Oct. 13, 1970 SHIGERU SUZUKI ET AL 3,533,691

ELECTROPHOTOGRAPHIC DUPLICATOR

Filed Oct. 2, 1967 2 Sheets-Sheet 1

FIG. 1

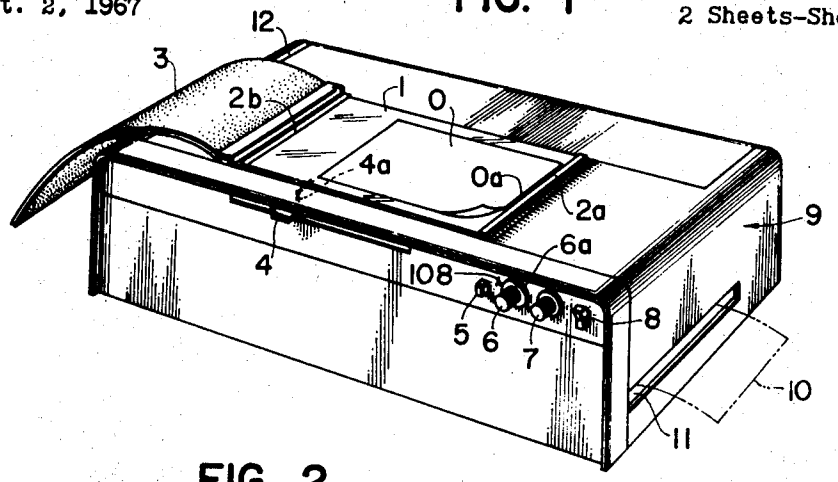


FIG. 2

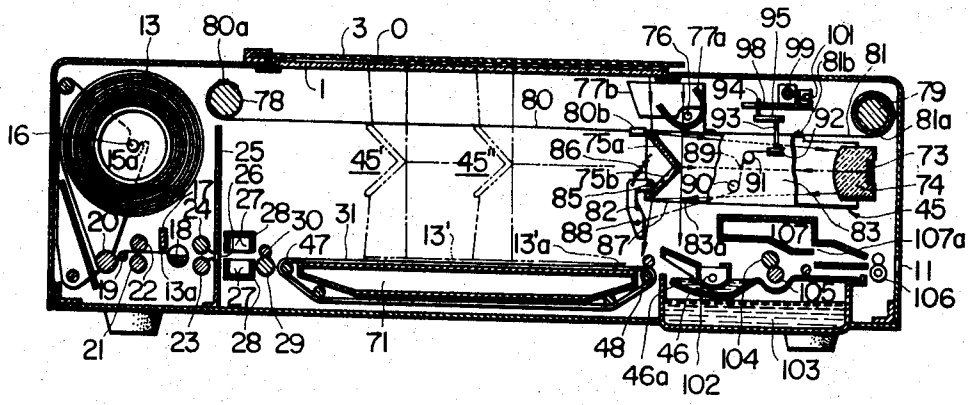


FIG. 3

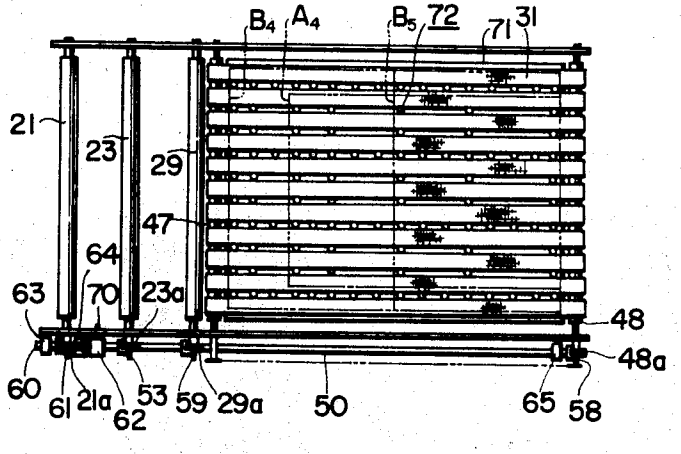
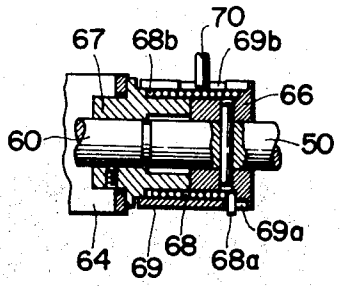


FIG. 4



Oct. 13, 1970 SHIGERU SUZUKI ET AL 3,533,691

ELECTROPHOTOGRAPHIC DUPLICATOR

Filed Oct. 2, 1967 2 Sheets-Sheet 2

FIG. 5

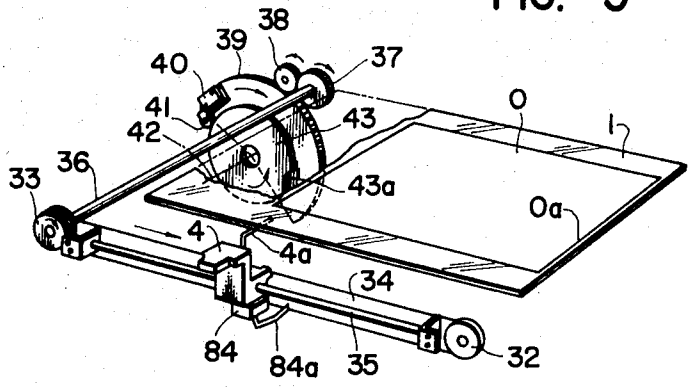


FIG. 6

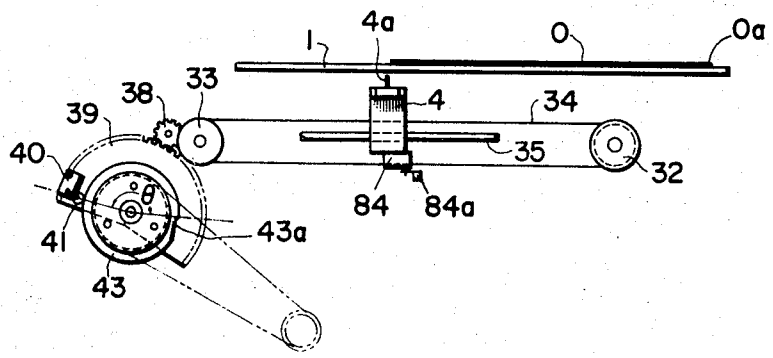


FIG. 7

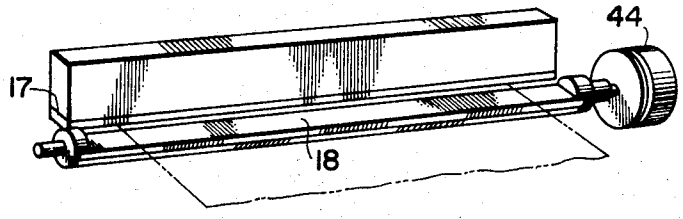


FIG. 8

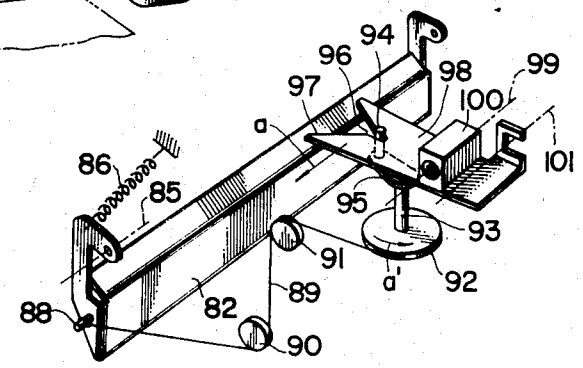
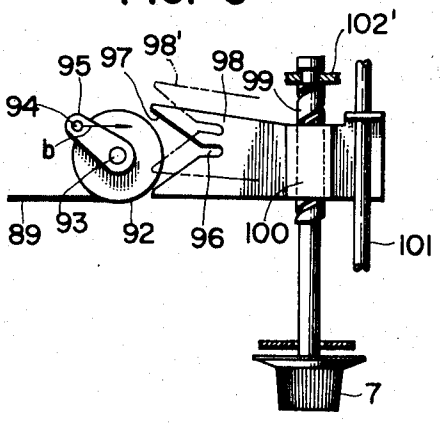


FIG. 9



United States Patent Office 3,533,691 Patented Oct. 13, 1970

3,533,691

ELECTROPHOTOGRAPHIC DUPLICATOR

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Claims priority, application Japan, Oct. 22, 1966, 41/69,542
Int. Cl. G03b 27/00; G03g 15/00
U.S. Cl. 355—13 4 Claims

ABSTRACT OF THE DISCLOSURE

An electrophotographic duplicator having a roll of copy paper at one end mounted in a light-impervious chamber. The copy paper is freely removed from the roll and passed into a suction chamber and fed by belts across a surface which faces a transparent supporting surface for an original to be duplicated. A continuously slidable indicator extends along the supporting table and is coupled with a cutting device and a device for feeding paper such that a given length of paper corresponding to the setting of the indicator will be fed to the belts. The adjustment of the indicator is continuous and the indicator is set to the position of the leading edge of the original to be duplicated.

This invention relates to an electrophotographic duplicator. The object of this invention is to provide a functionally excellent electrophotographic duplicator.

In the duplicator of this invention rolled printing paper is used. Said rolled printing paper is cut in accordance with the length of an original positioned on an original set table fixed on the top plate of the duplicator. This cut printing paper, after passing through the charging device, is stopped where it is forwarded just under said original. Hereupon, a movable exposure device shifts between said original and the printing paper and gives a latent electrostatic image onto the printing paper. At the same time exposure by said exposure device is completed, the printing paper bearing the latent electrostatic image is forwarded into a developing device and a fixing device, and finally discharged out of the machine.

The printing paper fed out of a printing paper roll is led into a cutting device after passing through a roller device for curl dekinking. The cut printing paper is slightly bent during the developing process, and in the other processes, it is shifted on a flat path. The printing paper is, therefore, shifted quite smoothly, and the unreasonable shift and the friction of printing paper seen in a turned path of a conventional automatic duplicator are totally overcome.

Said movable exposure device is changed its moving range in accordance with the length of the cut printing paper. Namely, the slit light of said exposure device, crossing through the printing paper, is shifted from the front end of said printing paper to the rear end, and thereby gives exposure onto the printing paper. However, when said slit light reaches the rear end of the printing paper, a part of said exposure device operates a microswitch and moves back the exposure device to its initial position. This shifting range of the exposure device is determined by a device for adjusting the length of the printing paper. In this way, by changing the movable range of the exposure device in accordance with the length of the printing paper, unnecessary movements of the exposure device can be avoided and the rapid duplication operation is conducted.

In order to cut the rolled printing paper in accordance with the length of the original, a pointer which is movable along the side edge of the transparent original set table needs only to be registered with the rear end of the original. Said pointer is to be moved and positioned manually through an operating member provided for sliding at the front of the duplicator.

The duplicator of this invention has, in addition to the above-mentioned means, means to obtain a fine copy, for example, an exposure amount adjusting means for the moving exposure device and means to keep the printing paper in flat.

The invention is explained with reference to the drawings illustrating a preferred embodiment of this invention in which:

FIG. 1 denotes a perspective view of an electrophotographic duplicator showing a preferred embodiment of this invention.

FIG. 2 denotes a sectional view of the duplicator.

FIG. 3 denotes a plan view of a moving device for printing paper.

FIG. 4 denotes a sectional view of a one revolution clutch only.

FIG. 5 denotes a perspective view showing only a positioning device to cut the printing paper fed out of a printing paper roll in any length in accordance with the length of an original.

FIG. 6 denotes a front view of the device in FIG. 5.

FIG. 7 denotes a perspective view of a cutting device which cooperates with said positioning device.

FIG. 8 denotes a perspective view indicating an exposure amount adjusting device of a slit exposure device.

FIG. 9 denotes a plan view of a portion of the device in FIG. 8.

In FIG. 1, the both end edges of a transparent original set table **1** is fixed to the top plate of the duplicator with catching metal fittings **2***a* and **2***b*. The original **0**, turned upside down, positioned on said set table **1** with the front end **0***a* corresponding to one metal fitting **2***a* is pressed against against the set table **1** with a pressing plate **3** with one edge thereof pivoting to the top plate. For said pressing plate **3** is used material fit for contacting the original **0** closely with the set table **1**, for example, comparatively heavy rubber plate. On the front of the duplicator housing are provided an operating member **4** for positioning the printing paper and cutting it in accordance with the length of the original, a starting button **5**, a positioning dial **6** indicating the number of times to repeat the operation of the duplicator, an exposure adjusting knob **7**, and an electric source switch **8**. On the right side plate **9** of the duplicator housing an ejecting port **11** for the finished printing paper **10** is provided. The left side plate **12** of the duplicator housing is removably secured to the housing. By removing this side plate **12** from the housing, the rolled printing paper **13** (see FIG. 2) is loadable.

In FIG. 2, the lower portion of the roller printing paper **13** is rotatably supported by inserting a shaft **16** into the notch **15***a* of a frame plate **15** pivoted to a fixed member through a shaft **14**. The front end **13***a* of the printing paper drawn out of the rolled printing paper is drawn to a cutting device comprising a fixed blade **17** and a movable blade **18**. On said frame plate **15** is pivoted a printing paper pressing roller **20** in order to pressure-contact the printing paper against a roller **19** which is comparatively small in diameter. Said roller **19** dekinks the curl of the printing paper.

A pair of drawing-out rollers **21** and **22** provided on the left side of the cutting device begin to rotate when the starting button **5** (see FIG. 1) is pushed on, and stop automatically after one revolution of the roller **21**. This revolution depends on the one revolution clutch to be described below. When said drawing-out roller **21** completes one revolution, an end **13***a* of the printing paper is caught by a pair of feeding rollers **23** and **24** rotating continuously, and is sent rightwards through a slit **26** of

a partition **25**. On the right side of the slit **26** is provided a pair of charging devices **28** which face each other and have wire electrodes **27** extending in the direction across the printing paper path. The printing paper, after passing through said charging devices, is ejected out onto belts **31** by rollers **29** and **30**. The printing paper drawn out of the printing paper roll through said feeding rollers **23** and **24** is cut automatically to the length corresponding to that of the original **0**.

FIG. 5 denotes a device to determine the time to operate the movable blade of the cutting device in order to cut the printing paper in accordance with the length of the original **0**. In the figure, to the operating member **4** with a pointer **4***a* fixed thereto which shifts along the side edge of the original set table **1** is fixed a part of wire **34** stretched around a pair of pulleys **32** and **33**. By sliding said operating member **4** along a guide bar **35** laterally, said pulley **33** is rotated. To eliminate slip between the wire **34** and the pulley **33**, the both ends of the wire **34** are wound up to the pulley **33** in the opposite direction respectively, and are fastened to said pulley **33** respectively. A gear **37** is fixed to a shaft **36** of said pulley **33**. and transmits the revolution to segment gear **39** through an idler **38**. An actuator **41** of the microswitch **40** fixed to the inner surface of the segment gear **39** is pressure-contacted with the periphery of a one revolution disk **43** which is freely rotatable against a shaft **42** of said segment gear **39**. In the course of rotation of said disk **43** in the direction of the arrow, the contact point of the microswitch **40** is closed by inserting said actuator **41** into the notch **43***a* of the disk **43**, a rotary solenoid **44** on the movable blade **18** of the cutting device (see FIGS. 7 and 1) is excited, and by rotating the movable blade **18**, in FIG. 1, about 30° in the clockwise direction, the printing paper is cut. Said disk **43** is stoppe dautomatically after just one revolution from the position shown in FIG. 6 after said starting button **5** (see FIG. 1) is pushed on. The relative position between the notch **43***a* of the disk **43** and the actuator **41** of the microswitch **40** is determined by the position of the operating member **4**. Now, when the operating member **4** is shifted rightwards, each of the pulley **33** and the gears is rotated in the direction shown by the arrow, the microswitch **40** is shifted in the direction approaching the notch **43***a* of the disk **43**, and as the result, the operation time of the microswitch becomes faster so that the printing paper is cut short. Thus, the angle θ (see FIG. 6) between the actuator **41** of the microswitch **40** and the notch **43***a* determines the operation time of the cutting device. Then, during the rotation of the disk **43** through the determined angle θ, the printing paper is drawn out from the printing paper roll in the same length of the distance between the pointer **4***a* and the front end **0***a* of the original **0**, and is cut.

In FIG. 2, when the front end **13***a*′ of the printing paper **13**′ cut according to the length of the original and drawn out onto the belts **31** reaches the right end of said belts **31**, said belts **31** having run so far is stopped, and a movable exposure device **45**, at the same time, begins to move rightwards. The linear shifting distance of said belts **31** which begins to run at the same time the starting button (see FIG. 1) is pushed on is fixed regardless of the length of the cut printing paper. That is, said belts **31** moves the length correpsonding to the distance between the position where the front end **13***a* of the rolled printing paper **13** begins to move at the same time said starting button **5** is pushed, and the position of the front end **13***a*′ of the cut printing paper, and is stopped automatically. Thereafter said belts **31** is moved again at the same time the exposure of the printing paper is completed, and feeds the exposed printing paper into a developing plate **46**.

The peripheral speed of each of the paper feeding rollers **21**, **23** and **29** is the same with the running speed of the belts **31**. Each of said rollers and rollers **47** and **48** around which the belts **31** is extended is cooperated with one another. FIG. 3 denotes a plan view showing the mechanism with the above-mentioned rollers cooperated with one another. In FIG. 3, gears **23***a*, **29***a* and **48***a* fixed to the shafts of the rollers **23**, **29** and **48** except the roller **21** respectively are engaged with gears **53**, **59** and **58** fixed to the cooperating shaft **50**. A gear **21***a* fixed to the shaft of the roller **21** is engaged with a gear **61** of a clutch shaft **60**. Said cooperating shaft **50** and said clutch shaft **60** are connected with each other on one axis through the one revolution clutch **62**. Reference numbers **63**, **64** and **65** denote bearings. Said one revolution clutch **62**, as shown in FIG. 4, comprises a cylindrical body **66** fixed to the cooperating shaft **50**, a cylindrical body **67** fixed to the clutch shaft **60**, a cylinder **69** loosely fitted with the cylindrical bodies **66** and **67**, a spiral spring **68** which is wound up around the peripheries of said cylindrical bodies **66** and **67**, one end **68***a* of which is mounted at a slot **69***a* of said cylinder **69**, and the other end **68***b* of which is opened, and an actuator **70** which is engageable with a groove **69***b* of said cylinder **69**. When the starting button **5** (see FIG. 1) is pushed on by an operator and the cooperating shaft **50** starts to revolve simultaneously, the actuator **70** slips out of the groove **69***b* so that the cylinder **69** is rotatable freely. Under this condition, when the cooperating shaft **50** rotates in the clockwise direction in facing the right side of FIG. 4, the clutch shaft **60** is integrated with the cooperating shaft **50** by the shrinkage of the spiral spring **68** and is rotated in the same direction. On the other hand, said actuator **70** is pressure-contacted against the periphery of the cylinder **69** immediately after slipping out of the groove **69***b*. And when the cylinder **69** has rotated one turn together with the cooperating shaft **50**, said actuator **70** dashes into the groove **69***b* again. When the cooperating shaft **50** continues to revolve under the condition that the revolution of the cylinder **69** is prevented by the actuator **70** and one end of the spiral spring **68** is not rotatable, the clutch shaft **60** is not given the revolution owing to the loosening of the spiral spring **68**. Therefore, the roller **21** which cooperates with said clutch shaft **60** is stopped, and the rollers **23**, **29** and **48** cooperating with the cooperating shaft **50** continue to revolve. It has already been mentioned that said rollers **23**, **29** and **48** are stopped temporarily to give exposure to the printing paper **13**′ (see FIG. 2).

On the top plate of a printing paper suction case **71** with a number of belts **31** contacted therewith, a number of suction holes **72** to attract the printing paper to be carried by the belts **31** to said belts **31** through the provision of the suction. The attracted printing paper is maintained in a preferable flat condition. In FIG. 3, when a chain line B_5 represents the paper size of Rank B, size **5**, a chain line B_4 represents Rank B, size **5**, and a chain line A_4 represents Rank A, size **4**, respectively, some of the rows of said suction holes **72** provided in the direction to cross the belts **31** are positioned where the front and rear ends of the printing paper can be attracted without fail, and prevents the edges of the printing paper from bending.

In FIG. 1, the movable exposure device **45** which gives slit exposure to the printing paper fixed on the belts **31** mainly comprises a duplicating lens **74** with a reflecting mirror **73** at the rear, reflecting mirrors **75***a* and **75***b* which are inclined at 45° to the imaginary horizontal plane including the optical axis of said lens **74** and the reflecting surfaces of which face the original **0** side and the printing paper **13**′ side respectively, an illumination tube **76** for illuminating said original **0**, reflecting plates **77***a* and **77***b* for reflecting the light from the illumination tube **76** to the original effectively, shutters **80** and **81** with the outer edges **80***a* and **81***a* fixed to a pair of winding-up spindles having winding-up function respectively and with the inner edges **80***b* and **81***b* fixed to the both ends of the movable exposure device, and a slit width adjusting plate **82** for the movable exposure device. The above-mentioned elements are mounted on an optical sup-

porting frame **83**. Said supporting frame **83** is supported to the duplicator housing by a guide rail (not shown in the drawings) so as to reciprocate between the stationary original **0** and the printing paper stopped temporarily. The slit exposure is performed to the printing paper while said supporting frame **83** is moving leftwards from the position shown in the figure, and thereafter the supporting frame **83** moves back to its initial position shown in the figure. The time when said movable exposure device **45** begins to shift leftwards is the same with the time when the belts **31** is stopped when the printing paper **13'** moves to the position shown in the figure. The shifting range of the movable exposure device **45** is changed in accordance with the length of the printing paper laid on the exposure position, more accurately, in accordance with the determined position of the operating member **4** (see FIG. 1) which determines the length of the printing paper to be cut. At the lower portion of said operating member **4** a microswitch **84** for switching is fixed as shown in FIG. 5. An actuator **84***a* of said microswitch **84** occupies its position in the shifting path of the movable exposure device **45**, switches the microswitch **84** by pushing a portion of said movable exposure device is moving forth, and moves back said exposure device **45**. For example, in the case of the printing paper cut in Rank A size 4 the movable exposure device is moved to the position **45'**, and in the case of the printing paper Rank B size 5, said exposure device is moved to the position **45''**. Then said exposure device is immediately moved back from such positions. In this way, it is very advantageous for rapid duplication to give the movable exposure device **45** the minimum movement in accordance with the size of the printing paper.

The slit width adjusting plate **82** pivoted at the supporting frame **83** with a shaft **85** at the neighborhood of the reflecting mirror **75***b* is given by a weak spring **86** rotationability around said shaft **85** in the clockwise direction, that is, in the direction to open a slit **87** between the lower edge of the reflecting mirror **75***b* and the edge **83***a* of the supporting frame **83**. One end of a connecting string **89** with the other end fixed at a pin **88** provided on the slit width adjusting plate **82** is fixed to the periphery of a rotating plate **92** through guide rollers **90** and **91** pivoted on the side surface of the supporting frame **83**. Said rotating plate **92** is fixed at the lower portion of the vertical shaft **93** suitable supported by said supporting frame **83**, and at the upper portion of said vertical shaft **93** a swing member **95** fixed to a pin **94** is secured rigidly. Said vertical shaft **93** is given rotating force by the elasticity of the spring **86** provided on the slit width adjusting plate **82**, and on the other hand, said vertical shaft **93** is given frictional force strong enough not to rotate said shaft **93** by the elasticity of said spring **86**.

In FIGS. 8 and 9, at a notch **96** for determining the position where said pin **94** is inserted when the movable exposure device is set in its initial position, and at an engaging member **98** with a V-shaped guide edge **97** connected with said notch **96**, a block **100** engaged with a screw rod **99** supported by the duplicator housing is fixed in perpendicular to the moving direction of said movable exposure device. By turning the adjusting knob **7** provided on the outer end of said screw rod **99**, said engaging member **98** is shifted in parallel to the axis of the screw rod **99**. The rotation of said engaging member **98** relative to the rod **99** is prevented by a guide bar **101** with a part of the engaging member engaged therewith. The movement of said screw rod **99** in the axial direction is prevented by a bearing **102'**.

In FIG. 8, when the engaging member **98** is shifted in the direction of an arrow *a*, the rotating plate **92** is rotated in the direction of an arrow *a'* and pulls the connecting string **89**. The slit width adjusting plate **82** is thereby swung in the direction to reduce the width of the slit **87** (see FIG. 2) around the shaft **85** against the elasticity of the spring **86**.

The pin **94** positioned by the engaging member **98** remains in its initial position even when the movable exposure device moves, separates from the engaging member **98**, and is inserted into the notch **96** of the engaging member **98** again when said movable exposure device moves back to its initial position again. Thus, when the movable exposure device is set in its initial position, the exposure amount, that is, the width of the slit can be adjusted with the adjusting knob **7** (see FIG. 1) mounted in the fixed position outside the duplicator by cooperating the swing member **95** provided in said movable exposure device and the engaging member **98** provided on the side of the duplicator housing.

The V-shaped guide edge **97** connected to the notch **96** for positioning said engaging member **98** is used for leading said pin **94** into the notch **96**, regardless of the swing position of the pin **94** and the changeable adjustment position of said engaging member **98**. Namey, even when the adjusting knob is rotated during the shift of the pin **94** along with the movable exposure device after separating from the notch **96**, for example, as shown in FIG. 9, even when the engaging member in the position shown by a dotted line **98'** is shifted to the position shown by a full line in said figure while said pin **94** is moving, the pin **94** which moves back in the direction shown by an arrow *b* is led into the notch **96** by the guide edge **97**.

As the movable exposure device is shifted inside the duplicator housing, it is required to provide a hole long enough to cover the shift range of said movable exposure device in order to expose out the operating member which gives movement to the slit width adjusting plate provided at said movable exposure device. On the other hand, in the exposure adjusting device constructed as mentioned above, the hole is not necessary and when the movable exposure device is in the initial position, the slit width of said movable exposure device is easily adjusted with the adjusting knob provided at the fixed position outside the duplicator by providing on the side of the duplicator housing the engaging member which cooperates with the swing member on the movable exposure device. Further, when the movable exposure device moves back to the initial position, the V-shaped guide edge which leads said swing member **95** to the fixed position of the engaging member **98** is provided at said engaging member **98**, regardless of the swing position of the swing member **95** and the changeable adjustment position of the engaging member **98**, so that no troubles may be occurred between the exposure amount adjusting mechanism on the movable exposure device and the adjusting mechanism on the side of the duplicator housing, even if the adjusting knob is rotated by mistake, or even if said adjusting knob is operated as the next step of the exposure adjustment for exposure, while the movable exposure device is shifting.

In FIG. 2, at the same time the movable exposure device **45** is moved back to the initial position after one reciprocation simultaneously, the belts **31** which has remained stationary so far begins to move and feeds the printing paper **13'** having been exposed and bearing a latent electrostatic image onto the developing plate **46**. The developer injection tank **102** provided in the upper portion of the developing plate **46** is connected to a comparatively large developer tank **103**. The developer within said developer tank **103** is poured continuously into said developer injection tank **102** by a pump (not shown in the figures), and the developer poured into the injection tank **102** flows into said developing plate **46** through holes provided side by side on the side wall of said injection tank **102**. Then, the developer overflowed out of the rear end **46***a* of the developing plate **46** flows back into the developer tank **103** again.

The printing paper which has passed through the developing plate **46**, wherein the development is completed and a visual image is obtained with toner is forwarded towards a ejection roller **106**, passing between a hard roller **104** and a rubber roller **105**. The wet printing paper forwarded out by said rollers **104** and **105** is dried by air blown out of a ventilation opening **107***a*, and is forwarded out of the duplicator through the ejecting port **11** by means of said ejection roller **106**. As the air to be forcibly discharged out of a ventilation device **107**, air blown out of the paper suction case **71** by a suitable blower and air for cooling the lighting lamp **76** are used effectively.

In FIG. 1, the dial **6** is provided for determining the number of times of a series of duplicating actions mentioned above to be repeated automatically. For instance, when the starting button **5** is pushed on after the number "10" on the scale **6***a* integral with the dial **6** is registered to a stationary index **108**, the duplicating operations are repeated for ten times and ten copies are obtained for one original. As to counting means to construct said operation repeating device, various means are proposed and known publicly. However, the duplicator of this invention is adopted a mechanical counting means along with a microswitch, and comprises a stopper to determine the position corresponding to the number of times of the actions by means of the dial **6**, a rotationable notched disk the initial position of which is determined by said stopper, a ratchet means to revolve said disk from said initial position against the rotation habit of the disk, and an operating plate the engaging member of which is pressure-contacted with the disk on the rotation path of the notch of said notched disk, thereby prevent said disk from rotating by the rotation habit and which enables to release the pressure contact of said engaging member with the disk by means of the starting button **5**. When said engaging member is engaged with said notch, the microswitch for stopping the operation is operated by the engagement with said member, and the microswitch for starting the action is operated by releasing the engagement between said engaging member and said notch through the starting button **5**. The above mentioned device has been filed entitled "Action Repeating Device" as Japanese patent application No. 67022/1966 by the present applicant on October 12, 1966.

The electrophotographic duplicator, as described above, comprises a device to cut loaded rolled printing paper in any size in accordance with the length of an original, a charging device to charge the printing paper, a belt conveyer which carries the cut printing paper in a flat condition through the vacuum action of a paper suction case and which stops automatically when said printing paper is positioned at the predetermined exposure position, a developing device housing developer which circulates for obtaining clear toner images at all time, a blower device for drying the wet developed printing paper, a transparent original set table with a pressing plate fixed to the upper portion of said belt conveyer, a movable exposure device the shifting range of which between said original set table and said belt conveyer is changed in accordance with the cut printing paper and which reciprocates at the manimum range effective for the exposure so as to speed up the duplicating operation, device for adjusting the exact exposure amount through the operation of said movable exposure device from outside, and in said duplicator the printing paper path from the printing paper cutting device to the printing paper ejecting port is to facilitate the shift of the printing paper arranged in an imaginary plane.

What is claimed is:

1. An electrophotographic duplicator comprising an optical unit with a mirror positioned vertically at the back of an image focusing lens, two mirrors arranged above and below the optical axis of said lens with an inclination of about 45° and a support on which said lens and said mirrors are mounted, a supporting table of a transparent material covered with a plate for the support of an original to be duplicated, a sheet transfer table including belts mounted on pairs of rollers at the circumference of a printing paper suction case with a large upper square surface facing the supporting table, a device for cutting photosensitive paper to length, an indicator which is movable along a side edge of said transparent supporting table coupled to the cutting device to control the length of paper which is cut, a light impervious chamber in which a roll of copy paper is housed for mounting and free removal, a liquid developing device in which developer liquid is continuously agitated to keep a constant density, a drying device, and a charging device, said charging device, said sheet feed table and said developing device being arranged approximately in a line in the lower part of the duplicator, said original supporting table being arranged in the upper part face to face with said sheet feed table, and said optical unit being arranged to move parallel between said tables.

2. A duplicator as claimed in claim **1** comprising feed means for withdrawing paper from said roll of copy paper, and means connecting said indicator with said feed means and said cutting device to feed of paper from said roll of copy paper and cause a length thereof to be cut dependent upon the position of the indicator.

3. A duplicator as claimed in claim **2** wherein said indicator is continuously slidable along said table and the length of paper cut is continuously adjustable by moving the indicator.

4. A duplicator as claimed in claim **1** wherein said cutting device comprises a rotary member which begins to rotate from a predetermined position in union with a roller for feeding rolled printing paper and stops automatically after one revolution, a swing member which is mounted coaxially with said rotary member, and is presettable by hand in a position corresponding to the size of the printing paper to be cut, a switch which operates when said rotary member and said swing member take their respective definite relative positions, a movable blade and a driving means for said movable blade which operates simultaneously with the operation of said switch.

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355—28