June 27, 1972 SHIGERU SUZUKI ET AL 3,672,762

ELECTROPHOTOGRAPHIC COPYING MACHINE

Filed April 24, 1970 2 Sheets-Sheet 1

FIG. 1

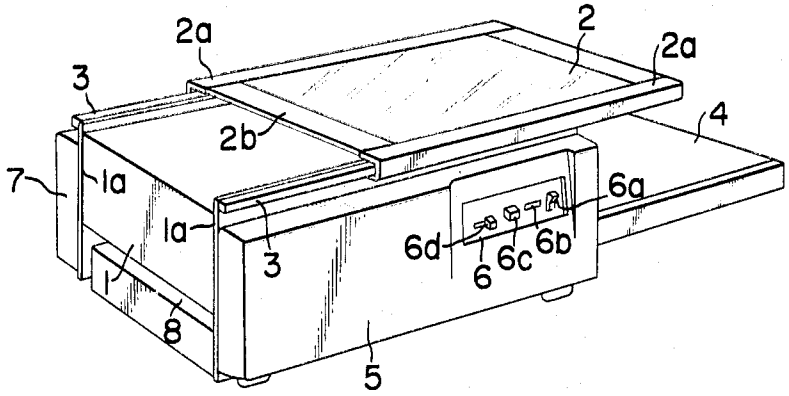


FIG. 2

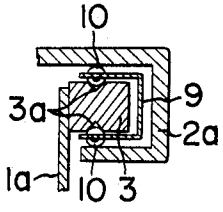


FIG. 3

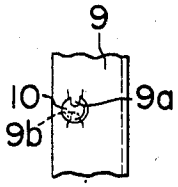


FIG. 4

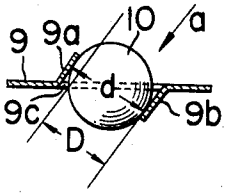


FIG. 5

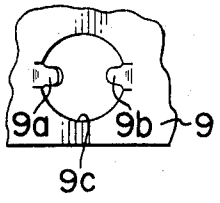


FIG. 6

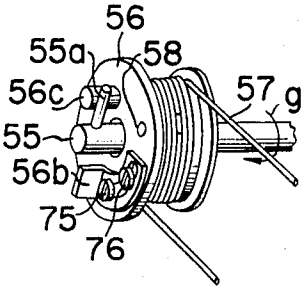


FIG. 7

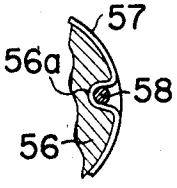
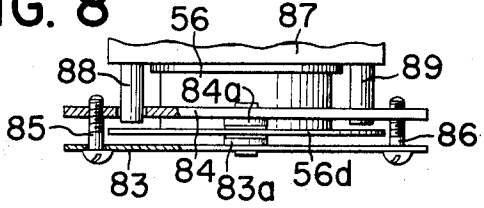


FIG. 8



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ELECTROPHOTOGRAPHIC COPYING MACHINE

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FIG. 9

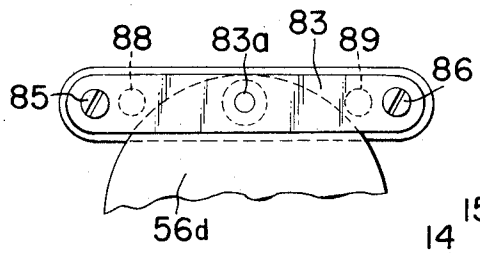


FIG. 10

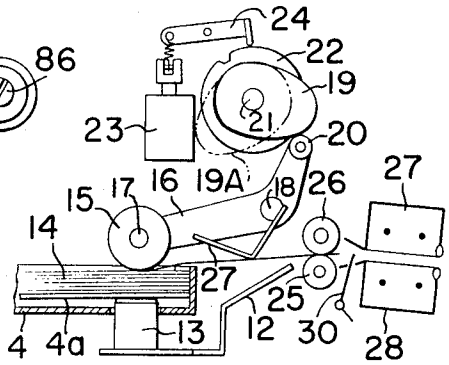


FIG. 11

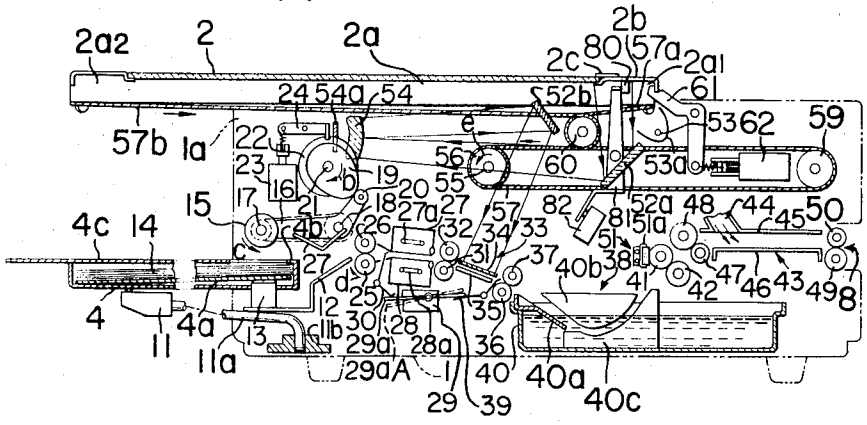
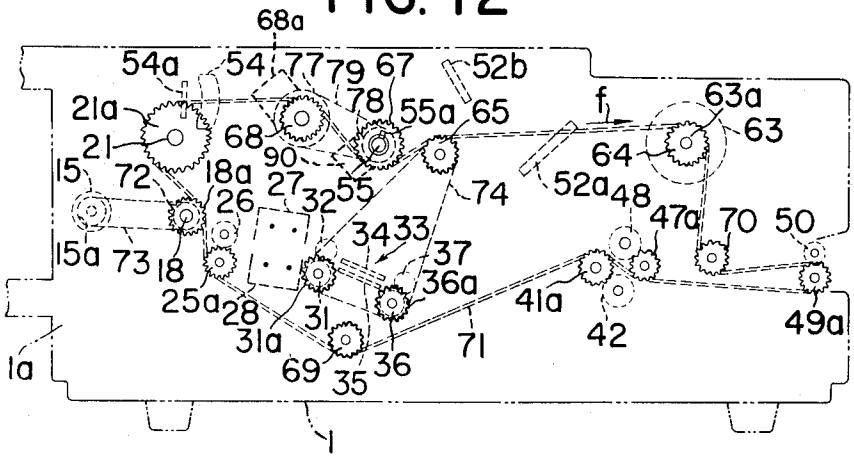


FIG. 12



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United States Patent Office 3,672,762
Patented June 27, 1972

3,672,762

ELECTROPHOTOGRAPHIC COPYING MACHINE

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Filed Apr. 24, 1970, Ser. No. 31,596
Claims priority, application Japan, Apr. 25, 1969, 44/32,511
Int. Cl. G03g 13/10
U.S. Cl. 355—10 7 Claims

ABSTRACT OF THE DISCLOSURE

An electrophotographic copying machine of the type in which both of an original to be reproduced and a copy paper are moved in synchronism with each other relative to a slit exposure optical system wherein the copy paper, upon admission into a charging station, actuates a common switch which energizes the charger, the light source in the exposure optical system and an electromagnetic clutch for coupling an original carrier device to a drive mechanism until the copy paper passes through the exposure station. Upon discharge of the copy paper from the exposure station, the charger, light source and clutch are de-energized while a reverse clutch is energized so as to return the carrier to the initial position. In order to attain the precise registration of the leading edges of the copy paper and original, a device for driving the carrier after predetermined time delay when said electromagnetic clutch is energized is provided along with a member for locking the carrier in the initial position until a start button is depressed, and a mechanism for preventing any slippage of the carrier drive cable.

BACKGROUND OF THE INVENTION

The present invention relates to a photocopying machine and more particularly an electrophotographic copying machine of the type in which both the original to be reproduced and a copy paper are transported for exposure in synchronism with each other and relative to a slit exposure optical system.

In an automatic electrophotographic copying machine of the type described, it is most essential that the carrier device upon which the original is placed to be reproduced is displaced in precise synchronism with the movement of the copy paper through at least an exposure station so that the whole pattern upon the original may be copied upon the copy paper. In machines of this type, it is exceedingly difficult to attain the precise registration of the leading edges of the original and copy paper in the exposure station since they are registered optically not physically. For this purpose, the conventional photocopying machine of the type described incorporates a microswitch or the like in the exposure station so that when the leading edge of the copy paper actuates the switch, the original carrier may be started immediately in synchronism with the movement of the copy paper through the exposure station. Therefore some complexity of the structure of the photocopying machine is inevitable, resulting in an increase in material and in cost. Even though the starting of the original carrier in synchronism with the admission of the copy paper into the exposure station is ensured as described hereinabove, when the original carrier is not smoothly displaced in synchronism with the movement of the copy paper throughout its passage through the exposure station, the electrostatic latent image formed upon the copy paper will become deformed. This defect is caused generally by the slippage of the carrier drive wire or the like and by unsmooth movement of the

original carrier over the guide rails. Furthermore, when the original is not firmly placed upon the original holder in predetermined position, the precise registration is not attained.

An electrophotographic copying machine of the type described generally includes a copy paper feeding station, a charging station, an exposure station, a developing station, a fixing station and an original carrier. It is not necessary to drive all of them all the time but they are preferably driven intermittently in a predetermined time-scheduled relation with each other. Therefore many electrical switches are used to provide a time-schedule control system in the electrophotographic copying machines in the prior art. An increased number of structural parts presents some problems in the assembly, adjustment, maintenance, and repairs of such electrophotographic copying machines.

The present invention overcomes those related problems encountered in photocopying machines in the prior art and of the type described.

Accordingly it is the general object of the present invention to provide an improved electrophotographic copying machine of the type in which both an original to be reproduced and a copy paper are moved in synchronism with each other and relative to a slit exposure optical system.

It is one of the objects of the present invention to provide an electrophotographic copying machine of the character described above in which almost all of the various stations and other mechanisms are intermittently driven or energized in precise synchronism with each other in accordance with a predetermined time schedule by a common switch, thereby reducing the required number of structural parts while increasing reliability and dependability in operation.

It is another object of the present invention to provide an electrophotographic copying machine of the character described above having a time delay control means which is adjustable so as to permit the precise registration of the optical registration of the leading edges of the original to be reproduced and a copy paper upon admission of the latter in the exposure station without the use of any special switch, thereby facilitating to a degree the assembly and adjustment of the copying machine.

It is a further object of the present invention to provide an electrophotographic copying machine of the character described above having an original carrier which may be securely locked in initial or home position so as to facilitate the placement of an original thereover and which has drive belting causing no slippage thereof, thereby further enhancing the precise registration of the original and the copy paper.

It is a further object of the present invention to provide an electrophotographic copying machine of the character described above which is compact in size and improved in appearance.

It is a still further object of the present invention to provide a method for retaining in a most simple yet very positive manner the ball bearings of the guides for the original carrier.

SUMMARY OF THE INVENTION

To attain the above and other objects, the present invention provides an electrophotographic copying machine of the type in which both an original to be reproduced and a photosensitized copy paper are moved for exposure relative to a slit exposure optical system including a light source and in synchronism with each other characterized by the combination comprising: means at a feeding station for feeding the copy papers one by one; means at a charging station for imparting a charge layer to the sur-

face of the copy paper, an exposure station at which a light image of the pattern of the original is projected upon the charged copy paper by said slit exposure optical system, thereby forming an electrostatic latent image thereon, means at a developing station for developing said electrostatic latent image into a visible image; means at a fixing station for fixing said develped image, a drive mechanism including means for driving said copy paper feeding station: means for transporting the copy paper from said copy paper feeding station through said charging station, said exposure station, said developing station and said fixing station: and means for driving an original carrier upon a pair of spaced guide means relative to the slit exposure optical system and in synchronism with the passage of the copy through aid exposure station. The original carrier driving means includes reverse clutch means for returning said original carrier back to its initial position upon completion of the exposure stroke; and switch means actuable by the copy paper being transported to be selectively switched between two positions, said switch means in one of said two positions energizing simultaneously said charging station, said light source in said slit exposure optical system and clutch means for coupling said drive mechanism to said carrier drive means, and in the other of said two positions de-energizing said charging station, said light source and said clutch means while energizing said reverse clutch means so as to reverse the coupling of said carrier drive means to said drive mechanism, thereby returning said original carrier back to its inital position. Means for locking said original carrier in said initial position are provided and adapted to be actuated in response to the depression of a start button of said copying machine so as to be released from the locking position, and time-delay control means are included for driving said original carrier drive means in a predetermined time delay after said clutch means is energized by said switch means for attainment of the precise registration of the leading edges of the original and copy paper upon admission of the latter into said exposure station.

According to one embodiment of the present invention, the time delay control means comprises a pair of driven pins extending from one side wall of a drive pulley for driving the original carrier and a drive pin extending from a rotary shaft loosely carrying the drive pulley. The pair of driven pins are diagonally spaced apart from each other and the drive pin engages with either of the driven pins so as to rotate the drive pulley in the forward or exposure direction or in the reverse direction. The drive pin is normally in engagement with the driven pin for the reverse rotation so that upon rotation of the rotary shaft in the forward direction, the drive pin makes an idle run from the driven pin for the reverse rotation to the driven pin for the forward rotation and then engages with the latter so as to drive the pulley in the forward direction. Thus the time delay control is effected. Furthermore since at least one of the driven pins is adjustable in position, a suitable time daley may be provided as needs demand.

In one embodiment of the present invention, the switch means comprises a seesaw type switch which is closed when the copy paper enters into the charging station and is opened when the copy paper is completely discharged out of the exposure station.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of the preferred embodiment thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of one embodiment of an electrophotographic copying machine in accordance with the present invention;

FIG. 2 is a fragmentary sectional view of an original holder supporting means;

FIG. 3 is a fragmentary view illustrating a ball and its retainer in the suporting means of FIG. 2;

FIG. 4 is a diagrammatic view for explanation of the relative position between the ball and retainer of FIG. 3;

FIG. 5 is a fragmentary view of the retainer;

FIG. 6 is a perspective view of a drive pulley for an original holder;

FIG. 7 is a fragmentary sectional view of part of the drive pulley of FIG. 6;

FIG. 8 is a top view partly in section of braking means for the drive pulley of FIG. 6;

FIG. 9 is a side view of the braking means of FIG. 8;

FIG. 10 is a diagrammatic front view illustrating a copy paper feed mechanism;

FIG. 11 is a sectional view of the copying machine shown in FIG. 1; and

FIG. 12 is a diagrammatic view for explanation of a drive mechanism of the copying machine of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 illustrating one preferred embodiment of the present invention, reference numeral **1** designates a main body of an electrophotographic-copying machine; **2**, a transparent holder for an original to be copied; **2***a*, an original holder frame or original carrier; **3**, a pair of guide rails laid upon the front and rear walls **1***a* of the main body **1** for slidably supporting the original holder frame **2***a*; **4**, a cartridge containing copy papers; **5**, a front cover for the main body **1**; **6**, a control panel upon the front cover **5**; **6***a*, a main switch button; **6***b*, a pilot lamp; **6***c*, a print-start button; **6***d*, an exposure adjustment sliding button; **7**, a rear cover; and **8**, an outlet through which the copies are discharged from the machine. Within the main body **1** are housed a charging device, an exposure device, a developing device, a fixing device and a drive mechanism to be described hereinafter. Both the original holder or carrier **2** and a copy paper are moved for exposure of the copy paper relative to an exposure optical system and in synchronism with each other.

As shown in FIG. 2, longitudinal V-grooves **3***a* are formed in both the upper and lower surfaces of the rails **3**. A plurality of balls **10** rotatably supported by a U-shaped retainer **9** are fitted into the V-shaped grooves **3***a* between the rails **3** and the frame **2***a*. As shown in FIG. 5, the retainer **9** is provided with ball receiving holes having a pair of inwardly extending lugs **9***a* and **9***b* which are bent in the opposed directions relative to each other. The ball **10** is fitted into the hole and held by the pair of lugs **9***a* and **9***b* and the peripheral edge **9***c* of the hole for rotation, as best shown in FIG. 3. Even when a force acting in the direction indicated by the arrow *a* in FIG. 4 acts upon the ball **10**, the diameter *d* of the ball **10** is larger than the distance D between the lug **9***b* and the peripheral edge **9***c* so that the ball **10** is positively prevented from falling out of the ball retaining hole of the retainer **9**. Thus, it is readily seen that the orignal holder frame **2***a* rides smoothly upon the rails **3**.

The arrangement of various devices housed in the main body **1** are best shown in FIG. 11. The copy paper cartridge **4** is supported at its rear portion by a supporting member **11** whose stay **11***a* is firmly anchored to the bottom of the main body **1** by a stay retaining member **11***b*. A copy paper guide plate **12** is firmly fixed to the front and rear walls **1***a* of the main body **1** and an upright supporting pin **13** is fixed to the horizontal portion of the guide plate **12** so as to engage with a copy paper supporting plate **4***a* in the cartridge **4**. The stack of copy papers upon the supporting plate **4***a* in the cartridge **4** is held in position by means of retaining pawls **4***b* formed at the upper corners of the inner surface of the front (leading) wall of the cartridge **4**. When the cartridge **4** is set in position upon the supporting member **11** and the

pin **13** as shown in FIG. 11, the front portion of the outer casing of the cartridge **4** lowers by its own weight and the stack of copy papers **14** are held in position by the retaining pawls **4***b*, whereby the copy papers **14** are ready to be fed into the machine. When the cartridge **4** is set, its cover **4***c* is half opened as shown in FIG. 11 so that a copy paper feed roller **15** may contact the upper surface of the copy paper **14**. The half-opened cover **4***c* also serves to prevent the copy papers **14** from being exposed by the external light.

As shown in FIGS. 10 and 11, the feed roller **15** is carried by a rotary shaft **17** which is rotatably journalled in one of the arms of a pair of rocking members **16** (only one is shown). The rocking member **16** is pivotably fixed to the front or rear wall **1***a* by a pin **18**. A cam follower roller **20** is rotatably fixed to the other arm of the rocking member **16** for engagement with a cam **19** which is carried by a rotary shaft **21** which is journalled in the front and rear walls **1***a* of the main body **1**. The cam **19** is drivingly coupled to a drive mechanism to be described hereinafter through a clutch **22** which is controlled by a pawl-like member **24** which rocks by the movement of the plunger of an electromagnet **23**. The electromagnet **23** is energized upon depression of the print-start button **6***c* so that the pawl-like member **24** is pivoted, thereby moving away from the clutch **22**. Upon disengagement of the pawl-like member **24** from the clutch **22**, the latter permits the cam **19** to make one rotation in the direction indicated by the arrow *b* in FIG. 11. When the cam **19** is not rotating, the cam follower roller **20** is so arranged as to engage with its larger diameter portion or most extending portion, but as the cam **19** rotates the cam follower **20** comes into contact with the smaller diameter portions, so that the feed roller **15** is gradually lowered and made to contact the copy paper **14** when the cam **19** rotates to the position indicated by the chain line **19**A in FIG. 10. Since the feed roller **15** is rotating in the direction indicated by the arrow *c* in FIG. 11 by the drive mechanism to be described hereinafter during the reproduction operation, the feed roller **15** coacts with the retaining pawls **4***b* so as to feed the uppermost copy paper **14** through the guide plate **12** toward a pair of feed rollers **25** and **26** pressed against each other.

A guide member **27** is fixed to the undersurface of the rocking member **16** so as to guide the copy paper **14** fed by the feed roller **15** toward the pair of feed rollers **25** and **26** when the arm carrying the feed roller **15** of the rocking member **16** is lowered. It is noted that the rocking member **16** is coupled to means for controlling a number of repetitive actions of this rocking member.

The cam profile of the cam **19** is of course designed in such a manner that the feed roller **15** is firmly pressed against the copy sheet **14** during the interval from the time when the copy paper **14** is started to be fed until the time when the leading edge of the copy paper **14** is held between the pair of feed rollers **25** and **26** and that the roller **15** may be moved away from the copy paper **14** when the leading edge of the copy paper **14** is firmly held between the pair of feed rollers **25** and **26**. That is, the peripheral length of the smaller diameter portion of the cam **19** for causing the above described motion of the feed roller **15** is substantially equal to the smallest size of the copy papers in the cartridge **4**.

The pair of feed rollers **25** and **26** rotatably journalled between the front and rear walls **1***a* of the main body **1** are driven in the direction indicated by the arrow *d* in FIG. 11 by the drive mechanism to be described hereinafter. Downstream of the feed rollers **25** and **26** are disposed a pair of chargers **27** and **28** having needle-shaped electrodes **27***a* and **28***a* respectively. Below the lower charger **28** is disposed a seesaw type switch **29** and one arm of its rocking switch actuating element **29***a* is so arranged as to engage when one arm of a rocking member **30** as shown in FIG. 11. The other arm of the rocking member **30** extends into the path of the copy paper between the upper and lower chargers **27** and **28**, so that when the leading edge of the copy paper **14** engages the upper arm of the rocking member **30**, the actuating eelment **29***a* is pivotably displaced to a position **29***a*A indicated by the broken lines in FIG. 11, thereby closing the switch **29**. Therefore, the chargers **27** and **28** are energized so as to impart a charge to the copy paper **14** in a manner well known in the art. The charged copy paper **14** is transported toward an exposure station **33** by a pair of feed rollers **31** and **32** so that when the copy paper is passing between a pair of transparent guide plates **34** and **35**, a light image is projected upon the copy paper **14**, thereby forming a latent electrostatic image in a manner well known in the art.

A rocking member **39** similar in construction as that of the rocking member **30** described hereinabove is arranged below the exposure station **33** in such a manner that the upper arm of the rocking member **39** extends into the path of the copy paper between the exposure station **33** and a pair of feed rollers **36** and **37** which transports the exposed copy paper **14** toward a developing device or station **38**. The lower arm of the rocking member **39** engages with the other arm of the actuating element **29***a* of the switch **29** in such a manner that when actuated by the copy paper **14** the rocking member **39** holds the actuating element **29***a* at the position **29***a*A after the trailing edge of the copy paper has passed over rocking member **30** and until the copy paper **14** has completely passed through the exposure station **33**. By this arrangement switch **29** remains on so that, the charge may be imparted uniformly and positively to the whole surface of the copying paper **14**.

The two pairs of feed rollers **31** and **32**; and **36** and **37** are rotatably journalled between the front and rear walls **1***a* of the main body **1** and are driven by the drive mechanism to be described hereinafter in such a manner that the movement or transportation of the copy paper **14** can be precisely synchronized with the movement of the original carrier **2**.

The developing device **38** comprises a developing solution chamber **40** and a plurality of copy paper guide members **40***a*, **40***b* and **40***c* disposed within the chamber **40** (see FIG. 11). The copy paper **14** is advanced along the guide members **40***a*, **40***b* and **40***c* immersed in the developing solution in the chamber **40**, whereby the latent electrostatic image upon the copy paper **14** is developed into a visible image in a manner well known in the art. The developed copy paper **14** is then transported by a pair of feed rollers **41** and **42** toward a fixing device or station **43** including a pair of guide members **45** and **46** which define a space in communication with a heated air supply pipe **44** and two pairs of feed rollers **47** and **48**; **49** and **50** disposed at the inlet and outlet of the fixing device or station **43** respectively. While the developed copy paper **14** passes through the space between the upper and lower guide mmbers **45** and **46**, the developed image is fixed by the heated air supplied from the pipe **44** and then the fixed copy paper **14** is discharged by the pair of feed rollers **49** and **50** through the outlet **8** out of the machine. The rollers **41**, **42**, **47**, **48**, **49** and **50** are journalled between the front and rear walls **1***a* of the main body **1** and are driven by the drive mechanism to be described hereinafter. A cleaning device generally designated by **51** and having a cleaning member **51***a* made of felt or the like is pressed against the roller **41**, thereby removing the toner or the like attached to the roller **41**.

Next the exposure station **33** will be described in more detail. Referring to FIG. 11 again, a reflecting mirror **52***a* is disposed at an angle on the right side of and below the original holder device **2** and a tubular light source **53** having a reflector **53***a* is disposed at the right of a reflecting mirror **52***b*. The light source **53** emanates the slit-

like light so as to illuminate an original to be reproduced which is held stationary upon the original holder **2**. The reflecting mirror **52***a* redirects the light reflected by the original to be reproduced toward a lens **54** having a reflecting mirror **54***a* integrally formed therewith. The light passed through the lens **54** is condensed and reflected back toward reflecting mirror **52***b* redirected at an angle and then impinges upon the copy paper **14** passing below the transparent guide plate **34**, thereby projecting a moving light image of the original upon the moving copy paper **14**. The optical path length between the lens **54** and the original is made equal to that between the lens **54** and the copy paper **14**. An original holder drive pulley **56** carried by a rotary shaft **55** journalled between the front and rear walls **1***a* of the main body **1** is disposed below the original holder device **2**. A wire or belt **57** is wrapped around the pulley **56** in such a manner that one portion of the wire **57** is fitted into a recess **56***a* formed in the peripheral surface of the pulley **56** as best shown in FIG. 7 and is held stationary by means of a pin **58** fitted into the recess **56***a* over the wire **57**. After the wire **57** is wrapped over a pulley **59** and a pulley **60**, one end **57***a* of the wire **57** is fixed firmly to the right end $2a_1$ of the frame **2***a*. The other end **57***b* of the wire **57** is firmly fixed to the left end $2a_2$ of the frame **2***a* after the wire is wrappe d over the pulley **60**. The wire **57** is wrapped over the pulley **60** so as not to interfere with the movement toward either end. The drive pulley **56** will be discussed in more detail hereinafter.

The bent edge of the right frame member **2***b* (at the left in FIG. 1) engages with a positioning stopper **61** which is pivotably fixed to the rear wall **1***a* and whose one arm (lower arm in FIG. 11) is connected to an electromagnetic plunger **62**. Therefore, it is seen that the original holder device **2** may be held in stationary position by the stopper **61** from where the photocopying operation is started as shown in FIG. 11. The electromagnetic plunger **62** is energized upon depression of the print-start button **6***c* whereupon the lower arm of the stopper **61** is pulled toward the plunger **62** so that the engagement between the original holder device **2** and the upper arm of the stopper **61** is released.

In the vicinity of the left side of the frame member **2***b* of the original holder device **2** is disposed an original positioning member **2***c* by which the original to be reproduced is held in reproduction position.

The drive mechanism of the photocopying machine of the present invention will now be described with reference to FIG. 12. The drive power is supplied from a motor **63** whose drive shaft **63***a* carries a sprocket wheel **64**. The rollers **15**, **25**, **31**, **36**, **41**, **47** and **49** have sprockets **15***a*, **25***a*, **31***a*, **36***a*, **41***a*, **47***a* and **49***a* fixed coaxially thereto respectively. Sprocket wheels **18***a* and **21***a* are loosely carried respectively by the pin **18** of the rocking member **16** and the shaft **21** of the cam **19**. A sprocket wheel **65** is rotatably fixed to the rear wall **1***a* above the sprocket wheels **31***a* and **36***a*. A sprocket wheel **67** is loosely carried by the shaft **55** of the drive pulley **56** through an electromagnetic clutch (not shown). A reverse sprocket wheel **68** is rotatably fixed at the left of the sprocket wheel **67**. A tension sprocket wheel **69** is rotatably fixed to the rear wall **1***a* at the lower position thereof. An endless chain **71** is wrapped over these sprocket wheels **64**, **65**, **67**, **68**, **21***a*, **18***a*, **25***a*, **69**, **41***a*, **47***a*, **49***a*, and a sprocket wheel **70** rotatably fixed to the right center position of the rear wall **1***a* in the order named. The endless chain **71** is advanced in the direction indicated by the arrow *f* in FIG. 12 upon rotation of the motor **63**. That is, all of the sprocket wheels except **64** are driven sprocket wheels. The motor **63** is started by depression of the main switch button **6***a*, as long as the button **6***a* remains depressed, all of the sprocket wheels are driven thereby transporting the copy paper **14** as described hereinabove.

A sprocket wheel **72** integral with the sprocket wheel **18***a* is also loosely carried by the pin **18** of the rocking member **16** so that the feed roller **15** may be driven by an endless chain **73** wrapped over the sprocket wheel **72** and a sprocket wheel **15***a* coaxially fixed to the feed roller **15**. The clutch **22** which drives the cam **19** is so arranged as to engage with the sprocket wheel **21***a* when the start button **6***c* is depressed.

The sprocket wheels **31***a* and **36***a* coaxially fixed to the rollers **31** and **36** are drivingly coupled through a chain **74** to the sprocket wheel **65** so as to be intimately coacted with the sprocket wheel **67** which drives the original holder device drive pulley **56**. Thus, the movement of the original holder **2** can be made in precise synchronism with the transportation of the copy paper **14** in the exposure station **33** as described hereinabove.

Next one illustrative embodiment of the time delay control means of the present invention will be described in detail with reference to FIG. 6. This time delay control means is for ensuring the precise optical registration of the leading edges of the original and the copy paper when the latter enters the developing station **38**.

As shown in FIG. 6, the drive pulley **56** is loosely carried by the shaft **55** and has two engaging members **56***b* and **56***c* which are disposed symmetrical with respect to the axis of the pulley **56**. A drive pin **55***a* extending from the shaft **55** between the members **56***b* and **56***c* engages with the member **56***b* when the shaft **55** rotates in the forward direction indicated by the arrow *g*, while when the shaft **55** rotates in the reverse direction, the drive pin **55***a* engages with the member **56***c*, so that the drive pulley **56** may be rotated in the forward or reverse direction with shaft **55**. The member **56***b* is held in position by means of screws **75** and **76** which are fitted in turn into an arcuate slot formed through the end face of the pulley **56** so that the position of the member **56***b* may be adjusted by loosening and retightening the screws **75** and **76**.

The shaft **55** is drivingly coupled such as through an electromagnetic clutch **90** (FIG. 12) to the sprocket wheel **67** and the sprocket wheel **77** loosely carried by the shaft of the sprocket wheel **68**, is drivingly coupled thereto also through an electromagnetic clutch **68***a* (FIG. 12), and a chain **79** is wrapped over the sprocket **78** carried by the shaft **55** and the sprocket **77**. The electromagnetic clutch **90** between the sprocket wheel **67** and the shaft **55** is energized when the switch **29** (see FIG. 11) is closed by the advancing copy paper **14** simultaneously when the chargers **27** and **28** are energized. However, if the pulley **56** was securely fixed to the shaft **55**, the pulley **56** would start to drive before the charged copy paper **14** reached the exposure station **33** and the wire **57** would be driven, thereby causing the original carrier **2** to move. As a result the original to be reproduced would be moved not in synchronism with the transportation of the copy paper **14** for exposure. Therefore, in the photocopying machine in accordance with the present invention the time delay control means is provided. More specifically, the pulley **56** is so arranged that it will not start its rotation even when the shaft **55** starts rotation upon closure of the switch **29** and energization of the electromagnetic clutch **90**, until the drive pin **55***a* engages with the member **56***b*. Consequently, only the charged copy paper **14** arrives at the exposure station **33**, will the drive pulley **56** be rotated by the shaft **55**, thereby ensuring the synchronization between the movements of the original holder **2** and the copy paper **14** for precise exposure, that is precise registration therebetween.

When the switch **29** is closed, the light source **53** is also energized, even before the leading edge of the copy paper **14** enters into the exposure station **33**. This is necessary because it takes generally about 0.5 sec. before the light source can emanate the light at its full luminescence from the time when it is energized. Thus, when the copy paper **14** enters into the exposure station **33**, a stabilized light image may be projected thereupon. When the copy paper **14** arrives at the exposure station **33**, the drive pulley

56 starts to rotate in the direction indicated by the arrow *e* (see FIG. 11) thereby driving the wire 57. Thus, the original carrier 2 is caused to move toward the right in FIG. 11. The velocity of this movement of the original carrier 2 is so determined as to be equal to that of the copying paper 14. Upon completion of exposure, the copy paper 14 is admitted into the developing station 38 and the switch 29 is opened in a manner as described hereinabove so that the chargers 27 and 28, the electromagnetic clutch between the sprocket wheel 67 and the shaft 55 and the light source 53 are all de-energized, but the electromagnetic clutch 68*a* between the sprockets 68 and 77 is energized. Since this electromagnetic clutch 68*a* serves to couple to the shaft 55 of the pulley 56 the sprocket 67 which is rotating in the reverse direction as shown in FIG. 12, the rotation of the shaft 55 is reversed. In this case, the drive pin 55*a* makes an idle run toward the member 56*c* and then engages therewith, thereby driving the drive pulley 56 (see FIG. 6). The time required for the drive pin 55*a* rotating from the driven pin 56*b* to the driven pin 56*c* is a time delay for attaining the precise registration of the leading edges of the copy paper and the original. It should be noted that the driven pin 56*b* is adjustable in position so that the delay time is also adjustable, whereby the adjustment of the timing relation between the starting of the original carrier 2 and the entrance or admission of the copy paper 14 into the exposure station 38 can be made in a more simplified manner. When the reverse rotation of the drive pulley 56 is stopped, the drive pin 55*a* remains in engagement with the member or projection 56*c*, so that when the next operation is started, the drive pin 55*a* makes a complete idle run from the projection 56*c* toward the member 56*b* until the leading edge of the copying paper 14 reaches the exposure station 33.

Upon reverse rotation of the drive pulley 56, the original holder device 2 is returned to the left, that is to its original position. A pin 80 extends from the undersurface of the frame member 2*b* of the original holder 2 while a rocking lever 81 is pivotably fixed to the rear wall 1*a* of the main body 1 immediately below the position at which the original holder 2 must be stopped. Therefore, the lever 81 is actuated by the pin 80 when the original holder device 2 reaches the stop position, so that the actuating member 82*a* of a stop switch 82 is actuated, thereby deactivating the electromagnetic clutch 68*a* between the sprockets 68 and 77 so as to stop the reverse rotation of of the drive pulley 56.

As shown in FIG. 8, disks 83 and 84 having relatively smooth brake shoes 83*a* and 84*a* made of nylon or the like respectively are so arranged and fixed in position by screws 85 and 86 so as to interpose the flange 56*d* of the drive pulley 56 between the shoes 83*a* and 84*a*. The disk 84 is loosely fitted over pins 88 and 89 extending from a stationary member 87 which in turn is firmly secured to the rear wall 1*a*. This arrangement serves to apply some brake to the pulley 56 so that the accurate going and returning motion of the original holder device 2 may be ensured. This arrangement serves also to effectively prevent excessive tension from being exerted upon the wire 57 especially when the motion of the original holder device 2 is reversed from the going to returning motion, thereby guarding the drive mechanism safely.

The present invention has been so far described with particular reference to the one preferred illustrative embodiment thereof, but it will be understood that variations and modifications can be effected without departing from the true spirit of the present invention as described hereinabove with reference to the accompanying drawings and as defined in the appended claims.

What is claimed is:

1. In an electrophotographic copying machine of the type wherein an original to be reproduced and a photosensitive copy paper are moved for exposure relative to a slit exposure optical system, the combination comprising:

(a) means for feeding and transporting copy papers one by one through respective means at a charging station, an exposure station, a developing station and a fixing station;

(b) a carrier for transporting an original in synchronism with the copy paper during exposure at said exposure station;

(c) carrier drive means including forward clutch means for advancing said carrier, and reverse clutch means for returning said carrier to its initial position after the exposure; and switch means actuated by the passage of the leading edge of a copy paper into said charging station for energizing simultaneously said charging station means, said optical system and said forward clutch means and for de-energizing said charging station means, said optical means and said forward clutch means and energizing said reverse clutch means to return said carrier to its initial position upon the passage of the trailing edge of said copy paper out of said exposure station.

2. An electrophotographic copying machine as in claim 1 wherein said switch means comprises a seesaw switch having two positions and actuated to one position when the leading edge of the copy paper enters into said charging station and to the other position when the trailing edge of the copy paper passes out of the exposing station.

3. An electrophotographic copying machine as in claim 1 wherein said carrier drive means comprises:

(f) a rotary shaft which is coupled to said carrier drive means through said forward and reverse clutch means when said switch means is actuated;

(g) a drive pulley loosely carried on said rotary shaft;

(h) a wire wrapped around said drive pulley a plural number of times and fixed to said drive pulley at a point approximately at the center of the length of said wire wrapped around said drive pulley; and

(i) guide pulley means about which the opposite ends of said wire are passed to be fixed to the leading and trailing edges of said original carrier respectively.

4. An electrophotographic copying machine as in claim 1 including carrier locking means comprising:

(f) an electromagnet;

(g) a hook-shaped member fixed to the leading edge of said carrier; and

(h) a V-shaped lever pivotably fixed to said machine, one arm of which has a notch for engagement with said hook-shaped member when said original carrier is in its initial position and the other arm of which is coupled to said electromagnet, such that upon energization of said electromagnet said V-shaped lever is pivoted releasing said hook-shaped member from said notch.

5. An electrophotographic copying machine as in claim 1 including guide means for said carrier comprising:

(f) a pair of spaced apart guide rails each having grooves formed in the upper and lower surfaces thereof in the longitudinal direction;

(g) a plurality of ball bearings riding in the grooves in said guide rail;

(h) a channel-shaped retainer member substantially U-shaped in cross section and having spaced apart holes formed through each of the opposing side walls thereof, each of said holes having a diameter substantially equal to that of a ball bearing and a pair of diametrically spaced apart lugs extending radially inwardly and at an angle in opposite directions from its periphery, said retainer member having the upper and lower series of balls rotatably

fitted into said holes and prevented from falling out out said holes by said lugs; and

(i) means on said carrier being so fitted over said guide rail that the latter is interposed between said upper and lower series of balls and said carrier slides over said balls when driven.

6. An electrophotographic copying machine as in claim **1** comprising:

(e) means for producing a predetermined time delay between the energizing of said forward clutch means by said switch means and the advancing of said carrier to achieve precise registration of the leading edges of the original and the copy paper upon admission of the copy paper into said exposure station.

7. An electrophotographic copying machine as in claim **6**, wherein said time delay means comprises:

(f) a rotary shaft coupled to said carrier drive means for forward and reverse rotation, through said forward and reverse clutch means when said switch means is actuated;

(g) a drive pulley loosely carried on said rotary shaft;

(h) a pair of spaced stop means on one of said rotary shaft and said drive pulley;

(i) a drive pin on the other of said rotary shaft and said drive pulley, arranged for alternate engagement with said spaced stop means to drive said drive pulley respectively in accordance with the forward and reverse rotation of said rotary shaft, said drive pin being normally in engagement with the stop means for reverse rotation of said drive pulley, so that upon rotation of said rotary shaft in the forward direction, there is an idle run before the engagement of said drive pin with the forward rotation stop means whereby a time delay is produced between the initiation of forward rotary shaft rotation and forward drive pulley rotation.

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U.S. Cl. X.R.

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