normally open contact 12LS-A of multi-copy delay limit switch 12LS is closed, and its normally closed contact 12LS-B is open.

As a document is inserted into the machine through the document guide, the document sensing switch 6LS is actuated to close its normally open contact. This switch through the contact 9LS-A of limit switch 9LS, which is closed in a stand by position, the normally closed contact 11LS-B of an "end of cleaning web" limit switch 11LS and closed contact 12 LS-A permits the cam release solenoid SOL1 to be energised. As the cam release solenoid SOL1 is energised, it will, through the action of levers 663, pull the clutch slide 640 out of engagement with the time out cam 630 thereby permitting the time out cam to rotate back to its home position by the action of the return spring 651, as previously described.

As the time out cam returns to its home position, the respective cam surfaces thereon will ride off the actuators for limit switches 8LS, 9LS and 12LS. The main drive motor MOT3 is then energised, through the now closed contact 9LS-B of limit switch 9LS, to rotate the xerographic drum 20, the copy drum 30 and the sheet conveyor mechanism

62. Also fuser solenoid SOL2 is energised to open the gate of the heat fuser 70, the discharge lamp LMP6, a fluorescent lamp, is energised through its circuit consisting of ballast L5 and starter switch S3, power is also supplied to the high voltage power supply PS1 to effect operation of the corona charging device 21, the corona transfer device 64 and the corona pre-cleaning device 84, and with the opening of contact 9LS-A, the cam release solenoid SOL1 is de-energised.

At the same time, the wait-to-dial indicator lamp LMP11 is energised through the transformer T3, this lamp being used to indicate to the operator that the machine is now performing a processing cycle, so that the operator will not turn the control knob 6 at this time.

Within a very short period of time after the closure of contact 9LS-B, the contact 8LS-B of limit switch 8LS is closed to energise through closed switch 13LS the motor MOT2 to effect operation of the developing apparatus 50 and toner dispenser 54, and to energise transformer primary winding T2-A whereby power is supplied to the lamps LMP-4 and LMP-5. At this time, the contact 8LS-A of limit switch 8LS is opened, allowing an over voltage from the secondary T2-B of transformer T2 to be added to the line supplying power to the fluorescent lamps LMP-2 and LMP-3 through the circuits consisting of ballasts L1, L2 and L3, L4, and starters S1 and S2, respectively. Prior to the opening of contact 8LS-A, during stand-by, with transformer T2 un-energised normal line voltage is supplied to this fluorescent lamp circuit.

When the cam release solenoid SOL1 is energised to release the clutch slide 640, the latch 673 releases the cam lever 277 whereby its rollers 278 will drop onto the surface of a roller control cam 281 fixed to shaft SH1.

When the time out cam rotates off the limit switch 12LS, the contact 12LS-A will be opened which interrupts the line to cam release solenoid SOL1, previously de-energised by opening of contact 9LS-A.

When the cam release solenoid SOL1 was energised, it caused the release of the cam lever 277 thereby allowing the roller 278 thereon to engage roller control cam 281. When the cam release solenoid SOL1 is de-energised upon the opening of contact 9LSA, the lever 663 of the latch mechanism will be biased by spring 671 in a counterclockwise direction, as shown in Figure 18, but its movement will be arrested by latch portion 279 of cam lever 277 contacting the face of latch 673. With the movement of lever 663 thus arrested, the clutch slide 640 will not have been moved sufficiently to the left, as shown in Figure 18, to permit the lug 641 of the clutch slide to engage one of the slots 634 of time out cam 630.

It is noted that when making single reproductions of documents, the programmer mechanism is set to its zero position, that is, the numeral one on the control knob will be at the twelve o'clock position. As previously described, the normally closed limit switch 7LS is open when the programmer mechanism is at its zero position.

At the end of a paper feed cycle, the paper separator rolls 61 are raised by the roller control cam, and as the roller 278 rises on the roller control cam 281 the latch portion 279 of cam lever 277 will ride off the face of latch 673 to be engaged by the latch.

As the latch portion 279 rides off the face of latch 673, the levers 663 can be biased by spring 671 to their extreme counterclockwise position, whereby the clutch slide 640 will be shifted sufficiently to the left, to the position shown in Figure 18, to engage the time out cam 630 for effecting rotation of the time out cam. The engagement or latching up of the cam lever 277 prevents the paper feed system from feeding additional sheets.

After approximately 300° of rotation of the xerographic drum from the time at which the clutch slide became engaged with the time out cam, the time out cam will have rotated sufficiently to again actuate the limit switches 12LS and then 8LS. This causes the contact 8LS-B of limit switch 8LS to open to thereby de-energise the developer drive motor MOT2, transformer T2 and lamps LMP4 and LMP5. Normal line voltage is now supplied to the fluorescent lamp circuit consisting of lamps LMP2 and LMP3 and their associated ballasts and starters.

Upon continued rotation of the time out cam 630, the time out cam when it reaches its stand-by position, as shown in Figure 5, will actuate limit switch 9LS, causing its contact 9LS-B to open, thereby de-energising the main drive motor MOT3 and associated elements. The machine is once again in a stand-by position and a reproducing cycle can be initiated again, merely by inserting a document into the document guide to close the document sensing switch 6LS, whereupon the cam release solenoid SOL1 will again be energised to initiate another reproducing cycle.

The operation of the machine, while making a reproduction of successive documents fed into the machine will now be described. The action of the machine upon the insertion of the first document is identical with that described previously. If another document, a second document, is inserted into the machine soon after the first document has been gripped on the copy drum for movement into the machine, the document sensing switch 6LS will be held in a closed position by the second document.

The machine will now go through the sequence of operation, described earlier, for one complete revolution of the xerographic

drum. At the time the drum pulse switch 5LS is closed on the second cycle of rotation, the document sensing switch 6LS is still being held closed by the second document waiting to be received by the machine. Since the document sensing switch 6LS is closed, closure of the drum pulse switch 5LS will again energise the cam release solenoid SOL1, whereby the clutch slide 640 is disengaged from the time out cam 630 and the paper latch mechanism is disengaged to permit another paper feed cycle. Thus at approximately 240° of rotation of the xerographic drum from the beginning of the first reproducing cycle, the paper feed arm is latched up, as described previously. At the same time, the time out cam 630 has begun its time out cycle and will have actuated switch 12LS closing the contact 12LS-A prior to the closing of the drum pulse switch 5LS. With the closing of the drum pulse switch 5LS, the continued closure of the document sensing switch 6LS and the re-closure of contact 12LS-A, the cam release solenoid SOL1 is energised to release the paper feed cam lever 277 and to release the time out cam 630 permitting the time out cam to rotate back to its home position.

The machine has now been reset and starts a completely new reproducing cycle. If no other documents are inserted into the machine it will shut down as described earlier. If, at any time, during the shut down cycle another document is inserted into the machine, the document sensing switch 6LS will be closed by this document. The document will be retained in the document guide until gripped by the gripper fingers on the copy drum. The next time the drum pulsing switch 5LS closes, it will cause the machine to re-cycle, as previously described. The machine therefore, will reset and begin a new reproducing cycle every time the drum pulsing switch 5LS closes, provided the document sensing switch 6LS is closed at the same time.

For making multiple reproductions of an original, the operator will preset the programmer control knob 6 to the desired number of copies before inserting the document into the machine. The action of turning the programmer control knob to any number from two to ten, inclusive, closes the multi-copy switch 7LS. The interposer pin 151 is also withdrawn to an inoperative position upon rotation of the programmer control knob 6, as previously described. The starting of the machine and the acceptance of the document is identical to that of a single document. The multi-copy switch 7LS, in effect, sets up a holding circuit for the cam release solenoid SOL1, whereby this solenoid remains energised for as many cycles as are necessary to reproduce the required number of reproductions. Keeping the cam release solenoid energised prevents the cam lever 277 from latching up as previously described, therefore allowing the paper feed system to feed a sheet of paper during each revolution of the xerographic drum. The cam releases solenoid SOL1 also keeps the clutch slide 640 disengaged from the time out cam 630 thereby keeping the machine in continuous operation.

At approximately half a drum revolution before the end of the reproducing cycle at which the last required reproduction is being exposed, the programmer mechanism will be reset to its zero position as previously described, thereby opening the multi-copy limit switch 7LS and simultaneously allowing the interposer pin 151 to return to its normal operating position. This action readies the machine for shut down, by de-energising the cam release solenoid SOL1 to permit timing out of the machine, and allowing the gripper fingers on the copy drum to open to reject the document from the machine. The machine now shuts down in the normal manner as previously described.

Included in the holding circuit with multi-copy limit switch 7LS is switch 12LS. The contact 12LS-B of this switch is closed during part of the machine operating cycle and its primary function is to prevent the current in-rush from the developer drive motor MOT2 and the fill-in lamp circuit, from going through the document sensing switch 6LS which has a relatively low current rating.

The contact 12LS-A, which opens on the fly-back of the time out cam prior to closing of drum pulse switch 5LS prevents the cam release solenoid SOL1 from becoming energised a second time by the closing of the drum pulse switch 5LS during the first cycle of rotation of the copy drum.

Included in the machine electrical circuit is a "low paper supply" limit switch 10LS which is positioned to be actuated or closed, by a paper switch arm 254 secured to torque tube 253, whereby this switch is closed when the supply of sheet material in the paper feed tray is depleted. When this limit switch is closed during machine operation, it will energise solenoid SOL3 a conventional buzzer mechanism, not shown.

Also included in the electrical circuit is an "end of cleaning web" limit switch 11LS. This limit switch is positioned adjacent the take-up roll 83 of the web cleaner, whereby material is advanced into contact with the xerographic drum to clean residual powder material remaining thereon, and will be wound on the take-up roll. As the web material is wound on the take-up roll 83, the effective diameter of the material on this roll will increase in direct ratio to a decrease in the amount of web material remaining on the supply roll. Thus, when the supply of the web material on supply roll 83 is nearly depleted, the diameter of material on take-up

roll 83 will have increased sufficiently whereby the web material will contact the actuator of limit switch 11LS. When this occurs the normally open contact 11LS-A will be closed to energise small indicator lamps LMP7, LMP8, LMP9 and LMP10, positioned in a group beneath an indicator panel of glass or other suitable material adjacent switch SW1, thus indicating to the operator that he should replenish the supply of web material in the machine. These indicator lamps can only be energised when the machine is in the stand-by condition, since the contact 11LS-A of limit switch 11LS is in series with the contact 9LS-A of limit switch 9LS which is only closed when the machine is in the stand-by condition. When contact 11LS-A is closed, as previously described, the normally closed contact 11LS-B is opened thereby preventing the machine from being actuated again until the supply of web material is replenished.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth.

WHAT WE CLAIM IS:—

1. A xerographic copying machine comprising a drum having a photoconductive surface upon which for production of an electrostatic latent image there is projected an optical image of an original to be copied and the surface of which drum when being rotated to effect a copying cycle passes through a number of processing stations which act on the drum, an original carrier connected for rotation in synchronism with the drum, controllable grippers associated with the original carrier, a control system which in a first position permits the grippers to grip an original on the carrier and which in a second position permits the actuation of the grippers to release the original, the system including a counter responsive to the number of copying cycles effected by the drum, which counter for the production of multiple copies is set in accordance with the number of copies to be made and which causes the control system to assume the first position until the drum has completed a number of copying cycles one less than the number of copies set on the counter and subsequently to assume the second position.

2. Apparatus as claimed in claim 1 wherein the original carrier is a copy drum movable in synchronism with the said drum by a common drive means and wherein there is provided a clutch operated control means controlled by the control system and connected to the drive means for forcing the drum to continue rotation after the last copying cycle set by the counter to effect a timing-out cycle.

3. Apparatus as claimed in claim 2 wherein the clutch operated control means comprises a cam normally co-operating with a clutch slide.

4. Apparatus as claimed in any one of claims 1 to 3 wherein the control system includes a spring loaded shaft mounted for rotatable and axial movement and a cam secured to the shaft and operatively connected with an interposer member which actuates the grippers.

5. Apparatus as claimed in claim 4 when appendant to claim 3 wherein the clutch slide is movable into and out of engagement with the cam with which it normally co-operates under the influence of a solenoid controlled by a holding circuit including a limit switch actuated by the cam secured to said spring loaded shaft.

6. Apparatus as claimed in claim 5 wherein the rotation of the shaft causes the cam secured thereto simultaneously to close the limit switch and moves a lever which in turn moves the interposer member.

7. Apparatus as claimed in any one of claims 4 to 6 wherein the shaft carries a projection for engagement with a fixed detent means encircling the shaft and having an enlarged notch thereon to allow the shaft to move axially with respect to the detent means when the projection is in line with the enlarged notch.

8. Apparatus as claimed in any one of claims 3 to 7 wherein the shaft has a ratchet fixed thereto to which ratchet a step-by-step rotation is imparted from drive means connected with the original carrier and the drum.

9. Apparatus as claimed in claim 7 and claim 8 wherein the detent means has a number of smaller notches thereon equal to the number of teeth on the ratchet.

10. Apparatus as claimed in claim 7 or claim 9 wherein the shaft carries a knob by means of which the shaft is rotatable by hand to vary the position of the projection angularly with respect to the detent means so as to vary the number of copying cycles effected before the cam secured to the shaft causes the interposer member to actuate the grippers.

11. A xerographic copying machine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

For the Applicants:
ARTHUR POOLE,
Chartered Patent Agent.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1966.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained

roll 83 will have increased sufficiently whereby the web material will contact the actuator of limit switch 11LS. When this occurs the normally open contact 11LS-A will be closed to energise small indicator lamps LMP7, LMP8, LMP9 and LMP10, positioned in a group beneath an indicator panel of glass or other suitable material adjacent switch SW1, thus indicating to the operator that he should replenish the supply of web material in the machine. These indicator lamps can only be energised when the machine is in the stand-by condition, since the contact 11LS-A of limit switch 11LS is in series with the contact 9LS-A of limit switch 9LS which is only closed when the machine is in the stand-by condition. When contact 11LS-A is closed, as previously described, the normally closed contact 11LS-B is opened thereby preventing the machine from being actuated again until the supply of web material is replenished.

While the invention has been described with reference to the structure disclosed herein, it is not confined to the details set forth.

WHAT WE CLAIM IS:—

1. A xerographic copying machine comprising a drum having a photoconductive surface upon which for production of an electrostatic latent image there is projected an optical image of an original to be copied and the surface of which drum when being rotated to effect a copying cycle passes through a number of processing stations which act on the drum, an original carrier connected for rotation in synchronism with the drum, controllable grippers associated with the original carrier, a control system which in a first position permits the grippers to grip an original on the carrier and which in a second position permits the actuation of the grippers to release the original, the system including a counter responsive to the number of copying cycles effected by the drum, which counter for the production of multiple copies is set in accordance with the number of copies to be made and which causes the control system to assume the first position until the drum has completed a number of copying cycles one less than the number of copies set on the counter and subsequently to assume the second position.

2. Apparatus as claimed in claim 1 wherein the original carrier is a copy drum movable in synchronism with the said drum by a common drive means and wherein there is provided a clutch operated control means controlled by the control system and connected to the drive means for forcing the drum to continue rotation after the last copying cycle set by the counter to effect a timing-out cycle.

3. Apparatus as claimed in claim 2 wherein the clutch operated control means comprises a cam normally co-operating with a clutch slide.

4. Apparatus as claimed in any one of claims 1 to 3 wherein the control system includes a spring loaded shaft mounted for rotatable and axial movement and a cam secured to the shaft and operatively connected with an interposer member which actuates the grippers.

5. Apparatus as claimed in claim 4 when appendant to claim 3 wherein the clutch slide is movable into and out of engagement with the cam with which it normally co-operates under the influence of a solenoid controlled by a holding circuit including a limit switch actuated by the cam secured to said spring loaded shaft.

6. Apparatus as claimed in claim 5 wherein the rotation of the shaft causes the cam secured thereto simultaneously to close the limit switch and moves a lever which in turn moves the interposer member.

7. Apparatus as claimed in any one of claims 4 to 6 wherein the shaft carries a projection for engagement with a fixed detent means encircling the shaft and having an enlarged notch thereon to allow the shaft to move axially with respect to the detent means when the projection is in line with the enlarged notch.

8. Apparatus as claimed in any one of claims 3 to 7 wherein the shaft has a ratchet fixed thereto to which ratchet a step-by-step rotation is imparted from drive means connected with the original carrier and the drum.

9. Apparatus as claimed in claim 7 and claim 8 wherein the detent means has a number of smaller notches thereon equal to the number of teeth on the ratchet.

10. Apparatus as claimed in claim 7 or claim 9 wherein the shaft carries a knob by means of which the shaft is rotatable by hand to vary the position of the projection angularly with respect to the detent means so as to vary the number of copying cycles effected before the cam secured to the shaft causes the interposer member to actuate the grippers.

11. A xerographic copying machine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

For the Applicants:
ARTHUR POOLE,
Chartered Patent Agent.

Leamington Spa: Printed for Her Majesty's Stationery Office by the Courier Press.—1966.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained