United States Patent

Quant

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[54] **TONER DISPENSER CIRCUIT FOR ELECTROSTATOGRAPHIC APPARATUS**

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[51] **Int. Cl.** **G03g 13/00**

[58] **Field of Search** 118/637, 7, 9; 95/1.7; 117/17.5

[56] **References Cited**

UNITED STATES PATENTS

3,196,831	7/1965	Sugarman	118/637
3,514,203	5/1970	Zerfahs	355/10
3,526,338	9/1970	Goodrich et al.	118/637
3,527,387	9/1970	Wilson	118/637

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[57] **ABSTRACT**

In an electrostatographic reproduction apparatus, a toner control system is provided for regulating the quantity of toner supplied to the developer station, said control system operating in response to signals produced by the copy counter switch and employing an electric timing mechanism for controlling the duration of application of the toner to the developer mechanism.

11 Claims, 2 Drawing Figures

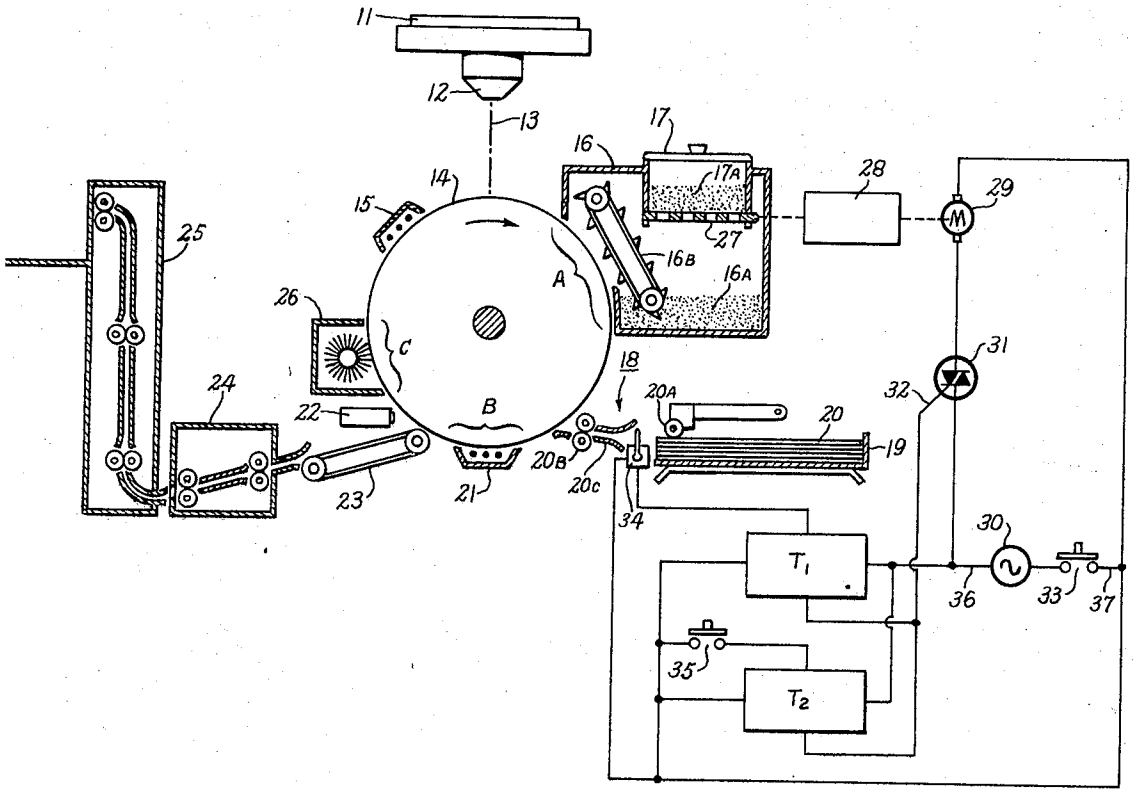
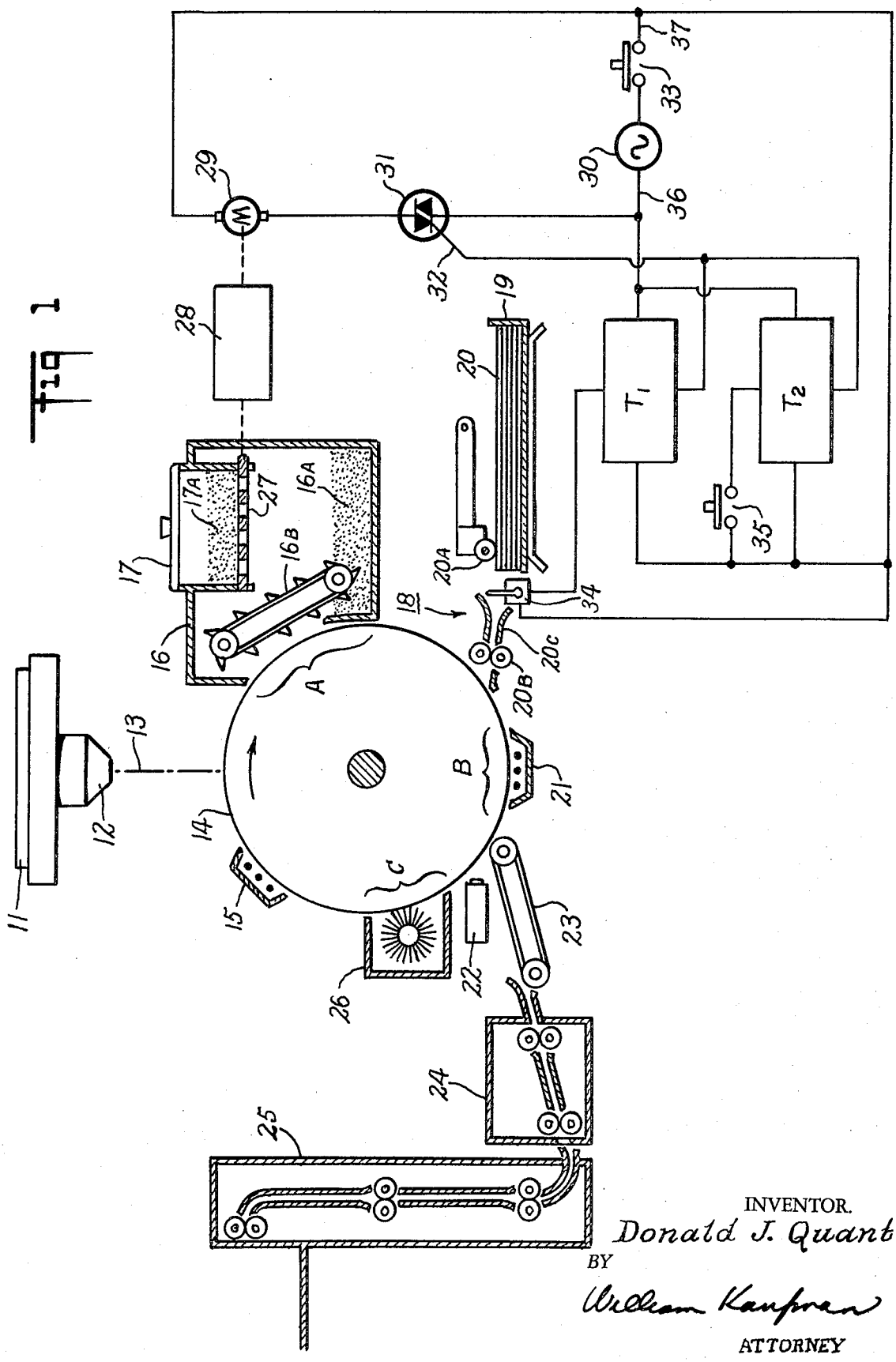


Fig 1



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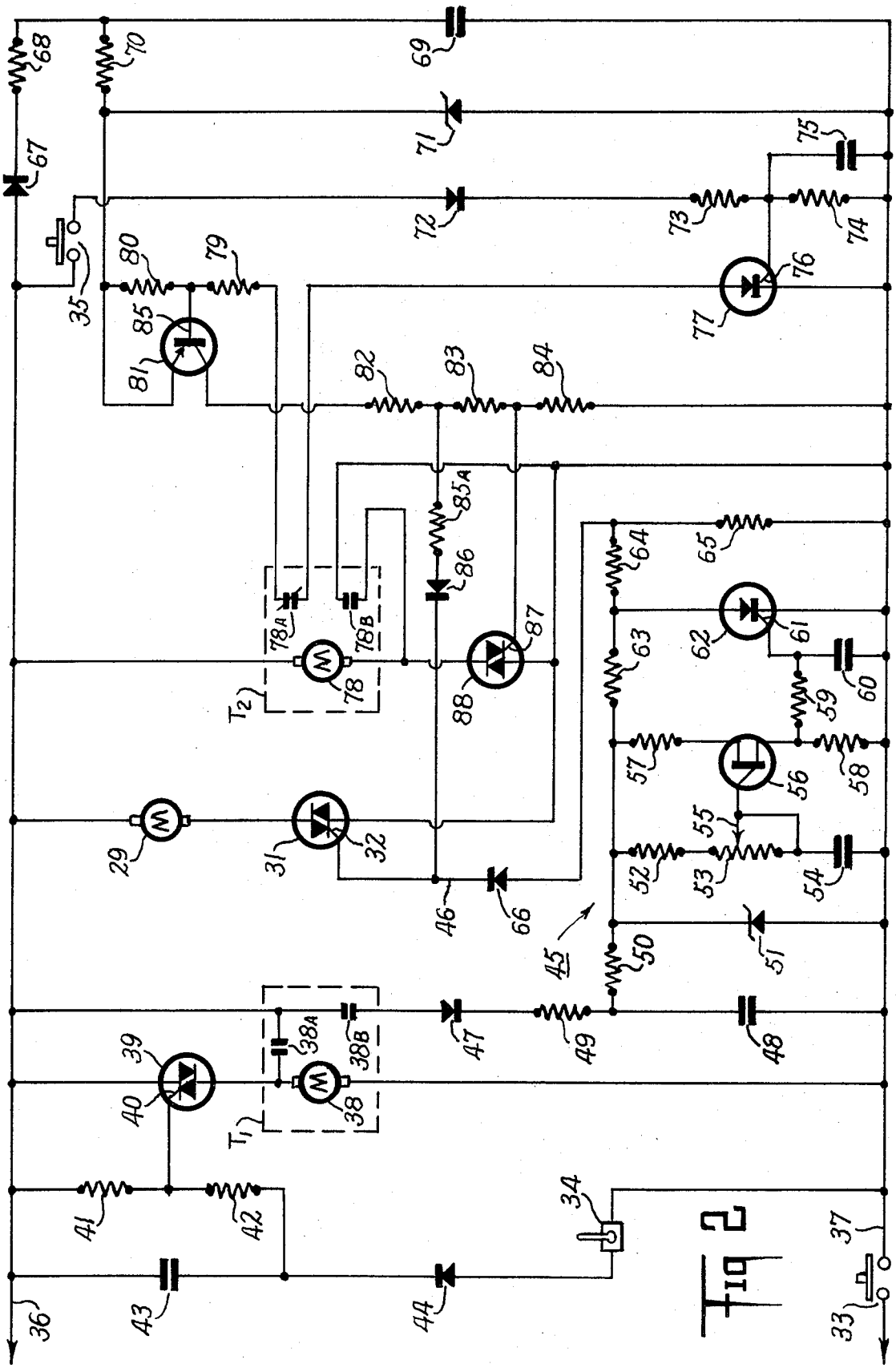

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Fig 2

TONER DISPENSER CIRCUIT FOR ELECTROSTATOGRAPHIC APPARATUS

This invention relates to improvements in a toner dispensing device for electrostatographic reproduction apparatus. More particularly, this invention relates to improvements in the manner of dispensing toner to facilitate the making of acceptable electrostatographic reproductions.

Generally, in dispensers employed in conventional electrostatographic reproduction apparatus, the quantity of toner supplied to the developing mechanism from a toner container is regulated by means of a motor which is activated for predetermined time durations. The activation of this toner motor is effected through a timing device, such as a timing motor having sets of periodically activated contacts. The timing motor itself is energized by activation of the print mechanism. The timing contacts of the timing motor are set to provide activation of the toner supply for relatively short time durations. Should density increase be desired, an additional arrangement employing a latching relay and a further timing motor, or the like, is arranged to provide additional activation time to the motor. In long copy runs however, where large multiples of copy are required, it is desired to provide some means of supplying toner a number of times during the long copy run.

Therefore the primary object of the present invention is to provide a toner control system for automatic dispensing of toner in response to the number of copies desired during a single printing cycle. It is a further object of the invention to provide a more accurate means of timing the activation of the toner motor in response to the number of copies run on a single print cycle, and to provide a density increase control usable in combination therewith.

The foregoing objects of the invention are attained, in a system for electrostatographic reproduction of an image wherein an electrostatic image is formed on a photoconductive surface and developed by application of toner by a developing mechanism, by employing a toner control system for regulating the quantity of toner supplied to the developing mechanism which includes a toner supply actuator for dispensing toner from a toner container into the developing mechanism, feeding means for supplying a transfer sheet to the photoconductive surface bearing the developed image, and a copy counter sensor means actuated by passage of the transfer sheet from the feeding means to the photoconductive surface for producing an actuating signal which is in turn applied to the toner supply actuator means for dispensing toner. The means responsive to the actuating signal is a gated timing device coupled to the copy counter switch for gating power from a source to an electronic timer which in turn supplies an activation pulse through a gated thyristor to the toner motor. The electronic timer remains on for the desired time duration. Thus, for each copy activating the copy counter switch, the toner motor will be actuated in accordance with the time cycle set by the electronic timer. For increasing density, a density increase switch activates an electronic switch, controlled by a timing motor for supplying in turn a further electronic signal to the gated thyristor associated with the toner motor for continuing the activation of the toner motor for the time set by the timing motor associated with the electronic switch.

The foregoing objects and brief description as well as further objects and advantages of the present invention will become more apparent from the following description and appended drawings wherein

FIG. 1 is a schematic view of the basic components of an automatic recyclable electrostatographic reproduction apparatus with timing circuits embodying the present invention, and

FIG. 2 is an electrical schematic diagram of the timing circuitry illustrated generally in FIG. 1.

Referring to FIG. 1, as is conventional in electrostatographic reproduction systems, a light image of copy to be reproduced is projected onto a charged photoconductive surface of an electrostatographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged electroscopic developing material, generally referred to as "toner", to form an electrostatographic powder image, corresponding to the latent image, on the plate surface. The powder image can then be electrostatically transferred to a transfer web such as paper to which it may be fused by a fusing device, whereby the powder image is caused permanently to adhere to the surface of said transfer web. Thus, as shown in FIG. 1, an imaging means **11** scans the data to be reproduced and projects said data through a suitable lens and focussing assembly **12** along an optical path **13** onto the surface of an electrostatographic plate arranged in the form of a drum **14**.

The electrostatographic drum **14** includes a cylindrical member mounted in suitable bearings in the frame of the machine and is driven in a clockwise rotation by a motor at a constant rate proportional to the scan rate of the data, whereby the peripheral rate of the drum surface is identical to the rate of movement of the reflected light image. The drum surface comprises a layer of photoconductive material such as selenium on a conductive backing that is sensitized prior to exposure by means of a screened corona generating device **15**.

The exposure of the drum to the light image discharges the photoconductive layer struck by light, whereby there remains on the drum a latent electrostatic image in image configuration corresponding to the light image projected from the data surface **11**. As the drum surface continues its movement, the electrostatic latent image passes through a developing station A in which there is positioned a developer mechanism including a casing or housing **16** having a lower or sump portion for accumulating developing material **16A**. A bucket type conveyor **16B** having suitable driving means, (not shown) is used to carry the developer material to the upper part of the developer housing where it is cascaded down onto the surface of the electrostatographic drum **14**.

Positioned next and adjacent to the developing station is the image transfer station B which includes a sheet feeding mechanism adapted to feed sheets of paper successively to the developed image on the drum at the transfer station. This sheet feeding mechanism, generally designated **18**, includes a sheet source such as a tray **19** for a plurality of sheets of a suitable transfer web **20** typically, sheets of paper or the like and a pivotally mounted separating roller **20A** adapted to feed the top sheet of the stack to feed rollers **20B** which direct the sheet material into contact with the rotating

drum **14** at a speed preferably slightly in excess of the rate of travel of the surface of the drum in coordination with the appearance of the developed image at the transfer station. In this manner, the sheet material is introduced between the feed rollers **20B** and is thereby brought into contact with the rotating drum at the correct time and position to register with the developed image. To effect proper registration of the sheet transfer material with the feed rollers and to direct the sheet transfer material into contact with the drum, guides **20C** are positioned on opposite sides of the feed rollers.

The transfer of the electrostatographic powder image from the drum surface to the transfer web is effected by means of a corona transfer device **21** that is located at or immediately after the point of contact between the transfer material and the rotating drum. The corona transfer device **21** is substantially similar to the corona discharge device **15** in that it includes an array of one or more corona discharge electrodes that are energized from a suitable high potential source and extend transversely across the drum surface and are substantially enclosed within a shielding member.

In operation, the electrostatic field created by the corona discharge device is effective to tack the transfer web electrostatically to the drum surface, whereby the transfer material moves synchronously with the drum while in contact therewith. Simultaneously with the tacking action, the electrostatic field is effective to attract the electroscopic toner particles comprising the electrostatographic powder image from the drum surface and cause them to adhere electrostatically to the surface of the transfer web.

Immediately subsequent to the image transfer station is positioned a transfer web stripping apparatus or paper pick-off mechanism, generally designated **22**, adapted to remove the transfer web from the drum surface. This device may include a plurality of small diameter, multiple outlet conduits on a manifold that is supplied with pressurized aeriform fluid which flows through the outlet conduits into contact with the surface of the drum slightly in advance of the sheet material. As a result, the leading edge of the sheet material is stripped from the drum surface and directed onto a horizontal conveyor **23** having an endless conveyor belt for carrying the sheet material to a fixing device in the form of a fuser assembly **24**, whereby the developed and transferred electrostatographic powder image on the sheet material is permanently fixed thereto.

After fusing, the finished copy is preferably discharged from the apparatus at a suitable point for collection externally of the apparatus. To accomplish this there is provided a vertical conveyor, generally designated **25**, by means of which the copy is delivered to a copy holder positioned in a suitable super-structure.

The next and final station in the device is a drum cleaning station C, having positioned therein a corona pre-cleaning device **26** similar to the corona charging device **15**, to impose an electrostatic charge on the drum and residual powder adherent thereto to aid in effecting removal of the powder. Also provided is a drum cleaning device adapted to remove any powder remaining on the electrostatographic drum after transfer, and a source of light, not shown, whereby the electrostatographic drum is flooded with light to cause dissipation of any residual electrical charge remaining on said drum.

In general, the electrostatic charging of the electrostatographic drum in preparation for the exposure step and the electrostatic charging of the support surface to effect transfer are accomplished by means of corona generating devices whereby an electrostatic charge on the order of 500 to 600 volts is applied to the respective surfaces, in each instance. Although any one of a number of types of corona generating devices may be used, a corona charging device of the type disclosed in Vyverberg U.S. Pat. No. 2,836,725, is used for both the corona charging device **15** and the corona transfer device **21**, each of which is secured to suitable frame elements of the apparatus and connected to an electrical circuit described hereinafter.

As the developing mixture is cascaded over the electrostatographic drum, toner particles are pulled away from the carrier and deposited on the drum to form powder images, while the partially denuded carrier particles pass off the drum into the reservoir. As toner powder images are formed, additional toner particles must be supplied to the developing mixture in proportion to the amount of toner deposited on the drum. To supply additional toner particles to the developing mixture, the toner dispenser **17** is used to accurately meter toner **17A** to the developer mixture. Although any one of a number of well-known powder or granulated material dispensers may be used, the toner dispenser shown is of the type disclosed in the Mayo et al U.S. Pat. No. 3,062,109.

The metering of the toner to the developer mixture, as is conventional, is effected by a time duration reciprocating movement of a grating structure **27** at the bottom of the toner container **17**. This reciprocating movement is accomplished by means of the grate actuator. Thus, activation of toner motor **29** will drive the grate actuator **28** causing reciprocating grate movement of the grate **27** at the bottom of the toner container **17**, resulting in dispensing of the toner material **17A** down into the casing **16**.

The timing circuit shown in FIG. **1** is arranged such that a source of power **30** is connected to one end of the timing motor, the other end of which is coupled through a thyristor such as triac **31** to the other lead of the source **30**. The gate electrode **32** of the triac **31** is coupled to the outputs of timing circuits T_1 and T_2, which are in turn coupled at one end to the source of power **30** and at the other end through a print switch **33** to the other end of the power source. The operation of the timing circuits T_1 and T_2 is such that application of power to these circuits by activation of the print switch **33** renders them ready to begin a timing cycle and activation of a gating input of the timing circuits begins the timing cycle. Thus, timing circuit T_1 is energized by closing of the print switch **33** and begins its timing cycle by activation of a transfer material sensor such as the copy counter switch **34** which is illustrated as connected to the end of the tray **19** containing the transfer material sheets **20**. It is understood that other forms of sensor means for sensing passage of transfer material may be employed, but that use of the copy counter switch is preferred since it is present in existing machines. Activation of the paper pick-off mechanism

20A will thus act to throw the switch of the copy counter 34, and provide a momentary impulse to activate the timing circuit T_1. Activation of the timing circuit T_1 will apply a gating pulse to the gate electrode 32 of triac 31, thereby completing the circuit between the source 30 and the toner motor 29. Timing circuit T_1 remains on in accordance with a preset duration, as will be explained in further detail below. At the end of this duration, the energizing pulse present at the gate electrode 32 of triac 31 is removed and the triac 31 will be switched off thereby disconnecting the power source 30 from the toner motor 29 and deactivating the grate actuator 28.

Upon the passage of a subsequent sheet of transfer web 20 from the tray 19 by means of the pick off mechanism 20A, the switch 34 will be reactivated and the cycle repeated. As is conventional, the print switch 33 will remain latched on for the entire print cycle, depending upon the number of copies being made. The cycle of the timer T_1 is set to be relatively short. Should further density increase be necessary, a density increase switch 35 is provided to the gate input of the timer T_2. Activation of the increase density switch 35 will activate the timer T_2, thereby causing a pulse to be applied to the gate electrode 32 of the triac 31. The output pulse of the timer T_2 remains activated in a manner to be explained further below for a relatively longer predetermined time period, thereby maintaining grate actuator 28 in the on condition in order to deposit sufficient additional powder material 17A into the developer mechanism housing 16.

Referring to FIG. 2, a circuit diagram for accomplishing the foregoing described timing operations is illustrated, wherein like numerals are employed to indicate like components. Thus, toner motor 29 is connected in series with the triac 31 between a source of power represented by the lines 36 and 37. The print switch 33 is illustrated schematically as connected in series with line 37, thereby indicating that activation of the printing switch 33 will supply power between the lines 36 and 37. As is shown in FIG. 2, the timer T_1 includes the timing motor 38 connected in series with the triac 39 between the power lines 36 and 37. The triac 39 includes a gate electrode 40 coupled to the junction of series connected resistances 41 and 42 which are in turn shunted by a by-pass capacitor 43. The copy counter switch 34 is connected through the diode 44 to the junction of the capacitor 43 and resistance 42. The timing motor 38 includes a first contact 38A connected from the junction of the motor 38 and triac 39 to the power line 36, and a second contact 38B connecting the power line 36 to an electronic timing circuit 45. The timing motor 38 has a 30 second cycle. The 30 second cycle is distributed such that the contacts 38A and 38B are closed for 6 seconds and open for the remaining 24. The operation of the timing motor is conventional, and the switch operation of the contacts 38A, 38B is effected by standard camming devices or the like. The timing circuit 45 acts in response to the closing of the contact 38B to provide a signal output along the line 46 which is coupled to the gate electrode 32 of the triac 31, thereby activating the toner motor 29. After a predetermined time delay, the timing unit 45 effectively removes the pulse appearing at the line 46, and the triac 31 becomes disabled.

In operation, the timer T_1 responds to a momentary impulse caused by activation of the copy counter switch 34 to pass power through diode 44 to the resistor divider 41–42 to which the gate electrode 40 of the triac 39 is coupled. Momentary activation of the gate electrode 40 by means of the pulse appearing from the copy counter switch 34 acts to render the traic 39 conductive, thereby turning on the timing motor 38. The first action of the timing motor 38 will be to close the contact 38A and 38B for 6 seconds. Closing of the contact 38A results in latching the timing motor 38 directly to the power line 36, thereby rendering the timing motor 38 active to continue its cycle for the entire 6 seconds period, regardless of the subsequent condition of the triac 39, which has been rendered nonconductive by virtue of the copy counter switch action being only momentary. Simultaneously, the closing of the contact 38B provides the impulse to the electronic timing circuit 45 which results in activation of the triac 31 by virtue of a pulse appearing on line 46 to the gate electrode 32, thereby completing the circuit energizing the toner motor 29.

The timing circuit 45 operates by passing an input pulse to the output line 46 for a predetermined time period. The circuit includes a diode 47 acting as a half wave rectifier and a capacitor 48 for smoothing the input waveform. Resistances 49 and 50 limit the input current magnitude. A zener diode 51 provides a maximum limit to the positive voltage level. A divider consisting of a resistance 52, a variable resistor 53, and a capacitor 54 is connected across the diode 51. The divider tap 55 is connected to the emitter electrode of a unijunction transistor 56 which has its base electrodes connected through resistors 57 and 58 respectively across the divider. The output of the unijunction is taken across resistor 58 through a resistor 59 and capacitor 60 to the gate electrode 61 of an SCR 62 which is connected across the timing circuit between resistors 63 and 64. The output of the circuit is taken across a resistor 65 through a diode 66 to output line 46. The length of operation of the timing circuit 45 is dependent upon the setting of the variable resistance 53, corresponding to the print density control set. Upon energization, an output appears at line 46 since the unijunction 56 is normally non-conducting and the SCR 62 is thus in a non-conducting condition. Depending upon the RC time constant of the network of resistances 52, 53 and capacitor 54, the potential at the emitter electrode 55 increases until the unijunction threshold is reached, whereupon the unijunction is rendered conductive. At that moment, a positive potential is placed upon the gate electrode 61 of SCR 62, rendering the SCR conductive, thereby shunting the point between resistances 63 and 64 to the line 37 and effectively removing the potential along line 46, causing the triac 31 to turn off and thereby deactivating the toner motor 29.

When further density increase is desired, activation of the density increase button 35 activates the toner motor for a longer sequence by means of the circuit shown. Power is applied through the diode 67, functioning as a half wave rectifier, and current limiting resistor 68, smoothing capacitor 69, and further resistance 70, and across the zener diode 71 which limits the maximum voltage applied. Activating the density

increase button 35 applies power through the diode 72, current limiting resistances 73 and 74 and across the bypass capacitor 75 to the gate electrode 76 of an SCR 77. The SCR 77 is connected in series with a set of normally closed contacts 78A of a timing motor 78, and resistances 79 and 80, across the zener diode 71. A transistor 81 is provided with its collector emitter path forming a series circuit with resistances 82, 83, 84 across the zener diode 71. Application of power to the gate electrode 76 of SCR 77 renders the SCR 77 conductive and results in application of a conducting potential on the base electrode 85 of the transistor 81 thereby causing a potential to appear at the junction of resistances 82 and 83 and applied through current limiting resistance 85A through diode 86 to the gate electrode 32 of the triac 31. The triac 31 is thereby energized and toner motor 29 activated. At the same time, the potential appearing at the junction of resistances 83 and 84 is applied to the gate electrode 87 of a triac 88 which in turn connects the timer motor 78 between power lines 36 – 37. A normally open set of contacts 78B is connected across the triac 88. The timer motor 78 can have, for example, a 60 second cycle; contacts 78A remain closed for 45 seconds after the activation of the timer motor and then opening for 15 seconds and contacts 78B remaining open for 10 seconds and closing for 50 seconds. Thus, the triac 31 will be gated on by the density increase timer for the 45 second closed contact period of contacts 78A. During the 45 second period, the triac 88 is bypassed by contacts 78B, thereby resetting the triac for the next cycle. Since the contacts 78A open while contacts 78B are still closed, the triac 88 is not reenergized until the next activation of the density increase button 35.

Although specific devices and conditions were set forth in the above exemplary description, these are merely intended as illustrations of the present invention. Various other devices such as those well known in the art may be substituted for those used above with similar results.

Other modifications of the present invention will occur to those skilled in the art upon a reading of the present disclosure. These are intended to be included within the scope of this invention.

What is claimed is:

1. In an electrostatographic reproduction apparatus wherein a plurality of reproductions of an original object are produced during a print cycle by successively forming a latent electrostatic image of the object on a surface of a photoconductive member, developing the image by applying to the surface a toner material from a developer mechanism, and transferring the developed image to a copy sheet, an improved toner replenishment arrangement for supplying to the developer mechanism a predetermined quantity of toner material for each copy produced, comprising:

a toner material container;

a toner material supply actuator means for dispensing toner material from the container into the developer mechanism;

feeding means for periodically supplying a copy sheet to the photoconductive surface during a printing cycle;

means actuated by the transfer of a copy sheet from said feeding means to said photoconductive surface for producing a signal having a predetermined period; and

means responsive to said signal for energizing said toner supply actuator means during said period whereby the transfer of a copy sheet causes the dispensing of a predetermined quantity of replenishment toner material to the developer mechanism.

2. The apparatus of claim 1 wherein said means for producing a signal comprises a sensor for sensing the occurrence of the transfer of a copy sheet from the feeding means to the photoconductive surface and for generating an electrical indication representative of the occurrence of the transfer, and circuit means coupled to said sensor and responsive to said electrical indication for generating a signal of predetermined period.

3. The apparatus of claim 2 wherein said sensor comprises an electrical switch having a movable contact element which is actuated by motion of a copy sheet.

4. The apparatus of claim 2 wherein said circuit means responsive to said electrical indication for generating a signal of predetermined period includes a trigger circuit arrangement for controlling the duration of said period.

5. The apparatus of claim 1 wherein said circuit means responsive to said electrical indication for generating a signal of predetermined period comprises means for providing a signal potential on a signal line upon the occurrence of said indication, and trigger circuit means for interrupting the signal potential after a predetermined period of time.

6. The apparatus of claim 5 wherein said trigger circuit means for interrupting the signal on said line is adapted for selectively varying the period of said signal.

7. The apparatus of claim 1 wherein said apparatus includes means for counting the number of copies produced during a printing cycle, said copy counting means including a switching device for sensing the transfer of a copy sheet to said photoconductive surface and said means for producing a signal includes said switching device.

8. The apparatus of claim 1 wherein said means responsive to said signal for energizing said toner supply actuator means comprises an electrically energized drive and a switching circuit arrangement responsive to said signal for coupling electrical energy to said drive upon the occurrence of said signal and for interrupting the coupling of energy to said drive upon the termination of said signal.

9. The apparatus of claim 8 wherein said circuit means for coupling energy to said drive includes a gated switching device.

10. The apparatus of claim 9 wherein said gated switching device comprises a gate electrode controlled semiconductor switching device.

11. In an electrostatographic reproduction apparatus wherein a reproduction of an original object is produced by forming a latent electrostatic image on a surface of a photoconductive member, developing the image by applying to the surface a toner material from a developer mechanism, and transferring the developed image to a copy sheet, an improved apparatus for replenishing toner material comprising:

means for sensing the transfer of a copy sheet from a copy sheet feeding mechanism to the photocon-

ductive surface and producing an indication of said transfer; and,

means for initiating the energization of a toner replenishment actuator upon the occurrence of said indication and continuing the energization for a predetermined period of time for dispensing a predetermined replenishment quantity of toner material from a toner container to the developer mechanism.

* * * * *