

Aug. 1, 1967

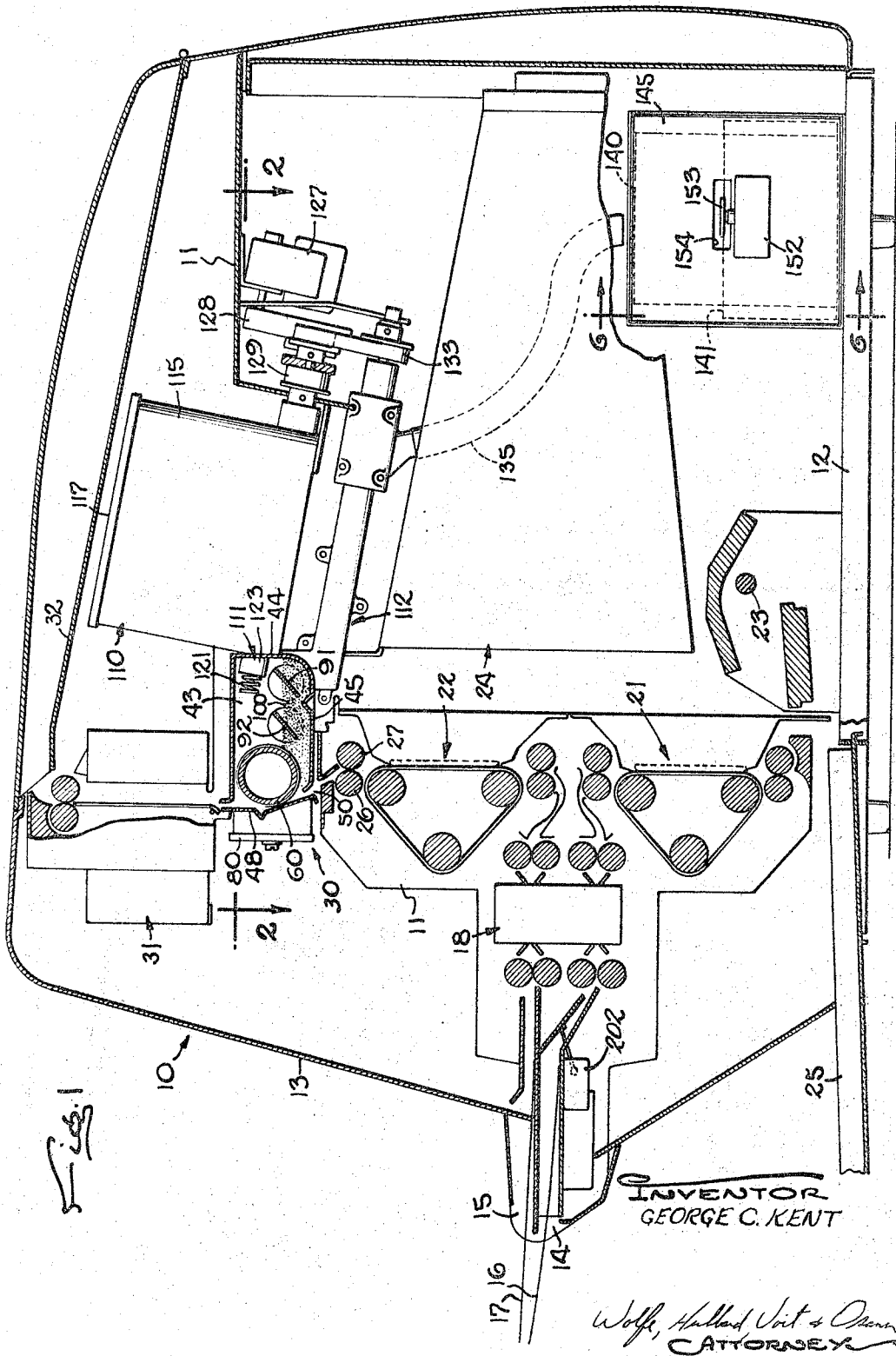
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3,333,566

DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

Filed May 6, 1963

5 Sheets-Sheet 1



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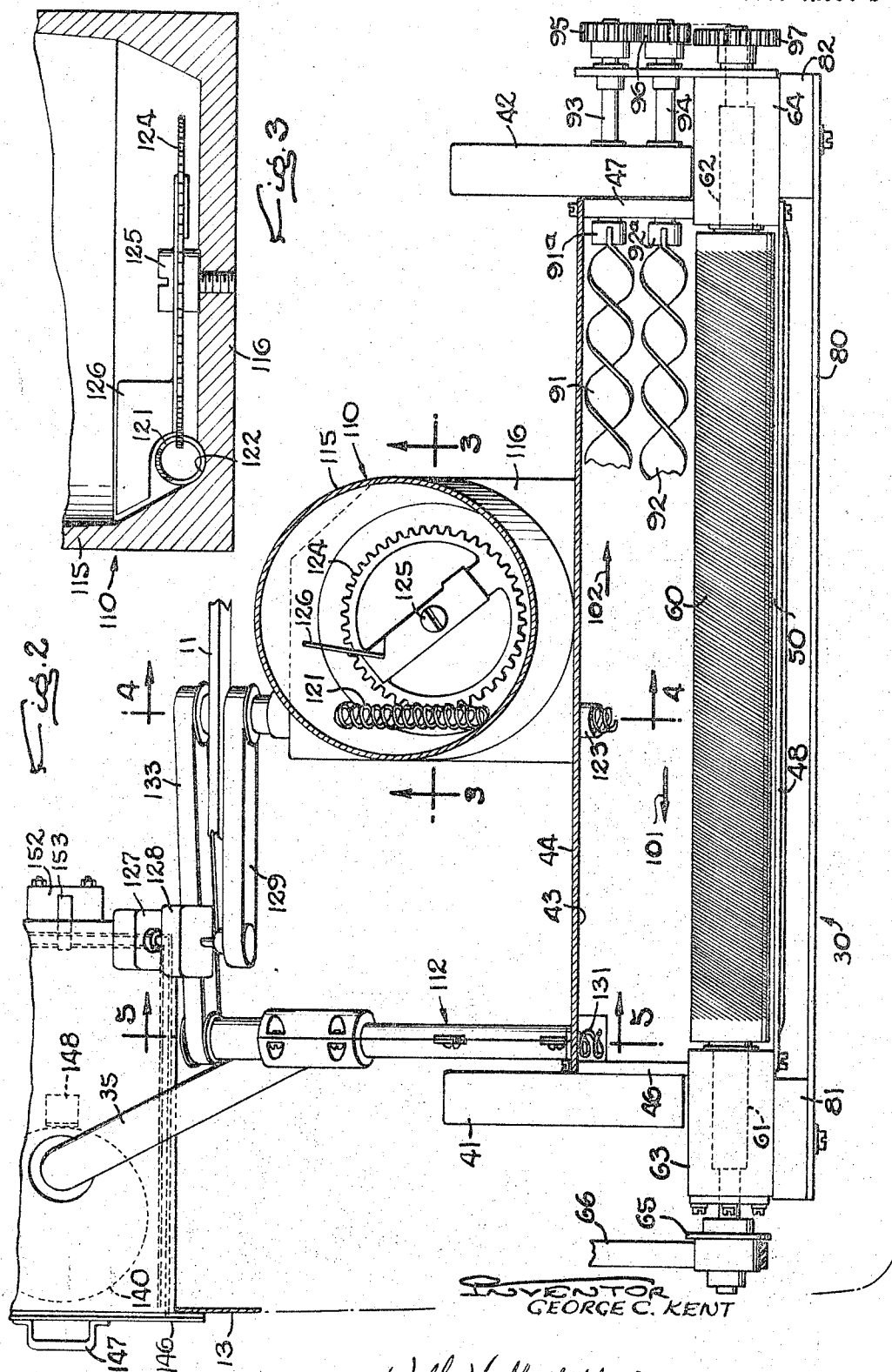
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DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

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5 Sheets-Sheet 2



Wolfe, Hubbard, Vait & Osann ATTORNEYS

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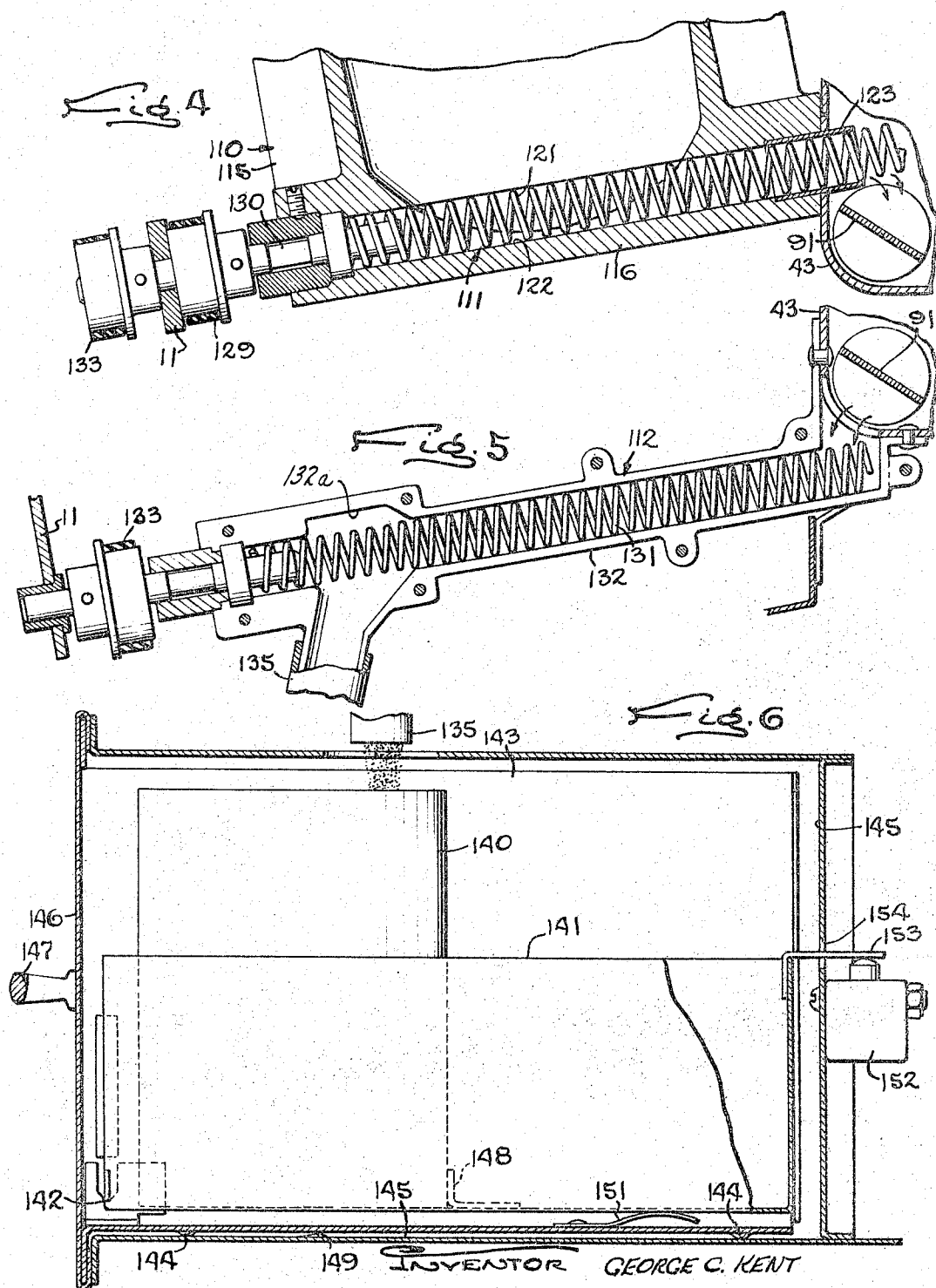
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DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

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5 Sheets-Sheet 3



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DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

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5 Sheets-Sheet 4

Fig. 7

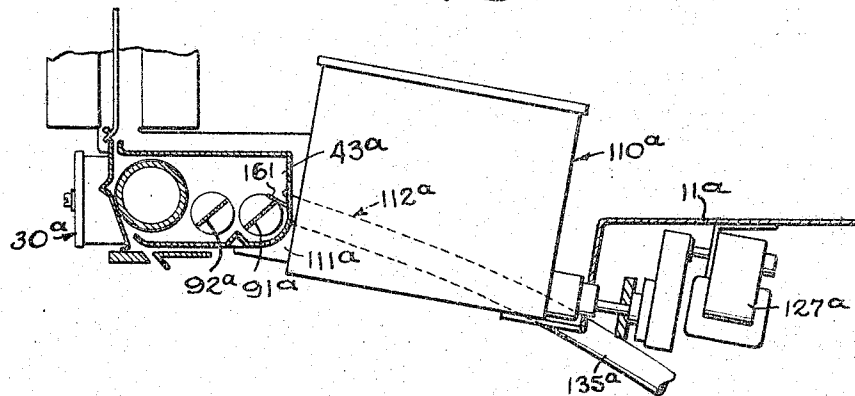


Fig. 8

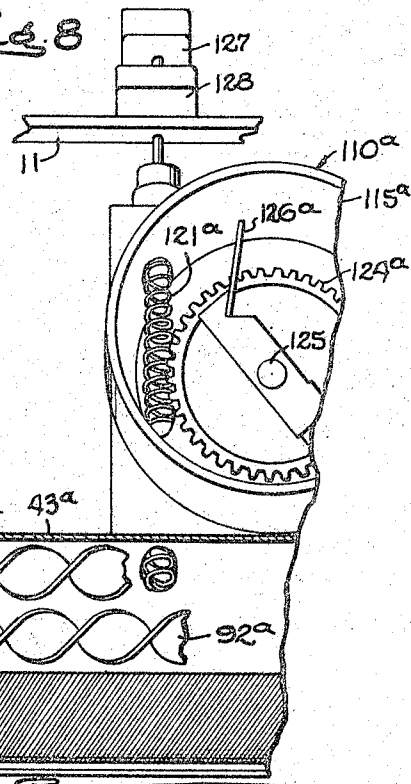


Fig. 9

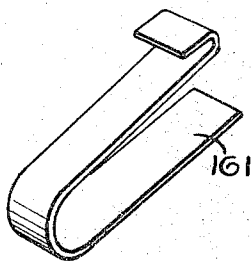
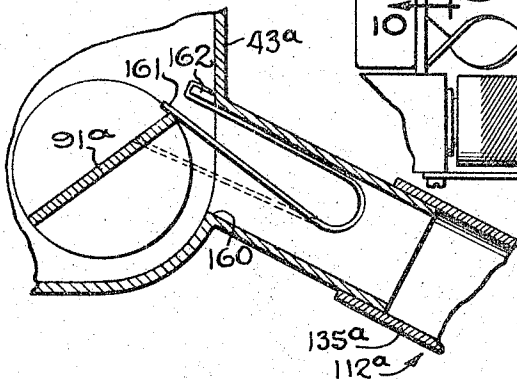


Fig. 10



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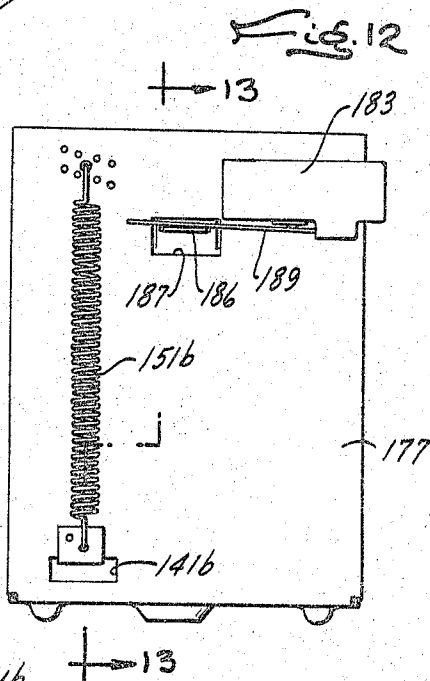
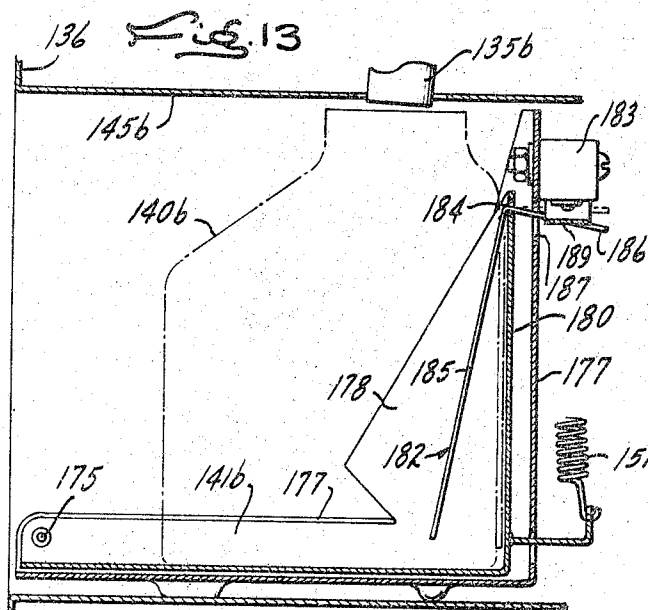
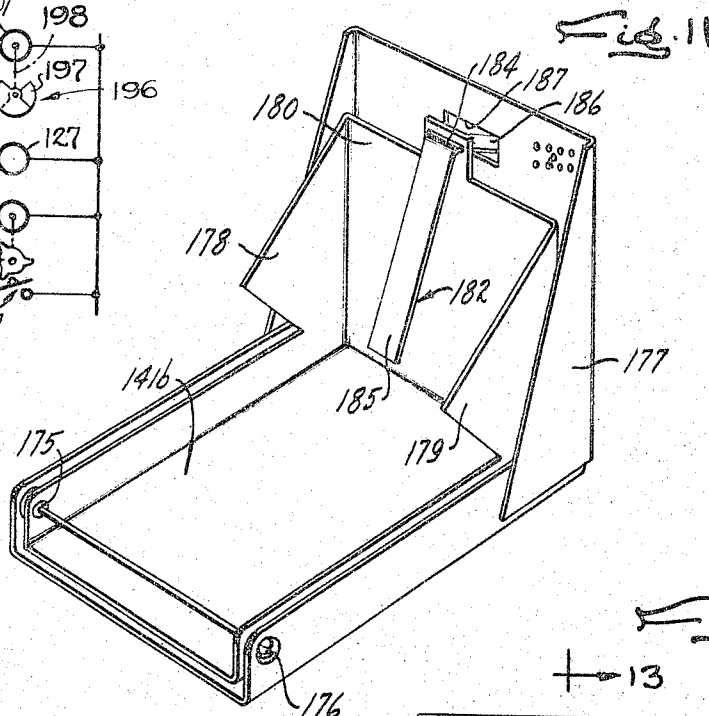
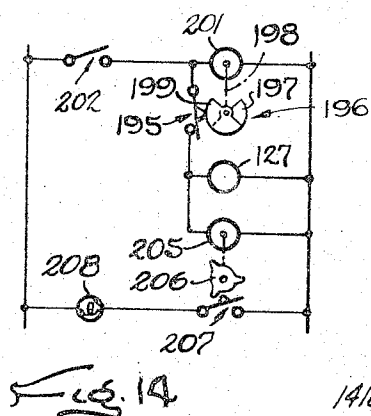
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DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

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5 Sheets-Sheet 5



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DEVELOPER SYSTEM FOR ELECTROSTATOGRAPHIC MACHINES

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2 Claims. (Cl. 118—2)

The present invention relates to electrostatographic printing machines and more particularly concerns a developer composition handling system for such machines.

An electrostatographic printing process includes the steps of uniformly charging a copy surface, exposing the surface to produce a latent image with dissipation of the charge from the light struck areas, and development of the image by applying a pigmented powder or developer composition which adheres to the remaining charged areas. In compact office copying machines, the image is generated directly on the copy sheet and the powder is subsequently fixed to the copy by radiated heat. The powder developer composition typically comprises a large proportion of magnetic carrier material, such as iron, together with a pigmented toner and perhaps special additives.

It has been found in such compact machines, with the heat fixing unit relatively close to the supply of powder in the developer unit, that heat buildup occurs in the powder that tends to cause the material to pack or "clump," resulting in streaked copies or otherwise improper operation.

Difficulties have also been experienced with replenishing the toner portion of the developer composition, the ingredient which is depleted upon operation, and mixing the toner with the remaining and reusable iron. Not only are adding the proper amounts of toner and properly mixing the replenished developer composition problems, but it has also been found that friction creation and mechanical working of the powder seems to cause the material to clump which again constitutes a source of poor copying performance.

Accordingly, it is the primary aim of the invention to minimize the above problems by incrementally renewing the developer composition in an electrostatographic machine rather than attempting to replenish the composition with the toner ingredient being depleted by the copying process.

More particularly, it is an object of the invention to maintain the developer composition in an electrostatographic copy machine by adding new powder and removing exhausted powder at the same rate while the machine is in operation. Preferably, the rate of developer composition renewal is selected to correspond with the average rate at which the toner ingredient is depleted during normal copy work.

It is also an object to provide a developer composition handling system which operates in the above manner while insuring that the renewed composition is thoroughly mixed before actual use and that only the "most used" material is discharged.

A further object is to provide a system of the above character having an economical and reliable powder discharge mechanism. A related object is to provide a disposable receptacle arrangement which can be easily serviced, which provides a suitable signal or other warning indicating service is required and which minimizes the likelihood of inadvertent spillage of the powder.

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

FIGURE 1 is a longitudinal section of an electrostatographic copy machine embodying the present invention;

FIG. 2 is an enlarged fragmentary section taken approximately along the line 2—2 in FIG. 1;

FIG. 3 is an enlarged fragmentary section taken approximately along the line 3—3 in FIG. 2;

FIGS. 4 and 5 are enlarged fragmentary sections taken respectively along the line 4—4 and 5—5 in FIG. 2;

FIG. 6 is an enlarged fragmentary section taken approximately along the line 6—6 in FIG. 1;

FIG. 7 is a fragmentary section similar to a portion of FIG. 1 which shows a modified form of the invention; FIG. 8 is a fragmentary plan of the structure shown in FIG. 7;

FIG. 9 is a perspective of an element forming a part of the modification illustrated in FIGS. 7 and 8;

FIG. 10 is an enlarged fragmentary section taken approximately along the line 10—10 in FIG. 8;

FIG. 11 is a perspective of a modified portion of this structure illustrated in FIG. 6;

FIG. 12 is an end view of the structure shown in FIG. 11;

FIG. 13 is similar to FIG. 6 and shows the modified structure otherwise illustrated in FIGS. 11 and 12; and

FIG. 14 is a diagrammatic showing of a portion of a control circuit for the machines of the several modifications illustrated in the above-identified drawings.

While the invention will be described in connection with preferred embodiments and procedures, it will be understood that I do not intend to limit the invention to those embodiments or procedures. On the contrary, I intend to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Turning now to FIGURE 1 of the drawings, there is shown an electrostatographic copying machine 10 intended for office use and having a frame 11, a base 12 and a housing 13. At the front of the housing two inlet slots are provided, a first slot 14 for the original and a second slot 15 for the copy sheet, with the two sheets, indicated as 16 and 17, being fed in together face to face. The sheets are separated and the copy sheet, which has a coat of zinc oxide or similar material having the ability to dissipate a stored electric charge in areas which are selectively struck by light, passes through a charging unit 18. The original is fed into an illuminating station 21 at the same time that the copy sheet 17 is fed into an exposing station 22 and with both sheets proceeding at the same speed. Light from a source 23 illuminates the original, with the image thereof being reflected by a mirror and lens assembly 24 onto the moving copy sheet. Subsequently the original is discharged into a return chute 25 while the copy sheet is conveyed upwardly by transport rollers 26, 27 into a developing unit 30 and fixing unit 31 for discharge rearwardly onto a tray 32 recessed in the top of the machine. For details of the fixing unit 31, which fixes in place the toner deposited on the sheet in the developing unit 30, reference is made to copending application Ser. No. 209,122, filed July 11, 1962, now U.S. Patent 3,159,735. For details of the construction and operation of the development unit 30, reference is made to copending application Ser. No. 211,779, filed July 23, 1962, now U. S. Patent 3,196,831. For present purposes, it will be sufficient to observe that the developing unit 30 includes a generally rectangular bin 43 mounted between brackets 41, 42 secured to the frame of the machine by any desired means. The bin has a back surface 44 and a bottom 45 which are secured to end members 46, 47 which may be of plastic or the like. The bin is enclosed along its front surface by a barrier or guide plate 48.

For the purpose of admitting the copy sheet into the underside of the developing unit, a longitudinal opening 50 is provided immediately behind the guide plate 48. This opening is normally closed by a flap (not shown).

of yieldable material which is so light as to be readily pushed aside by the leading edge of an advancing sheet, with immediate self-closure augmented by the weight of the developer composition or toner powder in the bin 43 as soon as the sheet has gone by.

For the purpose of wiping the face of the copy sheet with toner powder for adherence of the latter to the charged areas, a developing cylinder 60 is provided having stub shafts 61, 62 which are journaled in bearing blocks 63, 64 mounted in the end members of the developing unit. For rotating the cylinder 60 the shaft 61 carries a belt pulley 65 which is engaged by a belt 66 leading to the main driving motor (not shown), of the machine. The developing cylinder 60 is made of magnetic material having a pattern of upraised ridges or projections and means are provided for establishing a magnetic flux substantially at right angles thereto and through the copy sheet so that magnetic "tufts" or "brushes" of developer composition are formed on the ridges for wiping across the surface of the copy sheet.

The exact nature of the developer composition is outside of the scope of the present application and it will suffice to say that the composition consists of a mixture of a minor proportion of pigmented toner particles in a major proportion of magnetic carrier particles, with the toner particles adhering to the magnetic particles as a result of triboelectric effect and leaving the magnetic particles when the toner particles are brushed in contact with the surface of the copy sheet. Thus, operation of the copy machine depletes the quantity of toner particles in the developer composition mix, while the magnetic particles remain in the bin 43 in their original reusable state.

The means for establishing magnetic flux at right angles to the developing cylinder include making the bearing blocks 63, 64 of magnetic material and bridging the blocks by an elongated magnetic pole piece 80 parallel to the cylinder 60 and joined to the magnetic bearing blocks by permanent magnets 81, 82 which are polarized in parallel with one another, i.e., with same polarity, so that the flux is distributed more or less uniformly to the surface of the cylinder 60. The barrier or guide plate 48 is made of aluminum or other non-magnetic material so that it does not obstruct or distort the flux flowing to the cylinder.

For mixing and circulating the developer composition continuously in opposite directions so that the level of the toner in the bin 43 is constantly balanced, augers 91, 92 are mounted upon shafts 93, 94 adjacent the cylinder 60 and are so pitched and rotated that they tend to transport the powder oppositely with respect to one another. In the present instance this is achieved by employing augers of the same hand and with the drive shafts being coupled together by directly meshing gears 95, 96. As shown in FIG. 2 the latter gears are coupled to the shaft of the cylinder 60 by means of a drive gear 97 at the right hand end of the shaft.

While the augers 91, 92 may take various forms, it is preferred to use a simple strip of metal twisted into auger shape and with the ends being fitted into hubs 91a, 92a respectively.

The augers are preferably operated only partly submerged, with the level of the toner mix being indicated at 100 in FIG. 1. Thus, any tendency toward pileup of the toner mix, for example, at the left hand end of the bin tends to submerge the augers thereby increasing the efficiency of the "return" auger so that it transports a larger amount of material away from the region where the mix has tended to collect. The augers 91, 92 therefore keep the developer composition both level in the bin 43 and in continuous circulation around a closed path whose straight runs are indicated by the arrows 101 and 102 in FIG. 2. When the composition is moving along the run 101 the mix is in an active zone of use and subject to being picked up by the cylinder 60 and applied to the copy paper.

As has been pointed out, only the toner particles adhere to the copy paper and the magnetic particles are returned to the zone of use by the cylinder 60 and recirculated around the bin 43. Therefore, it has been the practice to replenish the developer composition by adding additional quantities of toner particles as the machine operates so as to maintain the desired developer composition. This practice is subject to the difficulties discussed on the first pages of the specification.

In accordance with the present invention, the developer composition is maintained by adding additional material to the bin 43 having the desired developer composition and discharging quantities of the composition from the bin at the same rate at which it is being added. Preferably, the rate at which new developer composition is added, and the old discharged, is quite slow and corresponds to the average rate at which toner particles are removed from the composition. That is, average copy work removes toner particles at a certain rate from the developer composition. A working figure for this rate would be in the range of 40 to 60 milligrams per 8½ x 11 inch sheet. The invention thus contemplates adding enough new developer composition per 8½ x 11 inch sheet copied to restore the removed amount of toner material to the mix. With a 95% carrier, 4% toner composition, this would mean adding, and discharging, between 1 and 1½ grams of developer composition to the bin for each sheet copied. The developer composition is thus removed at a rate approximating the rate at which the toner portion of the mix is depleted.

Pursuant to the invention, the machine 10 includes a magazine 110 for storing developer composition, which is connected by a conveyor 111 to the bin 43, and a discharge device 112 opening from the bin for removing powder from the supply. The conveyor 111 and the discharge device 112 are driven so that equal amounts of the developer composition are added and discharged with the result that the supply in the bin 43 remains constant.

In the illustrated embodiment, the magazine 110 is mounted on the machine frame 11 and includes a cylindrical body 115 supported on a base plate 116. Preferably, a removable top 117 (see FIG. 1) is provided to selectively seal off the contents of the magazine.

The conveyor 111 takes the form of a helical coil auger 121 disposed in a trough 122 formed in the base plate 116 and extended through a short tube 123 which opens into the bin 43. The coil auger 121 is "geared" to an agitator wheel 124 pivoted on a screw 125 so as to overlie the bottom of the magazine 110. Rotation of the auger 121 thus rotates the wheel 124, and the latter carries an upstanding paddle 126 which is effective to loosen and dislodge powder in the magazine so that it flows freely along under the positive drive of the coil auger 121.

The conveyor 111 is driven by a motor 127 which is coupled through a gearbox 128 and a belt 129 to a shaft 130 which supports the coil auger 121. It will be evident that energization of the motor 127 feeds developer composition from the magazine 110 into the bin 43. The control of the motor 127 is discussed below in connection with the circuit shown in FIG. 14.

In this embodiment, the discharge device 112 likewise takes the form of a helical coil auger 131 which rotates in a tube 132 opening into the bottom of the bin 43. The augers 121 and 131 are rotated in unison by a connecting belt 133 and are preferably of the same size and pitch but are formed of opposite hand. Thus, each of the coil augers 121, 131 moves the same amount of powder material during the period the motor 127 is energized, but the auger 121 moves this material from the magazine 110 into the bin 43 while the auger 131 moves this amount of material from the bin 43 and through the tube 132 where it is discharged down a tubular chute 135. The tube 132 is formed with an enlarged chamber 132a directly over the chute and this enlargement has been found to effectively eliminate packing or caking of the material being discharged.

In keeping with the invention, the conveyor 111 adds developer composition at a point of the circulation path within the bin 43 that is well in advance of the zone of use adjacent the cylinder 60 and the discharge device 112 removes composition from the bin at a point of the circulation path which is just at the end of the zone of use. In this way, the added material is mixed thoroughly as it is moved along the circulation path before reaching the zone of use and only the "most used" developer composition is discharged by the device 112.

As a further feature of the invention, the chute 135 discharges into a disposable receptacle 140 that is removably received in a tray 141. The tray 141 is pivoted at 142 in a box-like carrier 143 which slides on a plurality of feet 144 within a rectangular recess 145 formed in the side of the copy machine housing 13. The carrier 143 is formed with a front plate 146 which fits flush with the side of the housing 13 and which carries a handle 147 which the operator of the machine can conveniently use to slide the carrier 143 outwardly, to the left in FIGS. 2 and 6, and thereby service the machine by removing a full receptacle 140 and repositioning another disposable receptacle to receive the developer composition discharged from the bin 43.

Preferably, a stop 148 is positioned within the tray 141 so as to dispose the receptacle 140 toward the front end of the tray. A detent 149 is struck upwardly from the bottom wall of the recess 145 so as to arrest outward sliding movement of the carrier 143 by striking one of the feet 144 and thereby define the normal service position of the carrier 143. When so positioned, the receptacle 140 is clear of the housing 13 and can be easily removed. The tray 141 is so proportioned that, when pulled to the service position, it still underlies the chute 135 when the foot 144 is in engagement with the detent 149. In this way, continued discharge of developer composition through the chute 135 when the carrier 143 is pulled outwardly to service the disposable receptacle is simply received within the tray 141 and inadvertent spillage is avoided. In addition, the large capacity tray is well adapted to receive overflow from the receptacle 140 or, in the event that the carrier 143 is slid inwardly without replacing the removed receptacle 140, the tray 141 can act as an emergency receptacle without soiling the machine. In such an event, the carrier 143 can be slid over the detent 149 completely clear of the machine and the tray 141 easily lifted from the carrier and emptied.

In the illustrated construction, a spring 151 biases the tray 141 upwardly about its pivot 142 and a signal controlling switch 152 is associated with the biased tray so as to be operated upon downward displacement of the tray against the bias of the spring 151 when the receptacle 140 is substantially filled. The switch 152 is secured against the back side of the rear wall of the recess 145 and is operated by a finger 153 rigidly secured to the tray 141 which slips through an aperture 154 in the recess wall when the carrier 143 is slid to its normal illustrated operating position. As will be quite clear to those skilled in this art, the switch 152 can be arranged to actuate a signal lamp or audible alarm so as to indicate to the machine operator that the disposable receptacle 140 has become filled and should be replaced.

It is important to appreciate that while the switch 152 directly responds to the amount of material in the receptacle 140, this constitutes an indirect, but nonetheless quite accurate, signal indicating the need for replenishing the supply of developer composition in the magazine 110. That is, it is contemplated that the developer composition be packaged in containers like the receptacle 140. When the magazine is replenished, a full container of developer composition is added to the magazine 110 and the empty container is then placed in the tray 141 replacing the filled receptacle 140. By the actuation of the switch 152, the operator knows that replenishment is again necessary. Thus, an accurate indication of the need for replenishing

the supply of developer composition is obtained without elaborate mechanisms for sensing the amount of powder in the bin 43 or the magazine 110.

In the embodiment of FIGS. 7 to 10, parts similar to those previously described have been given the same reference numeral with the distinguishing suffix "a" added. In this embodiment, a discharge device 112a is arranged to open into a bin 43a of a developing unit 30a so as to discharge developer composition at approximately the same rate at which additional quantities of this composition is fed into the bin 43a by a conveyor 111a from a magazine 110a. The device 112a takes the form of a gravity chute 135a which is coupled directly to an aperture 160 in the lower portion of the bin 43a.

To insure movement of the developer composition at a proper rate down the chute 135a, an agitating element in the form of a U-shaped spring 161 is clipped to a lug 162 so as to extend through the opening 160 with the free end of the spring in the rotating path of an auger 91a that circulates the developer composition in the bin 43a. As best seen in FIG. 10, each rotation of the auger 91a flexes and snaps free the spring 161 so as to agitate and propel a charge of developer composition down the chute 135a. It has been found that this simple form of gravity discharge arrangement removes developer composition from the bin 43a at a rate closely approximating the rate at which the composition is added by the conveyor 111a.

In FIGS. 11 to 13, an alternate arrangement for receiving the discharged developer composition is shown in which parts similar to those previously described have been given the same reference numerals with the distinguishing suffix "b" added. In this embodiment, a chute 135b discharges into a disposable receptacle 140b that is removably received in a tray 141b. The tray 141b is pivoted at 175 and 176 in a generally L-shaped bracket 177 that is received within a rectangular recess 145b formed in the side of a copy machine housing 13b. The housing 13b encloses a copy machine that corresponds to the machine 10 previously described.

The tray 141b is formed with a pair of opposed wings 178 and 179 extending from a rear wall 180 and proportioned to snugly embrace the receptacle 140b. The correct operating position for the receptacle is established with the receptacle abutting the wall 180 and gripped between the wings 178, 179. When so positioned, the mouth of the receptacle lies squarely beneath the chute 135b (see FIG. 13).

As a feature of this embodiment of the invention, the tray 141b is biased upwardly by a spring 151b, and a sensing lever 182 and a switch 183 are arranged to indicate whether or not the receptacle 140b is full and whether or not it is properly positioned for receiving discharged developer composition. To this end, the lever 182 is L-shaped and pivoted at the bend in a slot 184 formed in the tray wall 180. One arm 185 of the lever 182 extends down in front of the wall 180 and the other arm 186 passes through an opening 187 in the bracket 177. The switch 183 is secured to the bracket 177 and provided with an operator 189 that is biased, by the resistance of the switch to operation, against the lever arm 186. That is, movement of the operator 189 upwardly operates the switch 183 and this movement is resiliently resisted by the normal tendency of the switch to assume a non-operated condition.

The switch 183 is arranged in the copy machine control system so as to activate a signal lamp or audible alarm whenever it is not operated. In other words, the operator 189 must be held up or the switch activates the signal circuit. Such circuit arrangements are well-known to those skilled in the art and, hence, are not described in detail here.

In operation, before the receptacle 140b is placed in the tray 141b, the spring 151b holds the tray up, but the lever arm 185 swings out freely from the wall 180 so that the

switch 183 is not operated and the warning signal circuit is activated. Placing an empty receptacle 140b in proper position against the wall 180 and between the tray wings 178, 179 presses the lever arm 185 against the wall 180 to the dashed line position illustrated in FIG. 13 and thus lifts the operator 189 so as to operate the switch 183. When the receptacle fills, its weight stretches the spring 151b and the lever arm 186 pulls away from the operator 189 so that operation of the switch is again interrupted. In this way, the warning circuit is actuated whenever a receptacle has not been properly positioned beneath the chute 135b, and whenever a properly positioned receptacle has been substantially filled.

In summary, the inventive procedure described above has been found to produce great stability of operation in a copying machine by eliminating the renewal and replenishing problems associated with the developer composition used by such machines. The mechanisms described have also proven simple, economical and very trouble-free in operation.

Those familiar with the art will understand that the rate at which the toner in the developer composition is exhausted depends on the number and size of sheets being copied, and also that the concentration of toner powder in the bin 43 affects the intensity of the copy. Thus, "darker" or "lighter" copies can result from controlling the rate at which the developer composition is replenished relative to the number and size of copies being made.

In carrying out the invention, an effective and economical control circuit is provided for adjustably controlling the energization of the motor 127 and thus the intensity of the copies being produced by the machine 10. The motor 127 is preferably an economical, constant speed motor energized through a normally open switch 195 that is operated by a rotatable, adjustable cam 196 (see FIG. 14). The cam 196 includes a lobe 197, fixed to a shaft 198, and an angularly adjustable lobe 199 which can be set on the lobe 197 so as to define a peripheral rise 200 varying, in the illustrated construction, from about 180° to 360°.

The shaft 198 is driven by a motor 201 which is engaged through a switch 202 that senses the length of sheets passing into and through the machine 10 (see FIG. 1). In a typical case, the speed of sheets moving into the machine is one inch per second and the motor 201 is a timing motor that rotates the cam 196 at a 1 r.p.m. rate.

Thus, in the typical machine under consideration, a plurality of sheets, or one long sheet, having a total length of about sixty inches would have to pass through the machine in order to drive the cam 196 through a complete cycle. During each cycle of the cam 196, the motor 127 is energized for a period determined by the setting of the cam. It is therefore possible, by setting the cam 196, to conveniently and easily adjust the amount of developer composition replenished for each, substantially uniform, increment of copy work; and thus control the intensity of the copies being made.

The above described circuit also readily permits another alternate way of signalling the operator when the magazine 110 should be refilled. In accordance with this embodiment, a timer motor 205 is connected in parallel with the motor 127 and is provided with a cam 206 that operates a normally open switch 207. The switch 207 controls a signal such as a light 208.

Preferably, the motor 205 rotates at a one hour per revolution rate and the cam 206 is formed with three equidistant lobes. Thus, the switch 207 is closed when-

ever the motors 127 and 205 have been operated for a total of twenty minutes. The figure of twenty minutes is selected, of course, since it requires about the length of time for the motor 127, operating constantly, to empty the magazine 110. Thus, the light 208 goes on to signal the operator that the magazine 110 should be refilled.

In the examples discussed above, the specific rates and times are illustrative only and can vary, depending on the related characteristics of the machine, without departing from the invention.

I claim as my invention:

1. In an electrostatographic printing machine, the combination comprising, means for passing sheets having an electrostatic image thereon successively through said machine, a magazine for storing a supply of developer composition, a bin for containing developer composition in position for contacting the electrostatic image on said sheets, a constant speed motor, means driven by said motor for feeding developer composition from said magazine to said bin, a switch for sensing the length of sheets passing through the machine, an adjustable cam, means including said switch for driving said cam whenever the switch is operated, and means including said adjustable cam for energizing said motor for a period determined by the setting of the adjustable cam during each cycle of said cam.

2. The combination of claim 1 including a timer arranged to be operated concurrently with said motor, and a signal operable by said timer whenever the timer has been operated for a certain total interval, said interval being selected to coincide with the time required by said motor to exhaust said magazine so that said signal indicates the need for refilling the magazine.

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