

[54] ELECTROPRINTING DEVICE

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[22] Filed: **Oct. 10, 1972**

[21] Appl. No.: **296,213**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 793,506, Jan. 23, 1969, abandoned, and Ser. No. 174,977, Aug. 25, 1971, abandoned.

Foreign Application Priority Data

Jan. 26, 1968 Japan..... 43-4271

[52] U.S. Cl..... **355/3 R**

[51] Int. Cl..... **G03g 15/00**

[58] Field of Search..... 355/3, 4, 11, 12, 14, 16, 17

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ABSTRACT

[57] An electroprinting machine comprising a master-sheet making device and a transcribing device following and directly connected to the master-sheet making device. The transcribing device comprises a rotating drum which receives the master-sheet and carries it on its periphery during its rotation. The master-sheet is charged by an additional charging device while being irradiated with light, the toner adheres to the image parts of the master-sheet in a succeeding development by a developer, and the toner on the master-sheet is transcribed to the transferred paper under suitable pressure and voltage applied to the drum and a transcription roller when each transcription paper is synchronously passed between the rotating drum on which the master-sheet is secured and the transcription roller.

4 Claims, 16 Drawing Figures

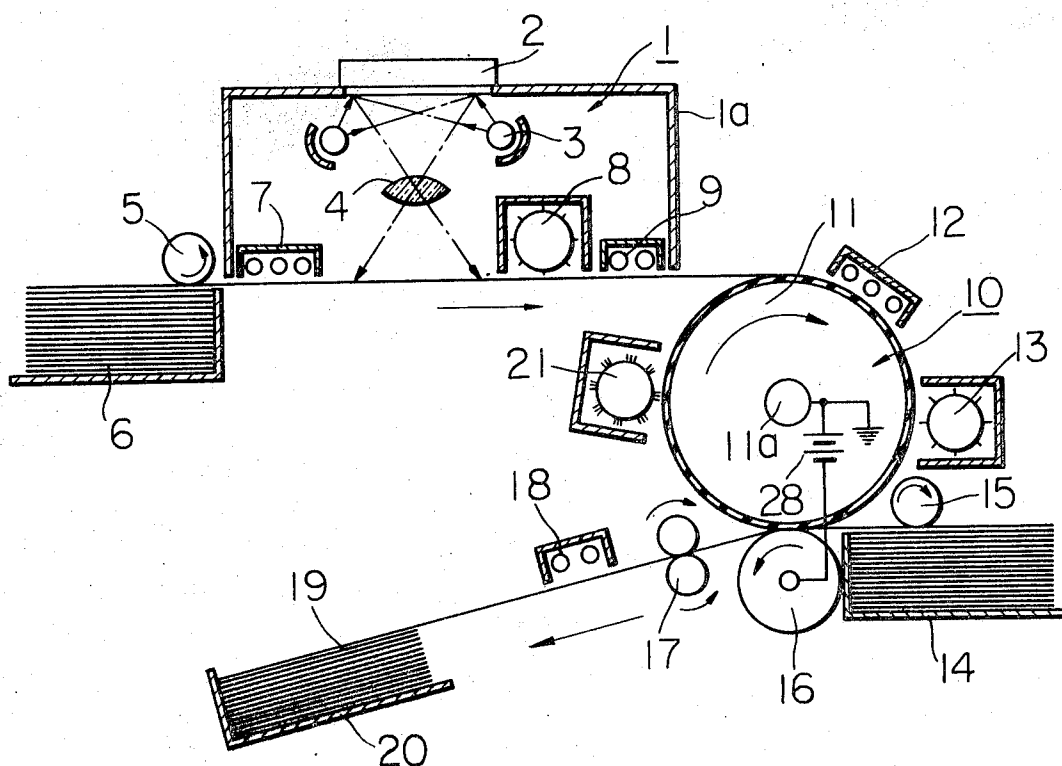


Fig. 3A

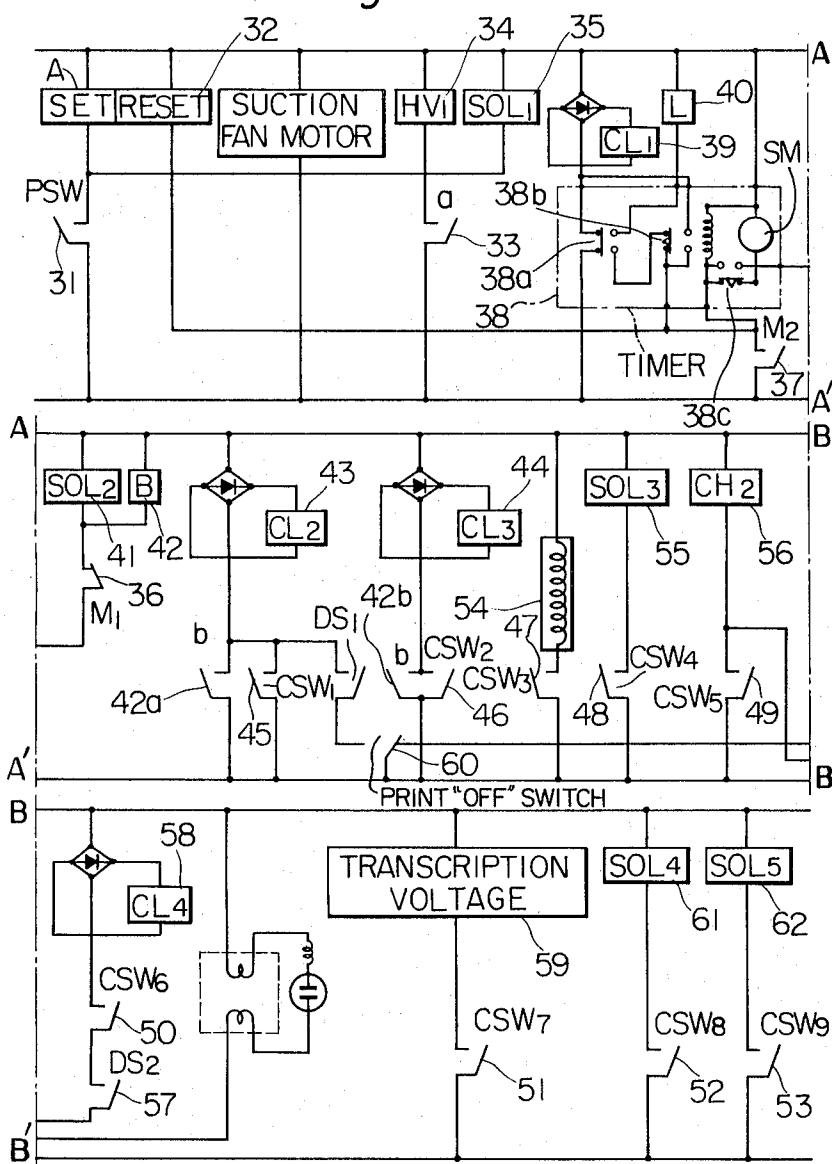


Fig. 3B

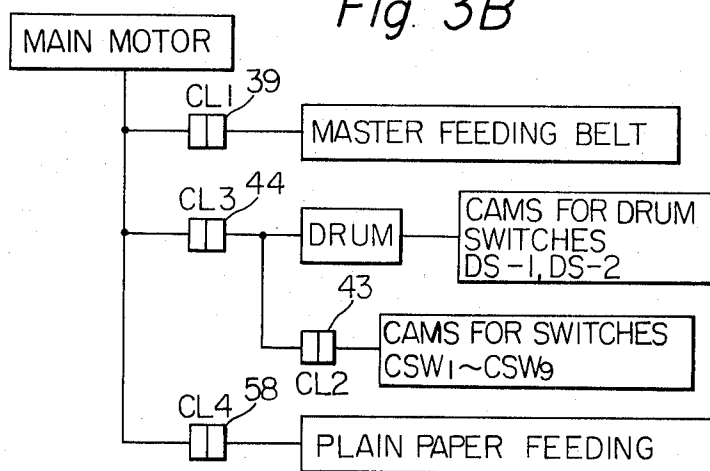


Fig. 5

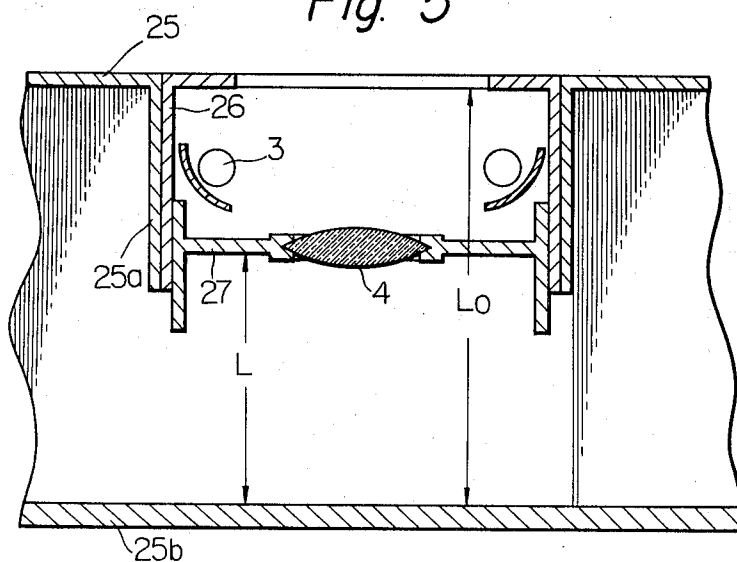


Fig. 4A

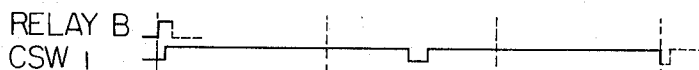


Fig. 4B

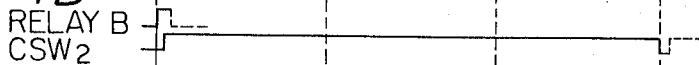


Fig. 4C

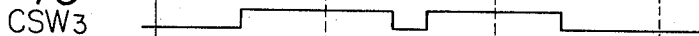


Fig. 4D



Fig. 4E

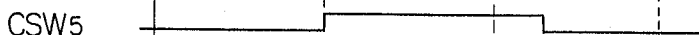


Fig. 4F



Fig. 4G

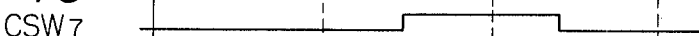


Fig. 4H



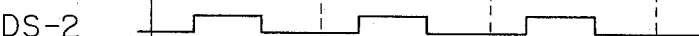
Fig. 4I



Fig. 4J



Fig. 4K



ELECTROPRINTING DEVICE

This is a continuation-in-part application of Ser. No. 793,506, filed Jan. 23, 1969, and its streamlined continuation application Ser. No. 174,977, filed Aug. 25, 1971, which are now abandoned.

The present invention relates to an electroprinting device composed of a master-sheet making device utilizing the technology of electrophotography and a transcribing device following and directly connected to the master-sheet making device.

In the conventional electrostatic printer, an electrostatic image is formed on a photoconductive substance such as solenium, and this image is developed and a large number of copies are printed by the transcription process. Therefore, at least two separate processes are necessary to produce a large number of copies.

The principal object of the present invention is to provide an electroprinting device having continuous processing for eliminating the drawbacks of the conventional electrostatic printer for making a large number of copies.

A further object of the present inventions is to provide an electroprinting device comprising a master-sheet making device utilizing the technology of electrophotography and a transcribing device for printing a large number of copies continuously from the master-sheet made by the master-sheet making device.

A still further object of the present invention is to provide an economical and practical electroprinting device which can produce a large number of copies from a cheap master-sheet by using conventional papers.

Further objects and advantages of the present invention will be apparent from the following description, reference being made to the accompanying drawings, wherein preferred embodiments of the present invention are clearly shown.

FIG. 1 is a schematic drawing of an embodiment of the electroprinting device according to the present invention.

FIG. 2 is a schematic drawing of another embodiment of the electroprinting device according to the present invention.

FIGS. 3A and 3B are block diagrams of a control device for the electroprinting device shown in FIG. 2.

FIGS. 4A to 4K are time charts explaining the function of the control device shown in FIG. 3.

FIG. 5 is a schematic drawing of the master-sheet making device of another embodiment of the electroprinting device according to the present invention.

Referring to FIG. 1, the electroprinting apparatus of the invention comprises a master-sheet making device 1 and a transcribing device 10 following and directly connected to the master-sheet making device 1. The master-sheet making device 1 comprises an electrostatic charging device 7, means for producing a potential image or latent electrostatic image on a paper delivered from the electrostatic charging device 7 and a developer 8 for developing the potential image on the paper, a fixer 9 for fixing the developed image on the paper, and a paper supply device including a feed roller 5. Any type of electrostatic charging device, for example the charging device disclosed in U.S. Pat. application entitled "Charging Device Applied for Making Electrophotography" filed by Takeo Tano and Morimasa Washiashi on Jan. 13, 1969, may be used for

the electrostatic device 7. The paper for making the master-sheet is stored in a reserve box 6. Means for making the latent image on paper delivered from the electrostatic charging device 7 comprises an optical system composed of a pair of light sources 3 and a lens 4 as shown in the drawing. A developer, as disclosed in U.S. Pat. application Ser. No. 772,752 entitled "An Improved Developing Apparatus Used in Electrophotography" filed by Akira Saito and Yukihiisa Shibasaki on Nov. 1, 1968 may be used for the developer 8. A heater type fixer is preferably used for the present invention. The electrostatic charging device 7, means for producing a potential image on a paper, developer 8 and fixer 9 are all covered by a case 1a so as to shut out light. Any suitable transport means is provided for transporting the master-sheet through the master-sheet making device 1 and delivering it to the transcribing device 10. The transport means includes means for stopping the master-sheet temporarily at the working position of the optical system comprising the lens 4 for forming a potential image on the sheet.

The transcribing device 10 comprises a drum cylindrical 11 rotatably mounted on a metallic shaft 11a, and a succession of work stations comprising an electrostatic charging device 12, a developer 13 and a cleaning device 21 are disposed in the given order at spaced circumferential positions around the drum 11 with respect to the rotational direction of the drum. The drum comprises rotary means for angularly advancing the master-sheet to the various work stations to enable the individual operations to be performed. As shown in the drawing, a paper supply source 14 is disposed at a position below the developer 13. The drum 11 is a metallic drum covered with a dielectric material. A number of plain papers or copy papers are supplied from the paper supply source 14 by the feeding action of a feed roller 15 while the plain papers stored in the supply source 14 are pressed against the feed roller 15 by means of a presser (not shown). A metallic transcription roller 16 is disposed below the drum 11 in such a way that the transcription roller 16 can be driven by frictional contact with the rotating drum 11. A voltage source 28 is connected to the drum 11 and the transcription roller 16 to apply a voltage for effecting transfer of toner from the master-sheet to the plain paper. A pair of delivery rollers 17 are disposed at an opposite side of the transcription roller 16 with respect to the feed roller 15. A box 20 for collecting the plain paper is disposed at the delivery side of the delivery rollers 17, a fixer 18 is disposed at a paper passage 19 between the delivery rollers 17 and the box 20. The drum 11 is provided with means for automatically attaching the master-sheet upon the drum (not shown). The conventional attaching means applied for XEROX may be used for the present invention.

The above-mentioned electroprinting device is operated in the following manner. A supply of sheet material is fed from the reserve box 6 and supplied to the master-sheet making device 1 by the feed roller 5. Next, an electrostatic charge is applied on the sheet by the charging device 7. An original paper 2 to be copied is irradiated by the light source 3 and made into an inverse image by means of the lens 4. Consequently, a potential or latent electrostatic image is formed on the photosensitive side of the sheet material delivered from the charging device 7. Next, the potential image on the master-sheet is developed with the developer 8 and the

developed image is permanently fixed by the fixer 9 to form a master-sheet. Thus, a stereotyped master-sheet is produced. The stereotyped master-sheet is attached automatically to the drum 11 by means of the automatic attaching means of the drum 11 and recharged by means of the charging device 12 being irradiated with light to carry out the development by the developer 13. By charging on the stereotyped master-sheet while irradiating the same with light, the charge remains only on the image which has been stereotyped or permanently fixed by the master-sheet making device, and toner adheres to the image part by the succeeding development by the developer 13. Consequently, the electroprinting machine of the invention can be provided with very simple construction which can be operated in a daylight room. A number of plain papers are successively fed to the nip line of the drum 11 with the transcription roller 16 by means of the feed roller 15 in such a way that the feeding of the plain paper is carried out synchronously with the moving of the master-sheet by the drum 11. Suitable pressure and voltage are applied between the drum 11 and the transcription roller 16 to transfer the toner on the master-sheet to the plain paper whereby a visible image conforming to the original is made on each plain paper in one revolution of the drum.

The plain paper, after the completion of the transcription, is carried to the fixer 18 by way of the delivery or feed rollers 17 by the plain paper peeling function, which is another function of the transcription roller, and is collected in the box 20.

On the other hand, the master-sheet is cleaned by means of the cleaning device 21, and the above-mentioned recharging, development and transcription are repeated in the same manner as mentioned above. When the required number of transcribed papers have been made, an operation button (not shown) is pressed to discharge the used master-sheet into the box 20 by the same route as the plain paper. Therefore, any required number of electroprinted copies can be economically made by the electroprinting machine of the present invention.

Referring to FIG. 2, another embodiment of the electroprinting device of the invention comprises similar elements to the first embodiment shown in FIG. 1, except for the omission of the developer 8 and the fixer 9 in a first device 22 and additional elements of a fixer 24 disposed at a circumferential position of the drum 11 after the developer 13 in a second device 23. In this embodiment, during the operation for applying electrostatic charge upon the master-sheet fed from the reserve box 6 and then forming the potential or latent image upon the photosensitive side of the master-sheet delivered from the charging device 7, the device 23 is controlled so as to be in a non-working condition so that the components used to effect the transcription are inoperative. Next, the second device 23 is operated so that the latent image of the master-sheet delivered from the master-sheet making device 22 is developed with the developer 13 and the developed image of the master-sheet is fixed by the fixer 24 of the transcribing device 23, while the electrostatic device 12, the feed roller 15 and the cleaner 21 are controlled so as to be in a non-working condition. By the above-mentioned operation, a stereotyped master-sheet is produced. Thereafter, this stereotyped master-sheet is used in the same manner as the first embodiment of the transcribing

ing device 23 shown in FIG. 1 so that the same result can be obtained. After completion of the above-mentioned operation, the fixer 24 is switched to non-working condition and the charging device 12, the feed roller 15, the transcription roller 16 and the cleaner 21 are switched to working condition. The succeeding electroprinting operation is then carried out in the same manner as the first embodiment of the invention mentioned above. Therefore, in the second embodiment of the invention, the image on the master-sheet is developed and fixed after the sheet is transferred to and during one revolution of the drum 11 while the visible image is made on the first sheet of plain paper during the next revolution.

Next, the switching mechanism which controls the electroprinting device shown in FIG. 2 will be described with reference to FIGS. 3A and 3B.

Referring to FIG. 3A, a print switch (PSW) 31 is a rebound type switch, that is, when it becomes free from the actuating pressure used to close the switch the movable contact of the switch opens. When the print switch 31 is closed, a set coil of a keep relay (A) 32 is energized and then a contact (a) 33 of the keep relay (A) is closed. As a result of this, a high voltage source (HV₁) 34 of the first electric charging device 7, and a master feed solenoid (SOL₁) 35, become operational. Then the master-sheet is fed from the reserve box 6 and negative charge is supplied to a surface of the master sheet by the high voltage source 34 of the first electric charging device 7. The feeding of the master-sheet causes it to push a micro-switch (M₁) 36 so as to open this switch. Next, when the front of this master-sheet pushes a micro-switch (M₂) 37 so as to close this switch, a timer 38 becomes operational. At the same time, the current of an electro-magnetic clutch (CL₁) 39 is cut off by an instantaneous contact 38a of the timer 38, and then the mechanism of the master-sheet feeding belt is isolated from the power source and the master-sheet stops. At the same time the master-sheet stops and a lamp for exposure 40 is switched on. When a setting time of the timer 38 has elapsed, two time limit switches 38b and 38c are exchanged, and then the lamp for exposure 40 is switched off by the time limit switch 38b and the electro-magnetic clutch (CL₁) 39 is energized and the master-sheet is again fed. In this case, the feeding mechanism is provided so that the feeding of the master paper is limited to one sheet.

As a result of this, the master-sheet to which the electrostatic charge is applied is fed to the drum 11. When a rear end of the master-sheet passes the micro-switch (M₁) 36 this micro-switch is closed and then a solenoid (SOL₂) 41 and a relay (B) 42 become operational. At the right moment, the front end of the master-sheet is in the position of a claw of the drum 11. Then the solenoid (SOL₂) 41 acts so as to close the claw, and the front end of the master-sheet is fixed on the surface of the drum 11. The relay (B) 42 then acts so as to energize electro-magnetic clutch (CL₂) 43 and (CL₃) 44 respectively by the switch contacts (b) 42a and (b) 42b. As shown in FIG. 3B, the clutch (CL₂) 43 transmits the mechanical power to a group of cam switches (CSW₁ - CSW₉) 45 - 53 and the clutch (CL₃) 44 to the drum 11. Then the group of cams for switches 45 - 53 and the drum 11 begin to rotate.

Then the potential image of the master-sheet is developed with the developer 13 shown in FIG. 2, while said master-sheet is wound round the drum 11. Next, the

first fixer 24 is energized with a cam switch (CSW₃) 47 and the developed image of the master-sheet is fixed on one side by the first fixer 24. Then the rear end of the master-sheet leaves from the micro-switch (M₂) 37, the timer 38 is reset and the contacts 38a, 38b, 38c of the timer 38 return to its original position. Next, the rear end of the master-sheet enters and is fixed to the drum 11 with a solenoid (SOL₃) 55 which is driven by a cam switch (CSW₄) 48. A cam switch (CSW₅) 49 then activates and the master-sheet is again charged with the charging device 56 and irradiated with light to carry out the development by the developer 13.

As the drum 11 and the group of cams for the switches which are synchronized with the drum 11 continue to rotate, a cam switch (CSW₆) 50 and a drum switch (DS₂) 57, which are revolving at the same speed as the drum 11, actuate an electro-magnetic clutch (CL₄) 58 which feeds the plain paper as shown in FIG. 3B and the transcription voltage 59 is supplied to the cam switch (CSW₇) 51.

Next, the cam switch (CSW₁) 45 is switched off and the cams belonging to the electro-magnetic clutch (CL₂) 43 are stopped. However, the drum 11 continues to rotate with the electro-magnetic clutch (CL₃) 44 and the printing is continued.

The print "off" switch 60 is pushed when the printing of the required number of copies is finished. Then a drum switch (DS₁) acts so as to energize the electro-magnetic clutch (CL₂) 43 and the group of the cams for switches are revolved. When the print off switch 60 is free from the pushing, its switch contact returns to the original position.

After the last plain paper is transcribed from the master sheet, the master-sheet is again fixed and the front and rear ends of the master-sheet are detached from the drum 11 by solenoids (SOL₄) 61 and (SOL₅) 62 with cam switches (CSW₈) 52 and (CSW₉) 53. After detachment the master-sheet is discarded from the drum 11 and the cam switches (CSW₁) 45 and (CSW₂) 46 stop the drum 11 and all the cams of the cam switch. If the drum 11 and the cams of the group of cam switches slip out of synchronization, synchronization may be reestablished in the stop position with the cam switch (CSW₁) 45 and (CSW₂) 46.

FIGS. 4A and 4B show time relation of the cam switches (CSW₁) 45 and (CSW₂) 46, with respect to the action of the relay (B) 42. The first developer activated by the cam switch (CSW₃) 47, as shown in FIG. 4C, and the rear end of the master-sheet is caused to be fastened by the cam switch (CSW₄) 48 as shown in FIG. 4D. Next, as shown in FIG. 4E, the cam switch (CSW₅) 49 is activated and the master-sheet is again charged by the charging device 12. Then the cam switch (CSW₆) 50, FIG. 4F, activates the electro-magnetic clutch (CL₄) 58 shown in FIG. 3B, which causes the plain paper to be fed and the cam switch (CSW₇) applies the transcription voltage as shown in FIG. 4G. FIGS. 4H and 4I show the time relation of the cam switches (CSW₈) 52 and (CSW₉) 53 which detach the lead and rear ends of the master-sheet. FIGS. 4J and 4K show the time relation of the drum switches DS-1 and DS-2.

If means for enlarging or contracting the original pattern 2 is combined in the master-sheet making device 22, the electroprinting machine of the present invention can be used more practically. An embodiment of the above-mentioned enlarging or contracting means

combined in the master-sheet making device is shown in FIG. 5, wherein, the light 3 and the lens 4 are disposed in an inside case 26 which can be adjusted in its relative distance L to the original distance L₀ between the upper plate 25 and the bottom plate 25b of the main case 1a of the device 1 by means of operating means (not shown) for sliding the inside case 26 along a guide plate 25a of the main case 1a, and further, the lens 4 is mounted on a frame 27 which can be adjusted in its relative distance L between the frame 27 and the bottom plate 25b to the above-mentioned distance L₀ by means of the same manner as that of the inside case 26. Therefore, any required enlargement or contraction of the image can be imparted to the master-sheet positioned on the bottom plate 25b of the main case 1a.

What is claimed is:

1. An electroprinting apparatus for making a selected number of copies of an original comprising: feeding means for feeding sheet material to be formed into a master-sheet during use of the apparatus; charging means for applying an electrostatic charge on the sheet material fed by said feeding means; means including an optical system for optically forming a latent electrostatic image of an original to be copied on the electrostatically charged sheet thereby forming a master-sheet containing thereon the latent image; first developing means for developing the latent image; fixing means for permanently fixing the developed image on the master-sheet; rotary means for receiving the master-sheet from said fixing means and angularly advancing same to successive work stations, said rotary means comprising a unidirectionally and rotationally driven cylindrical drum for receiving and carrying thereon the master-sheet; recharging means disposed adjacent the periphery of said drum and defining one work station for applying an electrostatic charge on the master-sheet as same is angularly advanced by said drum to recharge the master-sheet and form a latent electrostatic image conforming to the developed and permanently fixed image contained on the master-sheet; second developing means disposed adjacent the periphery of said drum circumferentially spaced from said recharging means in the rotational direction of said drum and defining another work station for applying toner to the master-sheet as same is angularly advanced by said drum to develop the recharged latent image; a rotatable transcription roller disposed adjacent the periphery of said drum to define a nip therebetween and circumferentially spaced from said second developing means in the rotational direction of said drum and defining a further work station; means for feeding copy paper during use of the apparatus into said nip in synchronism with the rotational speed of said drum; voltage applying means for applying suitable voltage between said drum and said transcription roller to effect electrostatic transfer of the toner from the recharged master-sheet to the copy paper to thereby form a visible image on the copy paper conforming to the original; and means for permanently fixing the visible image on the copy paper; whereby a copy of the original is made in one revolution of said drum.

2. An electroprinting printing apparatus according to claim 1; including cleaning means disposed adjacent the periphery of said drum circumferentially spaced from said transcription roller in the rotational direction of said drum and defining still another work station for cleaning residual toner remaining on the master-sheet

after each toner transfer to thereby prepare the master-sheet for recharging so that another copy can be made.

3. An electropainting printing apparatus according to claim 1; including cleaning means disposed adjacent the periphery of said drum at a location between said transcription roller and said recharging means in circumferentially spaced relationship from the former with respect to the rotational direction of said drum and defining still another work station for cleaning residual toner remaining on the master-sheet after each toner transfer to thereby prepare the master-sheet for recharging so that another copy can be made.

4. An electropainting apparatus for making a selected number of copies of an original comprising: feeding means for feeding sheet material to be formed into a master-sheet during use of the apparatus; charging means for applying an electrostatic charge on the sheet material fed by said feeding means; means including an optical system for optically forming a latent electrostatic image of an original to be copied on the electrostatically charged sheet thereby forming a master-sheet containing thereon the latent image; rotary means for receiving the master-sheet and angularly advancing same to successive work stations, said rotary means comprising a unidirectionally and rotationally driven cylindrical drum for receiving and carrying thereon the master-sheet; developing means disposed adjacent the periphery of said drum and defining one work station for developing the latent image as the master-sheet is angularly advanced by said drum; fixing means disposed adjacent the periphery of said drum circumferentially spaced from said developing means in the rotational direction of said drum and defining another work station for permanently fixing the developed image on the master-sheet as same is angularly advanced by said

drum whereby the latent image is developed and fixed in one revolution of said drum; recharging means disposed adjacent the periphery of said drum at a location between said developing means and said fixing means in circumferentially spaced relationship from the latter with respect to the rotational direction of said drum and defining a further work station for applying an electrostatic charge on the master-sheet as same is angularly advanced by said drum to recharge the master-sheet and form a latent electrostatic image conforming to the developed and permanently fixed image contained on the master-sheet; developing means consisting of said first-mentioned developing means for applying toner to the master-sheet as same is angularly advanced by said drum to develop the recharged latent image; a rotatable transcription roller disposed adjacent the periphery of said drum to define a nip therebetween and located between said developing means and said fixing means in circumferentially spaced relationship from the former with respect to the rotational direction of said drum and defining a still further work station; means for feeding copy paper during use of the apparatus into said nip in synchronism with the rotational speed of said drum; voltage applying means for applying suitable voltage between said drum and said transcription roller to effect electrostatic transfer of the toner from the recharged master-sheet to the copy paper to thereby form a visible image on the copy paper conforming to the original; and means for permanently fixing the visible image on the copy paper; whereby the first copy of the original is made in two revolutions of said drum and each successive copy is made in one revolution of said drum.

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