

March 11, 1958

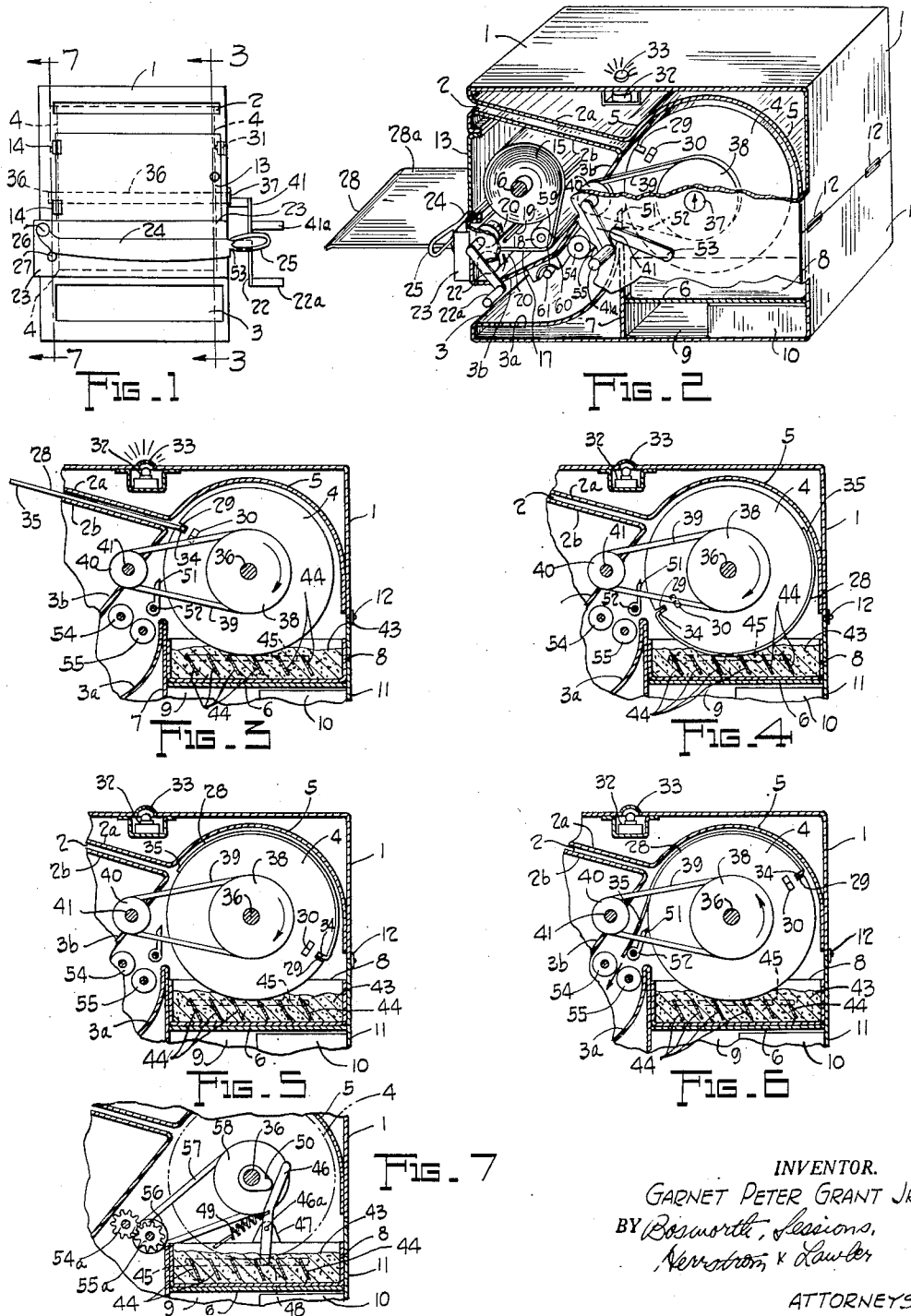
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2,826,168

MEANS FOR MAKING ELECTROSTATIC PRINTS

Filed April 16, 1956

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 8

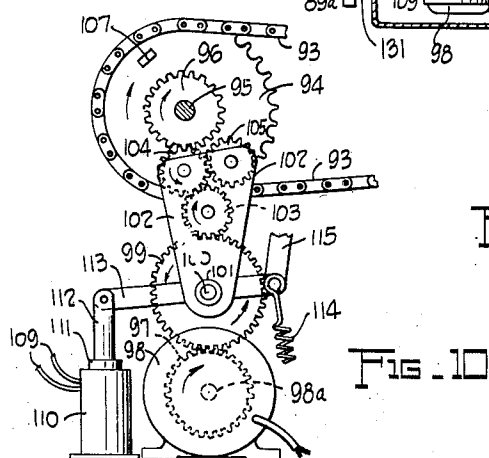
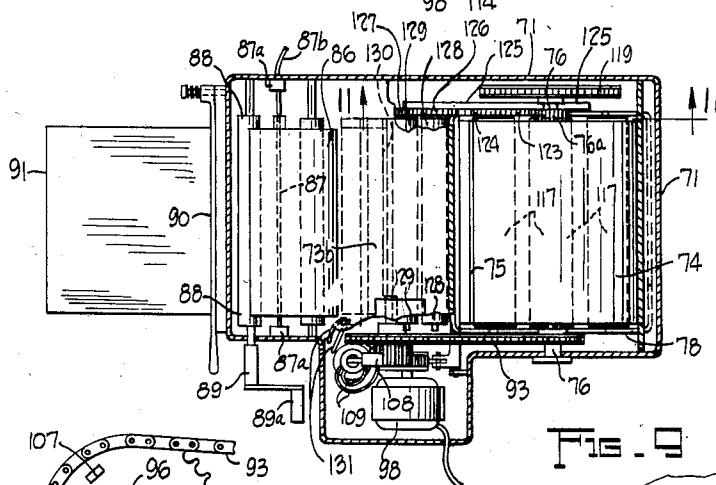
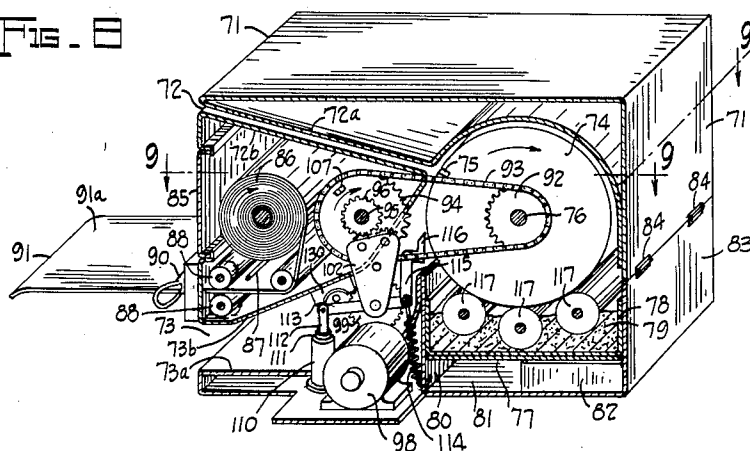


FIG. 9

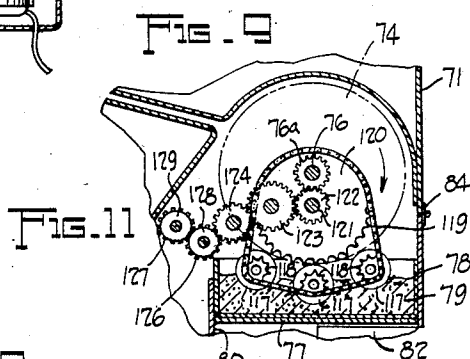


FIG. 11

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MEANS FOR MAKING ELECTROSTATIC PRINTS

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15 Claims. (Cl. 118—637)

This invention relates to means for making electrostatic prints.

Electrostatic printing systems are known, but in the past the methods and means used in and with them have in general tended to be cumbersome. The reason resides in the fact that it is not easy to carry out in one integrated sequence of steps or in a single unit the operations required to ready the print, expose it, develop in it the required electrostatic charge, apply to it the pigment by which the image is produced, and fix the image in permanent fashion. Although continuous systems have been proposed, in practise a series of separated units has usually been found to be preferable to the accomplishment of these ends.

The present invention consists in and has for its principal object the provision of ways and means for carrying out the various steps, exclusive of exposure to light, in one and the same apparatus. With that in mind, the invention contemplates a machine which incorporates means for cutting the print to the desired size, applying the electrical charge to it, supplying the pigment required to develop the latent image, and fixing the image by heat. According to the present invention, all of the stated functions, not including exposure of the print to light, are performed in a single machine which is at once compact, sturdy, and easy to service.

Other objects, advantages and features of the invention will be apparent from the description which follows and from the accompanying drawings, in which:

Figure 1 is a front elevation of the machine of the present invention.

Figure 2 is an isometric of the machine showing the parts as they would appear with the near side wall partially broken away.

Figures 3 to 6 are sections with certain parts in elevation seen as if from line 3—3 of Figure 1.

Figure 7 is a section with certain parts in elevation seen as if from line 7—7 of Figure 1.

Figure 8 is a view similar to Figure 2 showing a modification in which the more important operations are performed automatically.

Figure 9 is a plan of the machine of Figure 8 with the top of the housing broken away as indicated by lines 9—9 of Figure 8.

Figure 10 is an enlarged detail showing in elevation certain of the components appearing in Figure 8.

Figure 11 is a section with certain parts in elevation seen as if from line 11—11 of Figure 9.

In the embodiment of the invention shown in Figures 1 to 7, the mechanism making up the machine is enclosed with a metal housing 1 provided with an entry slot 2 and an exit slot 3, the two slots being defined by walls 2a, 2b and 3a, 3b, respectively. Within the housing is a cylindrical metal drum 4 mounted for rotation about a horizontal axis. Over roughly the upper half of its periphery, drum 4 is encompassed by a stationary metal shield 5 of generally semi-cylindrical shape one end or transverse edge of which is attached to the rear end of

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housing 1 and the other end or transverse edge of which is attached to the lower end of wall 2a of entry slot 2.

Directly beneath drum 4 is a horizontal partition 6 of which the near and far edges, seen as in Figure 2, are attached in any convenient fashion to the sidewalls of housing 1. To the inner transverse edge of partition 6 is rigidly attached a vertical partition 7. At its upper end, partition 7 is affixed to the upper end of wall 3a of exit slot 3, the two terminating below the central horizontal plane of the machine just above the point where they engage each other. Thus neither wall 3a of exit slot 3 nor vertical partition 7 blocks the exit slot at its upper end, which stands in communication with the interior of the machine. Horizontal partition 6 is used to support a tray 8 containing a finely divided pigment of the type commonly employed in electrostatic printing; below it is a shallow chamber 9 in which is contained the power pack 10. Access to power pack 10 may be had through a door 11 hinged as at 12 to the wall forming part of the housing at the rear end of the machine.

At the front end of the machine is a second door 13 pivoted on vertical hinges 14. Door 13 provides access to that portion of the machine between slot walls 2b and 3b, in which is housed a supply roll 15 of a material (usually paper) that is used as hereinafter explained in making prints. Supply roll 15 is mounted on a rod 16 extending transversely of the machine between its two longitudinally extending side walls. The paper is withdrawn from supply roll 15 in the form of a continuous web 17, passes downward to an underlying direction-changing roller 18, and then proceeds in a horizontal plane to and through a horizontally extending opening in the front end of the housing just above exit slot 3. Immediately after leaving roller 18, the paper passes beneath an electrically charged wire 19 carrying high voltage electricity, the current therefor being supplied from power pack 10 by suitable connections (not shown). At this stage, web 17 acquires an electrostatic charge, this as a result of passing closely beneath wire 19.

On its way out of housing 1, web 17 proceeds between two nip rollers 20, one of which is rotated by means of a crank 22 provided with a handle 22a (Figure 2). As it proceeds through the opening in housing 1, web 17 passes through a correspondingly slotted block 23 that is rigidly affixed to housing 1 immediately below door 13. Supported in juxtaposition to the slot in block 23 is a guillotine knife 24 that is provided with a handle 25 by which the body of the knife 24 may be raised and lowered. The knife is so pivoted on block 23 that handle 25 describes an arc about pivot pin 26. It may be raised as high as required, but is precluded by a stop 27 on block 23 from dropping below the horizontal position: see Figure 1. With the knife raised, the desired length of material is withdrawn from supply roll 15, after which the knife is urged downward with the aid of handle 25 to provide a cut sheet 28. In the latter, the electrostatic charge imparted by wire 19 to web 17 is substantially unimpaired.

Sheet 28 is then exposed through a negative of any suitable sort to form a latent image on top face 28a. The latter will already have been sensitized; i. e., prepared for the production of the image, by surfacing it in suitable fashion before the material from which it is cut is wound to form the supply roll. Sensitizing procedures of this sort are well known in the electrostatic printing art. The exposure to produce the image may be accomplished in any one of a variety of ways, as in a hand-held printing frame, an automatic printing machine, a machine for exposing blueprints, etc. The effect of exposing top face 28a of sheet 28 to the light transmitted through the negative is to modify the electrical charge in a pattern deter-

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mined by the negative, thereby preparing the sheet for processing in a machine of the kind described in the present application. Although the electrical charge may have been very extensively modified in the meanwhile, the sheet itself appears unchanged to the eye.

Thereafter, sheet 28 is inserted in slot 2 with its top face 28a next to wall 2a of entry slot 2. Immediately before this is done, drum 4 should be re-positioned within to the apparatus as a whole in such manner that there will be assurance of substantial alignment between exit slot 2 and a shallow slot 29 extending lengthwise of drum 4 in parallelism to its axis. Alignment of slot 29 with entry slot 2 can be and preferably is indicated by a signaling system of a suitable kind, such signaling system operating only when alignment is present. Once such alignment has been achieved, it becomes possible by urging sheet 28 into slot 2 to engage the leading end of the sheet in slot 29.

In the embodiment of the invention shown in Figures 1 to 7, the signaling system as a whole responds to the position of a lug 30 on the near end face of drum 4 (Figure 2). Lug 30 is so located that it can cooperate with a microswitch 31 on housing 1 (Figure 1). Preferably, such switch is of the type adapted for momentary actuation; if actuated, it operates to close a circuit which includes a lamp assembly 32 mounted on the inside of the top of housing 1 just below a window 33 of the jewel type. Whenever the switch is engaged by lug 30, the lamp in lamp assembly 32 will be illuminated; in other words, the lamp will flash once for each 360° of rotation of drum 4. It will remain illuminated only so long as there is substantial alignment between entry slot 2 and slot 29 in drum 4 (Figure 3).

With the parts as represented in Figure 3, the lamp in lamp assembly 32 is illuminated, slots 2 and 29 are in alignment, the leading end 34 of sheet 28 projects out of slot 2 into slot 29, and the trailing end 35 of sheet 28 is in the vicinity of the entrance end of slot 2.

Drum 4 is mounted on a shaft 36 that extends from the near side to the far side of the housing as seen in Figure 2. At its near end, shown in elevation in Figure 2, shaft 36 carries a knob 37 provided with an indicating arrow that points up when the lamp in lamp assembly 32 is illuminated. Just inside the near wall of housing 1, shaft 36 mounts a pulley 38 connected by a belt 39 to a second pulley 40 of smaller diameter. Pulley 40 is mounted just inside the near wall of the housing at the inner end of a crank 41 so positioned that its shank passes through the wall. Crank 41 is provided with a handle 41a by which it, pulley 38 and drum 4 may be rotated in unison.

With the parts in the position shown in Figure 3, clockwise rotation of crank 41 serves to rotate drum 4 in the clockwise direction. Drum 4 draws sheet 28 with it by virtue of the engagement of the leading end of the sheet in slot 29. The trailing end of the sheet is constrained by shield 5 to follow the surface of the drum as the latter revolves about the axis of shaft 36. By the time crank 41 has been turned sufficiently to produce about 300° of rotation of drum 38, which state of affairs is shown in Figure 4, the leading end 34 of sheet 28 has been pulled into, through, and out of tray 8. Trailing end 35 has not yet been pulled through tray 8 but is still in the area in which shield 5 exercises its restraining action on the sheet.

Continued rotation of crank 41 brings drum 4 and sheet 28 into the positions shown in Figure 5, in which both the leading and trailing ends of the sheet are free of the tray. By this time, drum 4 has made one and a half revolutions, in the course of which the lamp in lamp assembly 32 has flashed twice, once at the outset and once after 360° of rotation. The angular position of the drum, measured radially, is revealed by the arrow on knob 37 on shaft 36, which at this stage points down.

While sheet 28 is being drawn through tray 8, it comes into intimate contact with a powdery pigment 43 of one of the kinds conventionally employed in making electro-

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static prints. Pigments of this sort may vary considerably in composition but in a typical case may contain iron filings, carbon black and a finely divided thermoplastic resin that fuses at moderate temperatures. The pigment mixture is picked up by sheet 28 as it follows the course already described through tray 8. It attaches itself to those parts of sheet 28 in which the latent image has been formed by exposure of the sheet to light. Thus the pattern of the negative is reproduced in positive fashion on sheet 28.

In order to keep pigment 43 thoroughly mixed, vanes 44 are provided in tray 8, each of them being pivoted at each of its two ends to the adjacent portion of the tray. Near their upper ends, vanes 44 are interconnected by two links 45, one at the near end of the tray and one at the far end. Links 45 are provided in order to move vanes 44 in unison. Occasional movement of the vanes at irregular intervals is sufficient.

To introduce such movement, the far end of the tray; i. e., the side seen in Figure 7, is provided with an upright lever 46 that is pivoted at 46a to a bracket 47 on the tray wall. At its lower end, lever 46 makes a pin and slot connection with the underlying link 45, such connection being indicated at 48 (Figure 7). A coil spring 49 connected at one end to the tray itself biases lever 46 toward shaft 36. Periodically it is urged away from shaft 36 by a cam 50 which is fixed to and rotates with the shaft.

The parts having respectively attained the positions shown in Figure 5, the next step is to remove sheet 28 from the machine. This is done by reversing the direction of rotation of crank 41, which results in movement of pulleys 38 and 40 in the counterclockwise direction. In order to disengage the trailing end 35 of sheet 28 from the drum, the machine is provided with a deflector 51 fastened to a pivoted rod 52 extending transversely through housing 1. Deflector 51 may consist of a single blade extending all the way across the housing or of a series of spaced fingers, the latter being the preferred construction. Normally; i. e., during clockwise rotation of drum 4, deflector 51 will stand upright, as indicated in Figures 3 to 5.

When, however, it is desired to reverse the direction of rotation to release sheet 28 from the drum, deflector 51 is moved into the inclined position shown in Figure 6, this being done by moving an arm 53 attached to rod 52 on the outside of the housing. Thereafter, when counterclockwise rotation of drum 4 is initiated, the trailing end 35 of sheet 28 is bodily deflected from the surface of the drum, preventing it from coming into renewed contact with the pigment 43 in tray 8. Instead, sheet 28 moves downwardly between two adjacent discharge rollers 54 and 55 in the manner indicated by the arrow in Figure 6.

On the far side of the machine; i. e., the side at the left in Figure 1, discharge rollers 54 and 55 are equipped with intermeshing gears 54a and 55a. Gear 55a is driven by a pulley 56 that is coupled by a belt 57 to a larger pulley 58 on shaft 36. Thus when drum 4 (indicated in dotted lines in Figure 7) is rotated in the counterclockwise direction, the upper surfaces of rollers 54 and 55 move toward each other in such manner as to encourage sheet 28 to enter into the bight between them. If drum 4 is rotated in the clockwise direction, rollers 54 and 55 rotate in the reverse directions without doing any harm.

In order to fuse the pigment which adheres to sheet 28 where the latent image has been formed, a heating unit 59 is located on the exit side of rollers 54 and 55 in approximately the position shown in Figure 2. Along with suitable leads (not shown), heating unit 59 incorporates a reflector 60 and an electrical heating element 61. It is adapted to produce a degree of heat sufficient to fuse the fusible components of the pigment which adheres to sheet 28, thus fixing the image. This is done gradually as the print is propelled through rollers 54 and 55. Ultimately, the print drops down into exit

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slot 3, which acts as a receptacle, from which the print can easily be removed.

A modification in which certain of the operations that would otherwise have to be performed by hand are performed automatically is shown in Figures 8 to 11. In such modification, housing 71 has an entry slot 72 and an exit slot 73 arranged much as in the previously described embodiment of the invention. Within housing 71 is a drum 74 provided with a transverse slot 75 in its periphery. Drum 74 is mounted on a shaft 76 that extends across the machine from the near side to the far side, seen as in Figure 8.

Below drum 74 is a horizontal partition 77 on which is mounted a tray 78 for pigment 79. A vertical partition 80 adjoins horizontal partition 77 to provide therebelow a shallow chamber 81 in which is received the power pack 82. Access to tray 78 and power pack 82 may be had through a door 83 hinged to the housing as at 84. At the left hand end of the machine as a whole, seen as in Figure 8, is a door 85 similar to the door 13 of the previously described embodiment of the invention. Accessible through door 85 is a supply roll 86 containing the material that is to be made into prints. The material proceeds in web form beneath a charged wire 87 to and between nip rollers 88, one of which is turned manually by a crank 89 provided with a handle 89a. After leaving nip rollers 88, the web passes through a suitable opening in the front end of the housing. It is severed by means of knife 90 to form a cut sheet 91 of the desired length.

After being exposed to light as already described, sheet 91 is introduced into entry slot 72 with its sensitive top face 91a adjacent upper slot wall 72a. Its leading edge is engaged in transverse slot 75 in drum 74, which is so synchronized with the rest of the apparatus that when the parts are in the position shown in Figure 8, transverse slot 75 is always in juxtaposition to the entry slot. By means of a small sprocket 92, a chain 93 and a large sprocket 94, the diameter of the large sprocket being fifty percent greater than that of the small sprocket, drum 74 may be driven from a pinion 96 on a stub shaft 95. Pinion 96 is connected through an intervening gear train to a similar pinion 97 on the shaft 98a of an electric motor 98 (Figures 8 and 10).

As best seen in Figure 10, pinion 97 meshes with a gear 99 mounted on a stub shaft 100. This shaft is encompassed on one side of gear 99 by a sleeve 101 to which is rigidly affixed a plate 102 of generally triangular shape. On the far side of the plate 102, in alignment with gear 99, are three small gears 103, 104 and 105. These gears are mounted on stub shafts on plate 102; therefore, they always bear the same relationship to each other. However, the mounting plate itself is so arranged that the drive may be from gear 99 to gear 103 to gear 104 and thence to gear 96 or, alternatively, from gear 99 to gear 103 to gear 104 to gear 105 and thence to gear 96.

Whether gear 104 or gear 105 engages gear 96 depends on the position of the plate 102. With the parts in the positions shown in Figure 10, gear 105 is an ineffective idler. On the other hand, when this plate is rotated a few degrees to the left of the position shown in Figure 10, gear 104 is disengaged from, and gear 105 is engaged with, pinion 96. In the latter case, neither gear 104 nor gear 105 serves as an idler. The interposition of gear 105 in such case operates to reverse the direction of rotation of pinion 96 and large sprocket 94.

On large sprocket 94 is lug 107, seen in Figures 8 and 10, that is adapted to engage a microswitch 108 of the maintained-contact type (Figure 9). Switch 108 is mounted on housing 71 in a position in which lug 107 can, from time to time, make contact with it, thus moving the moveable switch contact from open to closed position or vice versa. Wires 109 from switch 108 lead to a solenoid 110 mounted on the base of housing 71 in the manner indicated in Figure 8. Solenoid 110 incorporates a plunger 111 mounted on a rod 112 which is pivotally connected to a lever 113 that is itself rigidly

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mounted on sleeve 101. Lever 113, rod 112 and plunger 111 are biased toward the position shown in Figure 10 by means of a coil spring 114.

Coupled to lever 113 at its right-hand end, seen as in Figure 8, is a link 115 which carries a deflector 116 operating on the bell-crank principle. It is fastened to a pivotally mounted rod similar to rod 52 (Figures 2 to 7). So long as the other parts are in the positions shown in Figures 8 and 10, it is out of contact with drum 74. As represented in Figures 8 and 10, the moveable contact in switch 108 has just been moved into open-circuit position by action of lug 107. Therefore, solenoid 110 is de-energized, the rotation of the pinions, gears and sprockets is as shown by the arrows in Figure 10, and drum 74 is rotating clockwise. Engagement of drum 74 by deflector 116 is not desired under these conditions.

Inasmuch as clockwise rotation of small sprocket 92 results from clockwise rotation of large sprocket 94, which is half again as large in diameter, drum 74 makes one and one-half clockwise revolutions for each clockwise revolution of large sprocket 94. Thus after lug 107 once moves the moveable contact in switch 108 into the open circuit position, the leading end of sheet 91 will be carried 540° around the axis of rotation of drum 74 before the lug again makes contact with switch 108. At this time, the leading end of the sheet is in a position corresponding to the leading end of sheet 28 in Figure 5 of the drawings dealing with the previously described embodiment of the invention. It is only when sheet 91 reaches this position that lug 107 re-engages switch 108 to cause the moveable contact of the switch to snap into the closed-circuit position.

When this happens, solenoid 110 is energized, thus drawing plunger 111 and plunger rod 112 into their retracted positions. This movement depresses the left-hand end and elevates the right-hand end of lever 113, seen as in Figure 10, which in turn rotates sleeve 101 and plate 102 a few degrees to the left about the axis of stub shaft 100. Thus gear 105 is cut into operation, after which the drive is from pinion 97 to gear 99 to gear 103 to gear 104 to gear 105 to pinion 96, which now turns counterclockwise. Counterclockwise movement of gear 96 produces counterclockwise movement of sprocket 94, chain 93 and sprocket 92, which in turn produces counterclockwise movement of drum 74.

At the same time, elevation of the right-hand end of lever 113 forces deflector 116 into engagement with the surface of drum 74. After this happens, it is in a position to deflect what was originally trailing end of sheet 91 exactly as in the case of sheet 28 in the embodiment of the invention already described. Under the influence of the counterclockwise movement of drum 74, sheet 91 then passes between exit rollers 128 and 129 (Figure 9) and thence past heating unit 130 (Figure 8). The latter is operated from leads 131 (Figure 9). As the sheet is propelled past heating unit 130, the pigment fuses to give the desired permanent image. The sheet when released by rollers 128 and 129 drops down onto lower wall 73a of exit slot 73, from which it can readily be retrieved.

To reveal the position and direction of rotation of drum 74 at a given time, a signaling system of any suitable kind may be provided.

During the time when drum 74 is rotating in the clockwise direction, it carries sheet 91 into and through the pigment 79 in tray 78. In the embodiment of the invention shown in Figures 8 to 11, vanes are not used to keep the pigment mixed; instead, three magnetized rolls 117 apply the pigment to the exposed surface of the sheet. Rolls 117 are positively driven by sprockets 118 at the far end of the machine (Figure 11). Sprockets 118 are driven by a chain 119 which is itself driven by a large sprocket 120 on a rotatable stub shaft 121. Sprockets 118 and 120 and chain 119 are in a common plane adjoining the far side wall of housing 71; see Figure 9,

Shaft 121 is driven by means of a gear 122 that is in engagement with a pinion 76a on shaft 76 in the space between sprocket 120 and the adjacent end of drum 74.

Shaft 76, through pinion 76a and gear 122, also drives a gear 123, which in turn drives a gear 124. Shaft 76 is journaled in a bracket 125 on which are mounted stub shafts carrying gears 123 and 124. These two gears form part of the gear train communicating power to the exit rollers. Gear 124 drives the nearer of two meshing gears 126 and 127, one at the end of exit roller 128 and the other at the end of exit roller 129. The shafts carrying exit rollers 128 and 129 are journaled in bracket 125; see Figure 9. Below the exit rollers on the upper wall 73b of exit slot 73 is the heating unit 130, indicated in Figure 9 in dotted lines, to which electricity is supplied by leads 131.

The foregoing description and the accompanying drawings set forth two illustrative embodiments each of which in its own way incorporates some of the novel features of the present invention. One of these embodiments, that illustrated in Figures 1 to 7, is essentially a hand-operated machine; the other, that illustrated in Figures 8 to 11, is essentially automatic in operation, requiring little more than manual actuation and de-actuation of an electric motor. In addition thereto, other embodiments will suggest themselves, for it is apparent that changes in either or both of these embodiments may be made by those skilled in the art without departing from the spirit of the invention.

It is intended that the patent shall cover, by summarization in appended claims, all features of patentable novelty residing in the invention.

What is claimed is:

1. Apparatus for processing electrically charged sheet material comprising a housing; a drum within the housing adapted for rotation in clockwise and counter-clockwise directions; means associated with the housing for feeding sheet material to the surface of the drum; means for applying powder to the sheet material, said means including a powder reservoir at the bottom of the housing; means for separating the sheet material from the surface of the drum during the movement of the drum in one of said directions; and, acting on the sheet material leaving the drum, means for subjecting the sheet material to the action of heat.

2. Apparatus for processing sheet material as in claim 1 in which the drum is provided with means engaging the leading edge of the sheet.

3. Apparatus for processing sheet material as in claim 2 in which the means engaging the leading end of the sheet takes the form of a slot in the drum.

4. Apparatus for processing sheet material as in claim 3 in which the housing incorporates an internal shield for guiding the trailing end of the sheet.

5. Apparatus for processing sheet material as in claim 4 in which the housing incorporates selectively positioned means for deflecting the trailing end of the sheet from the surface of the drum.

6. Apparatus for processing an electrically charged print comprising a drum; means for attaching the print to the surface of the drum; means for imposing on the

drum rotary movement first in one direction and then in the opposite direction; means including a powder reservoir beneath the drum for applying a powder to the exposed surface of the print during rotation of the drum; means for detaching the print from the surface of the drum during rotation of the drum; and means for guiding the print away from the drum.

7. Apparatus as in claim 6 in which the drum is provided with means limiting its movement in the first direction.

8. Apparatus as in claim 6 in which the drum is provided with means limiting its movement in the opposite direction.

9. Apparatus as in claim 6 in which the drum incorporates a system of gearing for limiting movement of the drum in either direction.

10. Apparatus for processing electrically charged sheet material comprising a container; a drum in the container; means for rotating the drum first in one direction and then in the opposite direction; means for engaging a sheet of electrically charged material with the drum during movement of the drum in the first direction; means for disengaging said sheet of electrically charged material from the drum during movement of the drum in the opposite direction; and means for applying a powder to said sheet of electrically charged material while the drum is being rotated in the first direction, said means including a powder reservoir in proximity to the bottom of the drum.

11. Apparatus as in claim 10 in which the means for engaging the sheet of electrically charged material with the drum comprises a slot in the drum into which the leading end of the sheet of electrically charged material is introduced.

12. Apparatus as in claim 10 in which the means for disengaging the sheet of electrically charged material from the drum comprise one or more deflectors which are maintained out of contact with the drum during movement of the drum in said first direction but which are maintained in contact with the drum during movement of the drum in the opposite direction.

13. Apparatus as in claim 12 in which the deflectors take the form of spaced fingers disposed at intervals across the surface of the drum.

14. Apparatus as in claim 13 in which the fingers are pivoted in such manner that they can be swung into and out of contact with the surface of the drum.

15. Apparatus as in claim 14 in which the pivoted movement of the fingers is coordinated with the movement of the drum.

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