ABSTRACT

A continuously operating conveyor moves sheet material through the exposure station, the latter including illuminating apparatus and a lens defining an optical axis. The illuminating apparatus and the lens are mounted for reciprocal movement along the optical axis to vary the size of the image which is focused on the sheet material. A first sensor adjacent the conveyor detects the leading edge of the sheet and actuates a cutter. Another sensor adjacent the conveyor and downstream of the first sensor detects the leading edge of the sheet for energizing the illuminating apparatus. The sensors are mounted for movement in either direction along a path parallel with the path of movement of the sheet at the exposure station for varying the length of the sheet and for permitting equal spacing of the leading and trailing edges of the sheet from the optical axis when the illuminating apparatus is energized regardless of the length of the sheet. The original material to be reproduced may be rotated about the optical axis for changing the orientation of an image on the sheet.

14 Claims, 9 Drawing Figures
IMAGE REPRODUCTION MACHINE WITH IMPROVED EXPOSURE STATION FOR MAKING VARIABLE SIZE COPIES

BACKGROUND OF THE INVENTION

1. Field of the Invention
The field of the invention relates to machines for reproducing images on flexible sheet material; more particularly, the present invention relates to improvements in electrostatic copying machines. Specifically, the invention has to do with improvements for making variable size copies of the original material. The invention is disclosed and illustrated within the context of a machine for making electrostatic copies of original material in the form of microfilm. Of course, the invention is not to be limited to that particular type of machine as it will be apparent that the invention has broad applicability to electrostatic copying machines in general.

2. The Prior Art
It is known in the prior art to provide copying machines having means for varying the length of the copy sheet material. Such machines are supplied with sheet material in continuous or roll form in which case a cutting mechanism is provided for severing the sheet material to obtain individual sheets in the desired lengths. A sensor is provided at the exposure station for detecting arrival or passage of the sheet for actuating the cutting mechanism. Plural sensors spaced longitudinally of the path of sheet movement may be provided to obtain sheets of different lengths; alternatively, the variable length sheets may be obtained by providing a single sensor adjustably mounted for movement along the path of sheet movement. Representative patents showing the aforementioned construction are: Johnston U.S. Pat. No. 3,560,086 and Margulis et al. U.S. Pat. No. 3,655,283.

According to these prior art machines, the image projected on a sheet of the sheet material will be centered with respect to the sheet leading and trailing edges only for one predetermined length of sheet. This result obtains because the illuminating means is energized to project the image on the sheet when the leading edge of the latter arrives at a predetermined fixed point along its path of travel, irrespective of the length of the sheet.

It is also known in the prior art to provide mechanism in electrostatic copying machines of the type under consideration for centering the projected image on sheets of varying lengths. According to these machines, the illuminating means is energized for projecting the image when the leading edge of the sheet arrives at a predetermined fixed point during its path of travel through the exposure station, irrespective of the length of the sheet. Centering of the projected images in machines of this type is achieved by mounting the illuminating means, and/or the associated lens for focusing the image on the sheet, on a carriage which travels along a path inclined with respect to the optical axis defined by the aforementioned lens. It will be appreciated by those skilled in the art that such inclined path of travel is necessary due to the fact that the leading edge of the copy sheet always occupies the same predetermined position along its path of travel irrespective of the length of the sheet. The necessity for this inclined mounting complicates the mechanism for supporting the illuminating means and/or the lens and requires additional space within the machine since the carriage must move not only toward and away from the copy sheet at the exposure station and along the optical axis, but laterally of the optical axis as well.

SUMMARY AND OBJECTS OF THE INVENTION

The present invention relates to a new and improved mechanism constituting the exposure station in an image reproduction machine, such mechanism permitting the making of variable length copies with the image centered with respect to the leading and trailing edges of the sheet irrespective of the length thereof.

A primary object of the present invention is the provision of an exposure station in a machine of the type described, which exposure station includes means defining an optical axis along which an image is projected on sheet material, and first and second movably mounted sensors responsive to passage of the leading edge of the sheet material for respectively actuating a cutting mechanism and energizing the illuminating means thereby to provide for equal spacing of the leading and trailing edges of the sheet from the optical axis irrespective of the length of the sheet.

Still another object of the present invention is the provision of exposure station mechanism according to the foregoing object, wherein the illuminating means and/or an associated lens are mounted for reciprocal movement along the optical axis thereby to vary the size of the projected image.

Another object of the present invention is the provision of mechanism according to the foregoing object, wherein a carriage mounts the illuminating means and/or lens, and wherein a frame is provided for holding the original material to be reproduced, which frame is mounted for movement relative to the carriage and about the optical axis thereby to change the orientation of the projected image on the sheet material.

Still another object of the present invention is the provision of exposure station mechanism of the type described wherein the illuminating means and lens for focusing an image on a sheet of the sheet material are mounted for reciprocal movement along the optical axis defined by the lens thereby to vary the size of the projected image, wherein a sensor is provided for detecting arrival of the leading edge of the sheet thereby to energize the illuminating means, and wherein the sensing means is mounted for movement in either direction along a path parallel with the path of movement of the sheet material at the exposure station thereby permitting automatic energization of the illuminating means and with the leading and trailing edges of the sheet equally spaced from the optical axis irrespective of the length of the sheet.

These and other objects and advantages of the invention will become apparent from the following specification disclosing a preferred embodiment shown in the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an image reproduction machine embodying the present invention;
FIG. 2 is a vertical central section of the machine and being somewhat diagrammatic in form;
FIG. 3 is an enlarged section taken along the line 3—3 of FIG. 2;
FIG. 4 is a section taken along the line 4—4 of FIG. 3;
FIG. 5 is an enlarged side elevational view of the movably mounted carriage shown in FIG. 2; FIG. 6 is a section taken along the line 6—6 of FIG. 5; FIG. 7 is a section taken along the line 7—7 of FIG. 5; FIG. 8 is an electrical schematic of the circuit forming part of the present invention; and FIG. 9 is an electrical schematic of another part of the circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the present invention will be described as being embodied in an automatic microfilm enlarger printer, generally designated 10. The present invention is shown in such a machine for purposes of illustration only and not by way of limitation. Such a machine is adapted to make copies or offset masters, by an electrostatic reproduction process, from original material in the form of microfilm.

The electrostatic copying process is well known to those skilled in the art and utilizes sheet material having a photoconductive coating thereon which receives an electrostatic charge and is then exposed to an image of the original to produce a latent electrostatic image of the original on the copy sheet material. The copy material carrying the latent electrostatic image is passed through a developing zone in which it is brought into contact with particles of toner material which adhere to the copy material on the charged areas of the latent image. After passing through the developing zone, the copy material is advanced through a drying station where the developed image is fixed. When it is desired to make offset masters, the copy material is passed through a conversion zone for coating the surface property of the copy material from hydrophobic to hydrophilic thereby making the copy capable for use as a master in an offset duplicating apparatus.

The microfilm printer 10 includes a housing or cabinet 11 having a control console 12 and access doors 13. A rear projection screen 14 is provided for viewing the microfilm to be reproduced through a suitable optical system. Accordingly, the microfilm printer 10 is what is known in the art as a “reader/printer.”

Referring now to FIG. 2, a roll of copy sheet material 15 is mounted on a spindle 16. The sheet material is driven or unwound by a belt 17 which engages the periphery of the roll. The belt is supported by fixed rollers 18 and 19, the latter being associated with another fixed roller 20. A roller 21 is engaged with the belt 17; this roller is movably mounted, as by means of an arm 23 connected to a spring 24. The movably mounted roller 21 will maintain the belt 17 in a taut condition as the size of the roll 15 diminishes as a result of paying out the sheet material. The rollers 19, 20 are intermittently driven by a suitable drive mechanism 25 for advancing the sheet material 15 as will be explained hereinbelow.

The sheet material is advanced by conveyor means including pairs of rollers 27, 28 and 29 to a cutting mechanism; the roller 29 is driven by the drive mechanism 25. This cutting mechanism is of the type known to those skilled in the art and capable of severing the sheet as the latter moves through the cutting mecha-
Another sensor in the form of a microswitch 70 has a sensing arm 70a. This microswitch is carried by a slide 72, the latter being mounted for vertical reciprocal movement on rails 73 supported from a bracket 74. This bracket is mounted adjacent the plate 69. As will be explained hereinbelow, the microswitch 70 energizes the xenon flash for projecting the microfilm image on the copy sheet material.

A paper length sensor knob 75 (FIG. 3), accessible through the doors 13, is suitably connected to a wheel 76 by mechanical means indicated by the broken line 77. The knob 75 is rotatable through approximately 270° for selecting copy sheet lengths between 8\(\frac{1}{2}\) inches and 18\(\frac{1}{8}\) inches.

A twenty-four tooth sprocket 76 is mounted on a shaft 78 and engaged by a chain 80, which chain is engaged with a 36 tooth sprocket wheel 82 mounted on a shaft 83. The shaft 83 is rotatably mounted by journals 84 and carries a thirty-two tooth gear 85, the latter being in meshing engagement with the sixteen tooth portion of a 16/30 tooth combination gear 86 mounted on a shaft 87, which shaft is supported by journals 88, 89. The thirty tooth portion of this gear is in meshing engagement with a sixteen tooth gear 91 mounted on a shaft 92 supported by journals 93. The shaft 92 mounts a 16 socket bead chain sprocket 95, which sprocket is engaged with a 92 bead chain shown by the dotted lines 96. The chain 96 is connected to the slide 72 thereby to impart vertical reciprocal movement to the latter in response to corresponding movement of the adjacent portion of the chain.

The chain 96 is trained around a 16 socket bead chain sprocket 98 mounted on a shaft 99 supported by journals 100. This shaft 99 mounts a 32 tooth gear 102 in meshing engagement with a 16 tooth idler gear 103 supported on a shaft 104 mounted by journals 105. This idler gear is in meshing engagement with a 32 tooth gear 107 mounted on a shaft 108 supported by journals 109. The shaft 108 mounts a 16 socket bead chain sprocket 110, the latter being engaged by a 74 bead chain 112. This chain is engaged with another sixteen socket bead chain sprocket 113 mounted on a shaft 114. This shaft is supported by journals 115 and mounts a 16 bead chain sprocket 116. Such sprocket is engaged with a 112 bead chain 117 which engages another 16 socket bead chain sprocket 118, the latter being rotatably mounted by an idler shaft 119. The chain 117 is engaged with the slide 66 for imparting vertical reciprocal movement thereto in response to corresponding movement of the adjacent portion of the chain.

It will be apparent that by reason of the drive chain just described, rotation of the knob 75 will result in vertical reciprocal movement of the slides 66, 72, the slides of course moving in unison. The various gears are designed and proportioned such that the slide 66 will move at a 2:1 ratio with respect to movement of the slide 72. These slides are positioned such that the microswitch 70 will be actuated to energize the xenon flash when the leading and trailing edges of the sheet of copy material are equally spaced with respect to the optical axis 46. By reason of the 2:1 ratio of movement of the slides 66, 72 relative to each other, this relationship of equal spacing of the leading and trailing edges of the sheet from the optical axis will be maintained irrespective of the length of the copy sheet material. That is to say, the image projected on the copy sheet at the exposure station will always be centered with respect to the leading and trailing edges of the sheet irrespective of the length of the latter.

The circuit including the microswitches 65, 70 for respectively actuating the cutter and energizing the xenon tube will be explained hereinbelow. These microswitches may be connected in the circuit in any suitable manner. By way of example, the rails 67, 73 may be made conductive and insulated from the respective supporting brackets 68, 74 and the slides 66, 72 may be provided with contacts (not shown) slideably engaged with such conductive slides.

The carriage 45 includes a pair of plates 120, 121 (FIG. 5) supported in vertical spaced relation by a plurality of spacer tubes 123. The plate 120 mounts a pair of journals 124, 125; similarly, the plate 121 mounts a pair of journals 126, 127. The journals 124, 126 are slidably mounted on a rod 128. In like manner, the journals 125, 127 are slidably mounted on a rod 129. Opposite ends of these rods are suitably supported by frame members 131, 132 (FIG. 2) attached to the cabinet 11. It will be apparent that the carriage 45 is mounted for horizontal reciprocal movement along the optical axis 46.

A threaded drive shaft 134 has its respective opposite ends journaled by the framework of the cabinet 11; one of such journals is illustrated in FIG. 5 and designated 135. The carriage plates 120, 121 are apertures for receiving the shaft 134. The plate 120 mounts a bushing 137 which receives the shaft 134; the plate 121 mounts a nut 138 threadedly engaged with the drive shaft 134.

A pulley wheel 140 is mounted on one end of the drive shaft 134 for rotating the latter. This pulley wheel is engaged by a belt 141, which belt is engaged by a pulley wheel 142 driven by a reversible electric motor 143. It will be apparent that energization of the motor 143 will cause movement of the carriage 45 along the optical axis 46 and in a direction depending upon the direction of rotation of the motor.

The plates 120, 121 mount respective swivel bearings 145, 145a, which bearings are engaged with a frame member 146 forming part of a film head assembly, generally designated 147. It will be understood that the swivel bearings mount the film assembly 147 for rotation relative to the carriage 45 and about the optical axis 46.

The frame member 146 mounts a pair of studs 148, 149, which studs are slideably received in respective slots 150, 151 formed in an arm 152. The plate 146 also mounts a stud 154 engaged with one end of a spring 155. The other end of this spring is connected to the arm 152, as by means of a pin 156. A slot 157 is formed in the arm 152 and receives the stud 154 to permit vertical reciprocal movement of the arm. It will be apparent that the spring 155 urges the arm 152 upwardly. A handle 159 is connected to the lower end of the arm 152 to permit actuation thereof.

The upper end of the arm 152 mounts a pin 160. This pin is adapted to be alternately received within recesses 161, 162 formed in an arcuate indexing plate 163. This indexing plate is secured to the carriage plate 121, as by means of fasteners 164, 165.

The film head assembly 147 mounts respective supply and take-up reels 168, 169 for a strip of microfilm
The microfilm is guided through a projection gate by means of pairs of rollers and a lens assembly and a xenon flash tube.

The components of the film head assembly also include a lens assembly and a xenon flash tube.

The film head assembly is guided through a projection gate by means of pairs of rollers and a lens assembly. The film is fed through the cutting mechanism by means of a pair of rollers.

When desired, the film head assembly is retracted and the film is positioned in the recess. The film is then released and returned to the position indicated in the drawings. The arm is again manually actuated for positioning the film in the recess. Thus, the film may be projected on the copy sheet material in either of two positions.

The circuit which includes the switches, relay and capacitor is shown in FIGS. 8 and 9. The lines represent a 115 volt AC power supply. The lines represent a 24 volt DC power supply, and the lines represent a 5 volt DC power supply.

Assume that the copy size is 75 inches long. The desired length of copy material and assume that the quality selector (located on panel 12, FIG. 1) has been actuated for making plural copies of the selected image on the microfilm strip. At this time it should be mentioned that prior to instituting a copy cycle, the various conveyors in the machine, including the conveyor, will be in operation and will operate continuously throughout the cycle.

When the copy cycle is commenced by actuating a print function switch, a relay is energized closing its contacts and releasing its contacts. The contacts are energized and the relay contacts are energized. The contacts close and release the energy pulse to the relay coil. This causes the leading edge of the sheet material to engage the contact and initiate charging of a capacitor which provides an energizing pulse to a relay. The energization of this relay will close the contacts for energizing a solenoid. This solenoid will actuate the cutting mechanism for severing the sheet material.

As the trailing edge of the sheet passes the switch, the movable member will be returned to the contact position for again pulsing the relay to actuate the drive mechanism as explained above, thereby to supply the successive sheet of copy material. The distance of the cutter blade associated with the cutter mechanism from the switch determines the distance between the trailing and leading edges of successive sheets. This sheet separation is, of course, important to prevent the simultaneous exposure of a single image on two sheets as the latter pass through the exposure zone.

As the copy sheet is advanced by the continuously moving conveyor, the leading edge of the sheet will engage the arm of the switch. This will cause engagement of a contact and a movable arm thereby flashing the xenon lamp through a trigger input of xenon supply which receives power from charged capacitor previously charged through the 5 volt DC line connected to the switch contact. When the trailing edge of the sheet passes the switch, the movable arm thereof will separate from each of the contacts for rearranging the circuit in the same manner as described above in connecting with rearrangement of the feed circuit.

As long as the relay is energized, copy sheet material from the roller will be intermittently supplied and severed by the cutting mechanism, as explained above. After the preselected quantity of copies has been made, the relay will be de-energized through appropriate circuitry (not shown) effecting opening of switch for maintaining the coron power supply on for a short period of time after relay is de-energized thereby assuring that the trailing edge of the copy is charged, a relay capable of closing associated contacts is connected across a charged capacitor. As the capacitor discharges through the relay it maintains the relay energized.

It is apparent that according to the present invention the carriage is selectively positioned along the optical axis depending on the degree of magnification desired. Since the carriage moves along the optical axis, the projected image will always be centered with respect to the optical axis, irrespective of the length of the copy material. By reason of the mounting means for the switches, the leading and trailing edges of the sheet, irrespective of the length thereof, will always be equally spaced from the optical axis whenever the switch is actuated for energizing the xenon flash. Further, the orientation of the projected image on the copy sheet material may be readily changed by manual actuation of the arm for swinging of the film head assembly about the optical axis.

We claim:
1. In a machine for producing a reproduction of an image on flexible sheet material, wherein the machine includes supply means for feeding the sheet material in continuous form, cutting means for severing the sheet material to form individual sheets, a charging station for applying a charge to the sheet material, an exposure station for exposing the sheet material to the...
image, which exposure station includes illuminating means defining an optical axis, a developing station for developing a reproduction of the image directly on the exposed sheet material, and conveyor means located downstream of said cutting means for advancing the sheet material through said exposure station, the improvement comprising:

a. first sensing means adjacent said conveyor means for sensing the leading edge of the sheet material thereby to produce a first control signal;

b. second sensing means adjacent said conveyor means and downstream of said first sensing means for sensing the leading edge of the sheet material thereby to produce a second control signal;

c. first control means responsive to said first control signal and connected with said cutting means for operating the latter;

d. second control means responsive to said second control signal and connected with said illuminating means for energizing the latter; and

e. first and second mounting means respectively supporting said first and second sensing means for movement in either direction along a path parallel with the path of movement of the sheet material at said exposure station so that equal spacing of the leading and trailing edges of the sheet material from said optical axis when said illuminating means is energized.

2. The improvement according to claim 1 further defined by, other means positioning and interconnecting said first and second mounting means such that the amount of movement of said first sensing means is twice the amount of movement of said second sensing means thereby automatically providing for the equal spacing of the leading and trailing edges of such sheet from the optical axis.

3. The improvement according to claim 2 wherein said other means includes a mechanical drive train connecting said first and second mounting means.

4. The improvement according to claim 2 further defined by, said machine including copy sheet size selection means, said selection means being connected with said other means.

5. The improvement according to claim 1 further defined by:

a. intermittently operable drive means associated with said supply means;

b. third sensing means located between said cutting means and said first sensing means for sensing passage of the trailing edge of a sheet of sheet material thereby to produce a third control signal; and

c. third control means responsive to said third control signal and connected to said drive means for operating the latter.

6. The improvement according to claim 1 further defined by:

a. said exposure station including a lens for focusing an image on a sheet of the sheet material, which lens defines said optical axis; and

b. support means mounting said lens for reciprocal movement along the optical axis for varying the size of the projected image to correspond to the length of a sheet of said sheet material as determined by the location of said first sensing means.

7. The improvement according to claim 6 further defined by:

a. said support means including a carriage supporting said lens and said illuminating means and mounted for reciprocal movement along said optical axis;

b. a frame carried by said carriage and mounted for movement relative to the latter and about said optical axis; and

c. further means on said frame for holding the material to be reproduced, said further means serving to hold the material in centered relationship with the optical axis and being movable with said frame thereby to change the orientation of an image on a sheet of the sheet material.

8. The improvement according to claim 7 further defined by:

a. said further means including a film projection gate; and

b. film strip handling means carried by said frame and including supply and take-up reels for a strip of film.

9. In a machine for producing a reproduction of an image on flexible sheet material, wherein the machine includes supply means for feeding the sheet material, a charging station for applying a charge to the sheet material, an exposure station for exposing the sheet material to the image, a developing station for developing a reproduction of the image directly on the exposed sheet material, the improvement comprising:

a. sensing means adjacent said exposure station for sensing the leading edge of a sheet of the sheet material thereby to produce a control signal;

b. said exposure station including illuminating means and a lens for focusing an image on a sheet of the sheet material, which lens defines the optical axis of the exposure station;

c. support means mounting said illuminating means and said lens for reciprocal movement along said optical axis for varying the size of the projected image;

d. control means connected with said illuminating means for energizing the latter in response to said control signal; and

e. mounting means supporting said sensing means for movement in either direction along a path parallel with the path of movement of the sheet material at said exposure station so that automatic energization of said illuminating means in response to arrival of the leading edge of a sheet at said sensing means and with the leading and trailing edges of the sheet equally spaced from said optical axis irrespective of the length of the sheet.

10. The improvement according to claim 9 further defined by:

a. said support means including a carriage supporting said lens and said illuminating means and mounted for reciprocal movement along said optical axis;

b. a frame carried by said carriage and mounted for movement relative to the latter and about said optical axis; and

c. further means on said frame for holding the material to be reproduced, said further means serving to hold the material in centered relationship with the optical axis and being movable with said frame thereby to change the orientation of an image on a sheet of the sheet material.

11. The improvement according to claim 10 further defined by:
a. said further means including a film projection gate; and
b. film strip handling means carried by said frame and including supply and take-up reels for a strip of film.

12. The improvement according to claim 9 further defined by:
   a. said supply means including means for supplying the sheet material in continuous form;
   b. cutting means for severing the sheet material thereby to form individual sheets;
   c. other sensing means adjacent said exposure station and located upstream of said first mentioned sensing means for sensing the leading edge of the sheet material thereby to produce another control signal;
   d. other control means connected with said cutting means for actuating the latter in response to said another control signal;
   e. other mounting means supporting said other sensing means for movement in either direction along a path parallel with the path of movement of the sheet material at said exposure station thereby permitting the cutting means to sever the sheet material to form sheets of varying length.

13. The improvement according to claim 12 further defined by, further means positioning and connecting said first mentioned mounting means and said other mounting means such that the amount of movement of said other sensing means is twice the amount of movement of said first mentioned sensing means thereby automatically providing for the equal spacing of the leading and trailing edges of such sheet from the optical axis.

14. The improvement according to claim 12 further defined by:
   a. said support means including a carriage supporting said lens and said illuminating means and mounted for reciprocal movement along said optical axis;
   b. a frame carried by said carriage and mounted for movement relative to the latter and about said optical axis; and
   c. further means on said frame for holding the material to be reproduced, said further means serving to hold the material in centered relationship with the optical axis and being movable with said frame thereby to change the orientation of an image on a sheet of the sheet material.

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