United States Patent

Yasu

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[54] AUTOMATIC TONER FEEDING DEVICE FOR ELECTRONIC COPYING MACHINES

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**137/560**, 251/70, 222/70, 355/10

[51] **Int. Cl.**.....**B67d 508**

[58] **Field of Search**.....137/560; 251/230; 222/70; 355/3, 10

[56] **References Cited**

UNITED STATES PATENTS

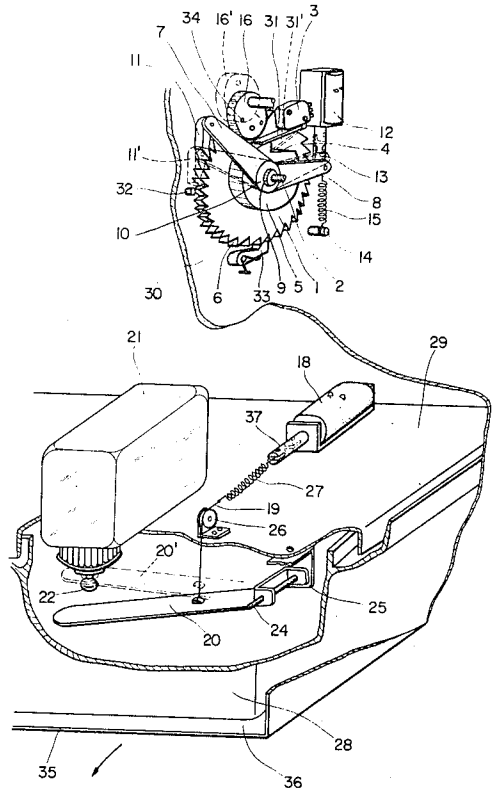
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Primary Examiner—Henry T. Klinksiek
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[57] **ABSTRACT**

An automatic toner feeding device for electronic copying machines which adds a certain amount of the toner each time a certain number of copying paper sheets are developed. A gear turns in response to the processing of the copying paper, and a toner feeding valve means is actuated at a certain angular position of the gear for adding the toner into a developer tank. The initial angular position of the gear is manually controllable.

2 Claims, 8 Drawing Figures



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SHEET 1 OF 4

FIG.1

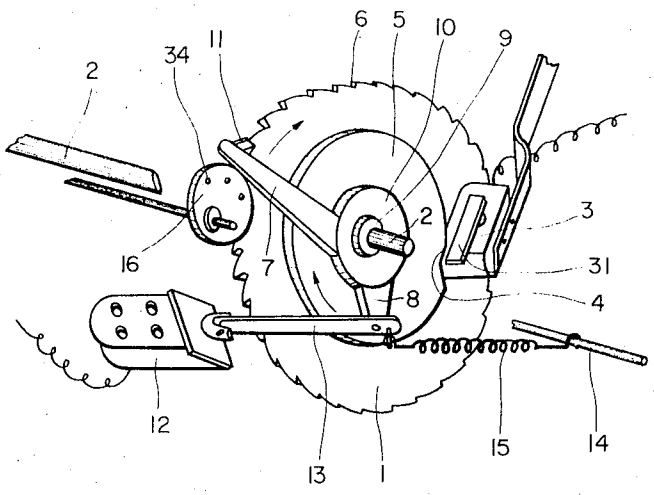


FIG.2

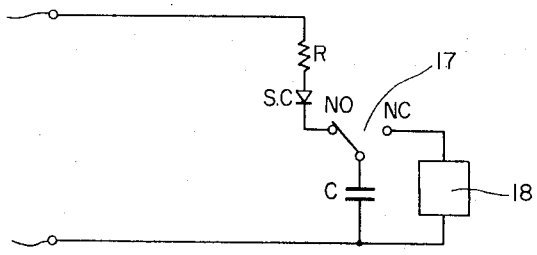
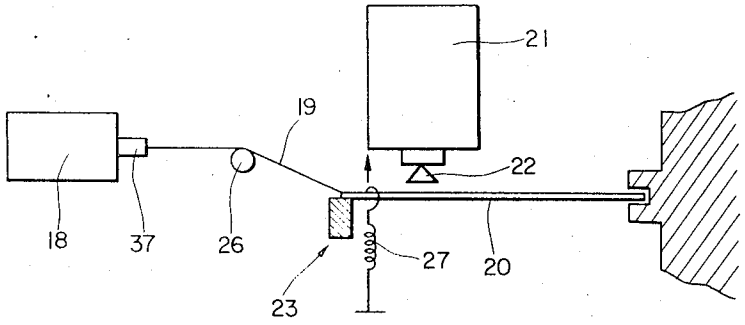


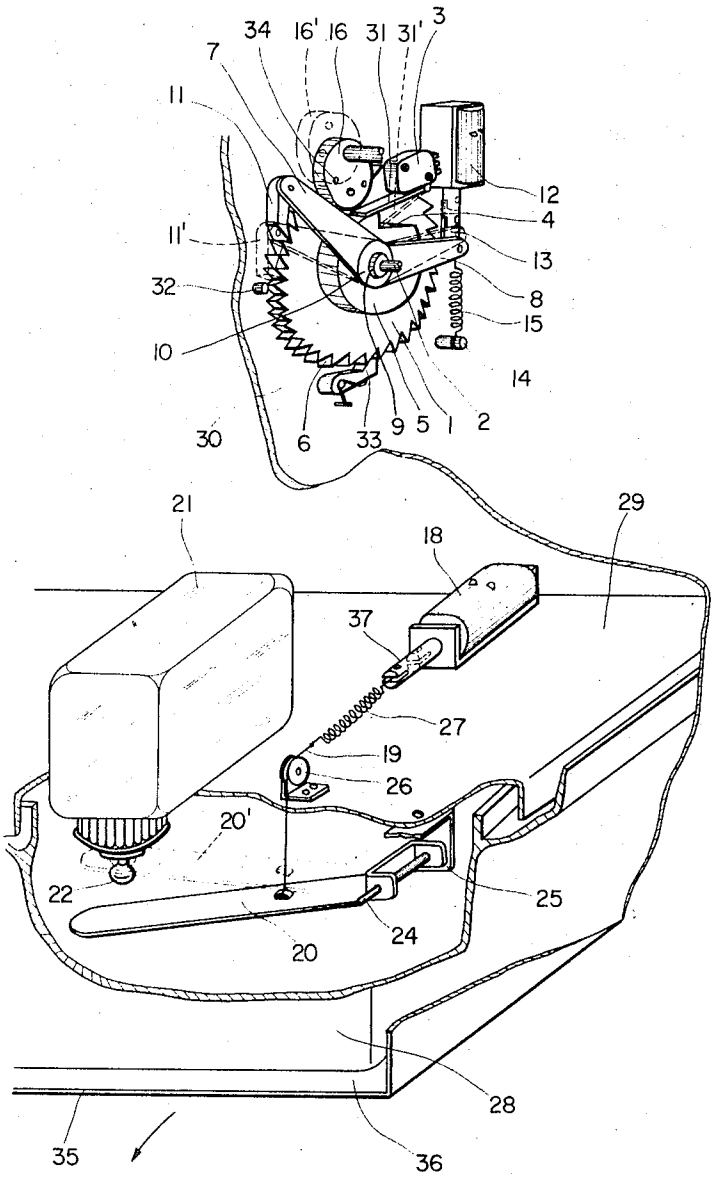
FIG.3



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FIG.4



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FIG.5

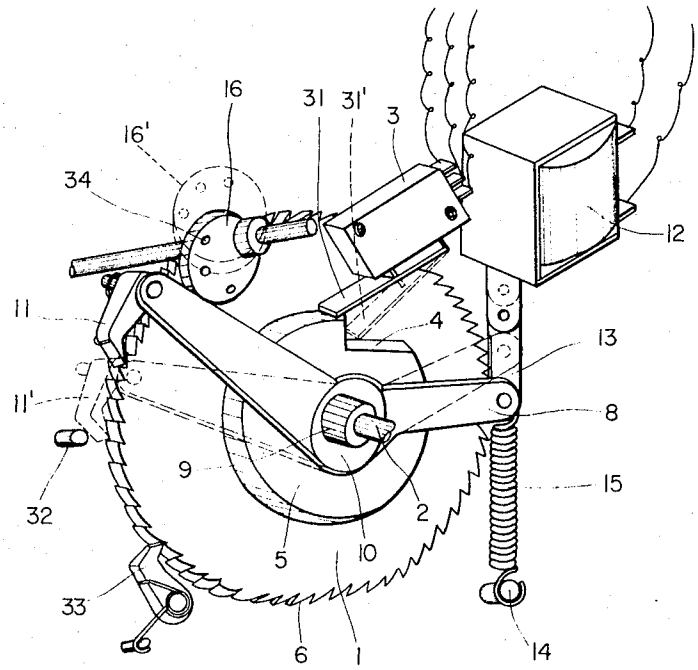
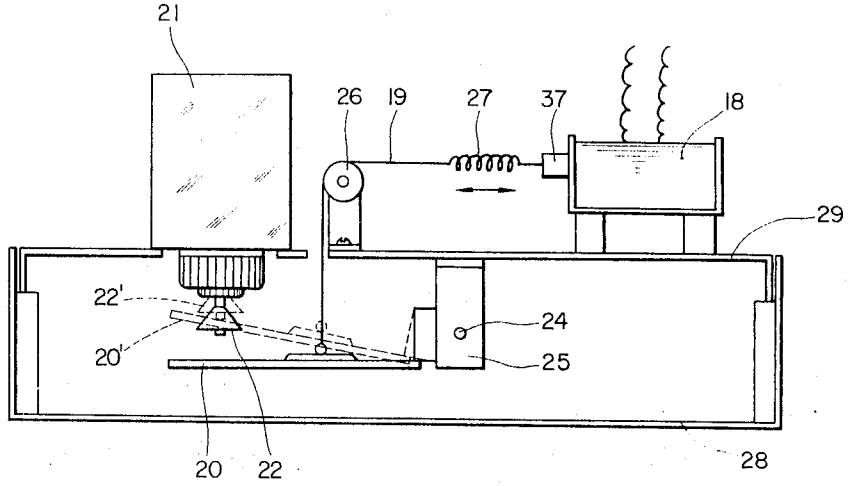


FIG.6



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FIG.7

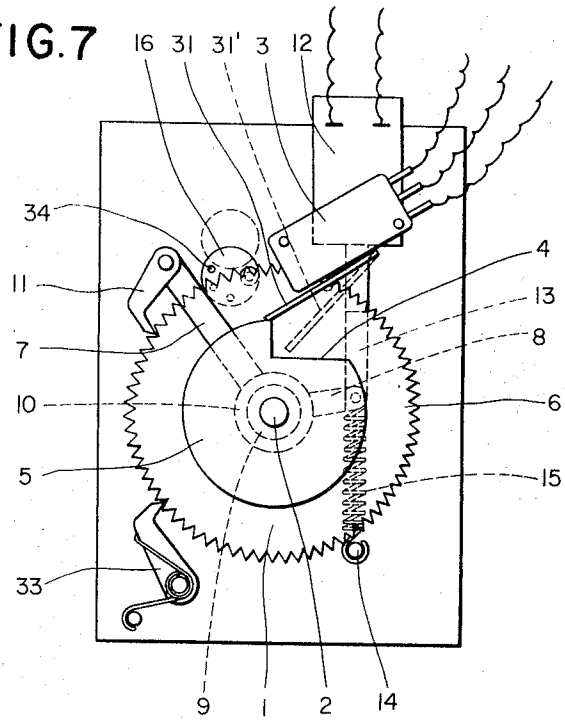
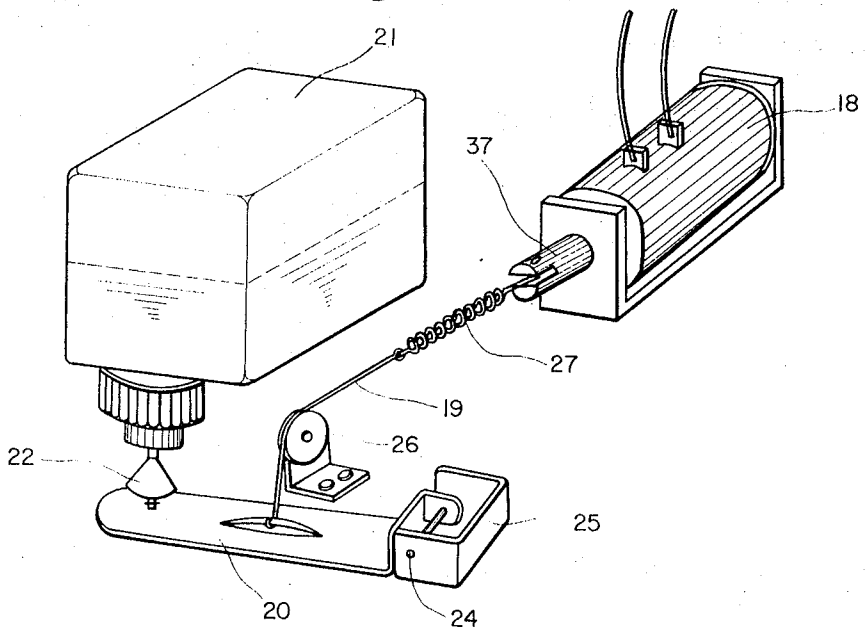


FIG.8



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AUTOMATIC TONER FEEDING DEVICE FOR ELECTRONIC COPYING MACHINES

This invention relates to an automatic toner feeding device for electronic copying machines, and more particularly to an automatic toner feeding device comprising a lever solenoid actuatable by a signal representing movement of photosensitive paper sheets inserted in a copying machine, a swingable lever driven by the lever solenoid, a gear rotatable by the lever, a disk integrally secured to the gear and having a notch, a microswitch to be actuated by the notch of the disk for generating a signal which is fed to a valve mounted on a toner container, and an eccentric cam engageable with another lever which controls the angular displacement of the gear, depending on the concentration of developer or the nature of the toner being used.

In general, an electronic copying machine produces a copy of desired original by uniformly charging a sheet of copying paper for sensitizing the sheet, exposing the sheet to actinic light carrying the image of the original, developing the sheet thus exposed, and then drying the sheet. With conventional copying machines, it has been experienced that, in the case of high-speed copying, as the number of repetitions of the developing operation increases, the concentration of toner in the developer decreases, to degrade the quality of the copies being produced. In order to prevent serious degradation of the quality of the copies, operators have to find out the degration in the early stage by their own eye sight and manually add the toner at right moment or replace the content of a developer tank with fresh developer by disassembling and reassembling the developer tank. Such manual addition of the toner and the replacement of used developer with fresh developer are troublesome and time consuming.

Therefore, an object of the present invention is to mitigate such difficulties of conventional electronic copying machines, by providing an improved automatic toner feeding device. In the automatic toner feeding device according to the present invention, a simple gear or ratchet wheel, which has a disk integrally secured thereto and is made of suitable metallic or synthetic resin material, is operatively connected to electric means including a solenoid and a microswitch in such a manner that outside electric signals representing the movement or passage of photosensitive paper sheets for automatically adding a suitable amount of toner each time a predetermined number of photosensitive paper sheets are developed. The number of the sheets for causing the addition of the toner is adjustable depending on the nature of the toner and the size of the photosensitive paper sheets being processed. Thereby, the need of detection of the degrading of the copy quality, manual addition of the toner, and the replacement of the used developer with fresh developer can completely be removed, so that the optimum concentration of the developer can be ensured by the automatic periodic addition of the toner. The automatic toner feeding device of the present invention is compact and can be installed within a limited space of the electronic copying machine, without requiring any modification of other components of the copying machine.

Other objects and advantages ofthe present invention may be appreciated by referring to the following description, taken in conjunction with the accompanying drawings,in which:

FIG. 1 is a schematic perspective view of the essential portion of an automatic toner feeding device for electronic copying machines, according to the present invention;

FIG. 2 is a schematic diagram of electric circuitry of the automatic toner feeding device;

FIG. 3 is a diagrammatic illustration of the structure of the automatic toner feeding device;

FIG. 4 is a partial cutaway view of the developing portion of an electronic copying device, which incorporates the automatic toner feeding device of the present invention;

FIG. 5 is a diagrammatic illustration of the manner in which the automatic toner feeding device of the present invention operates;

FIG. 6 is an enlarged side view of the toner feeding device, as seen from a direction opposite from the viewing direction of FIG. 3,

FIG. 7 is a front view of FIG. 5; and

FIG. 8 is a schematic perspective view, illustrating the operating mechanism in the automatic toner feeding device of FIG.6.

Like parts are designated by like numerals throughout the drawings.

Referring to FIGS. 1, 4, 5, and 7, a ratchet wheel or a gear 1, which is made of a suitable metallic or synthetic resin material is rotatably mounted on a shaft 2 secured to the framework 30 of a copying machine. Saw teeth 6 are formed on the peripheral surface of the gear 1. A disk 5 having a recess 4 formed on the periphery thereof is concentrically secured to the gear on the side opposite to the framework 30. The disk 5 is integrally fastened to the gear 1, so as to rotate together with the latter. A microswitch 3 is mounted on the copying machine in such relation with the disk 5 that the actuator lever 31 of the microswitch 3 operatively engages the peripheral surface of the disk 5, and when the actuator lever 31 engages the recess 4 of the disk 5, a movable contact 17 (FIG.2) of the microswitch 3 is electrically connected to a coacting contact NO thereof. The microswitch 3 is to generate a signal to a toner feeding mechanism 23 which includes a toner valve 22 for regulating the flow of toner from a toner container 21. The valve 22 is controlled either electrically by a valve solenoid 18 and/or mechanically by a suitable spring.

A bearing 9 is mounted on the shaft 2 for concentrically holding an annular lever holder 10, which holder 10 carries a long lever 7 and a short lever 8. The levers 7 and 8 extend radially away from the axis of the annular lever holder 10. The holder 10 is rotatably mounted on the shaft 2 by a suitable detent means (not shown). A ratchet 11 engageable with one of the saw teeth 6 of the disk 5 is pivotally connected to the that end of the long lever 7 which is away from the shaft 2. The extending end of the short lever 8 is pivotally connected to one end of a link 13, while the opposite end of the link 13 is connected to a movable core of a lever solenoid 12 secured to the framework 30. A coiled spring 15 is inserted between the extending end of the short lever 8 and a spring holder 14 secured to the framework 30, so as to resiliently bias the extending end of the lever 8 to the right, as seen in FIG. 1, or downwardly, as seen in FIGS. 4, 5, and 7.

An eccentric cam journalled by the framework 30 acts as a variable stopper for regulating the magnitude of each feeding stroke of the long lever 7. To this end, the angular position of the eccentric cam 16 can manually be controlled from the outside of the framework 30, so as to set the starting point of the movement of the long lever 7 by the engagement of the ratchet 11 with the selected one of the saw teeth 6 of the gear 1, whereby, the magnitude of each feeding movement of the gear 1 is set. In order to limit the rotation of the ratchet 11 and the gear 1, a stopper pin 32 is secured to the framework 30 at such position that when the ratchet 11 comes to a certain angular position together with the gear 1, the ratchet 11 comes into engagement with the stopper pin 32 for limiting the movement of the gear 1, as shown in FIGS. 4 and 5.

A detent claw 33 is pivotally mounted on the framework 30 in the proximity of the gear 1, which detent claw 33 engages the saw teeth 6 of the gear 1 and allows the gear 1 to rotate in one direction but not in the opposite direction. In order to index the angular position of the eccentric cam 16, a plurality of click holes 34 are formed thereon at suitable positions. As the eccentric cam 16 is manually turned from the outside of the framework 30, one of such click holes 34 operatively engages a coacting click means (not shown) for causing the eccentric cam 16 to assume one of a plurality of angular positions which correspond to desired magnitudes of the operative rotational strokes of the gear 1.

Referring to FIGS.4 and 6, the valve solenoid 18 in the illustrated embodiment is mounted on the lid 29 of a developer tank 28. The valve solenoid 18 is electrically connected to movable contact 17 of the limit switch 3, as shown in FIG.2. The valve solenoid 18 magnetically actuates a core 37, to which one end of a coil spring 27 is secured. The opposite end of the coil spring 27 is connected to a transmission rope 19

which extends to a valve-actuating lever 20 through a pulley 26 carried by the lid 29. The valve-actuating lever 20 is pivotally supported by a pin 24 carried by a bracket 25 secured to the lid 29 on the tank-facing surface thereof.

An inlet opening 35 is defined on the framework 30 of the copying machine along the bottom plate 36 thereof, so that the developer tank 28 can be moved in and out relative to the copying machine through such opening 35.

In operation of the automatic toner feeding device of the aforesaid construction according to the present invention, the angular position of the eccentric cam 16 is manually set, so that the angular position thus set may represent the desired frequency of the toner addition which is to be effected every time a selected number of copying paper sheets are developed. The number of the copying paper sheets thus selected is variable depending on the concentration of the developer and the nature of the toner, as well as the size of the sheets. The eccentric cam 16 engages the long lever 7, so as to determine the initial angular position of the gear 1. As the lever solenoid 12 is engergized by signals from a detector (not shown) of the passage of photosensitive copying paper sheets (not shown), the short lever 8 is pulled to the left (as seen in FIG.1) through the link 13, against the elasticity of the spring 15. Accordingly, the gear 1 rotates in a clockwise direction, as seen in FIG.1. The same revolving direction of the gear 1 is shown as counter-clockwise in FIGS. 4, 5, and 7. As a result, the long lever 7 rotates together with the short lever 8, from the position engaging the eccentric cam 16 to another position 11', as shown by dotted lines in FIG.4, where the ratchet 11 pivotally connected to the long lever 7 engages the stopper pin 32. Thereby, the gear 1 and the disk 5 rotate counter-clockwise together with the levers 7 and 8, as seen in FIGS. 4, 5 and 7. The last referred rotation of the gear 1 and the disk 5 is shown as clockwise in FIG.1.

When the ratchet 11 comes to the position 11', the actuator lever 31 of the limit switch 3 fits in the recess 4 of the disk 5, as shown by dotted lines 31' in FIG.5. Referring to FIG.2, the movable contact 17 of the microswitch 3 is turned to the NO side as its actuator lever 31 is at the position 31', so that a capacit or C across the valve solenoid 18 is charged through a semiconductor diode, such as a silicon diode SC.

Thereafter, as the lever solenoid 12 is de-energized, the spring 15 causes the gear 1 and the disk to turn clockwise, as seen in FIGS.4, 5 and 7, so that the actuator lever 31 is forced away from the position 31' by the cam surface of the disk 5. Consequently, the movable contact 17 of the microswitch 3 is turned to the NC side, as seen in FIG.2, so as to discharge the electric energy of the capacitor C through the valve solenoid 18. Referring to FIGS.3, 6, and 8, the actuation of the valve solenoid 18 causes the core 37 to be pulled toward the solenoid 18, so that the valve lever 20 is raised by the spring 27 and the transmission rope 19 to a position 20', as shown by dotted lines in FIG.6. Consequently, the valve 22 is raised by the lever 20 to a position 22', as shown by dotted lines in FIG.6. Whereby, a certain amount of the toner is allowed to leave the toner container 21 and pile up on that surface of the valve 22 which faces the toner container 21. When the electric charge of the capacitor 3 is consumed, the valve solenoid 18 is de-energized to allow the valve lever 20 to return to its lower position by gravity, so that the valve 22 moves downward. At the same time, the toner which piled up on the upper surface ofthe valve 22 is scattered into the developer tank 28. Any known valve can be used as the toner feeder valve 22, as long as it fufills the aforesaid toner feeding function.

As described in the foregoing disclosure, according to the present invention, a lever solenoid 12 is actuated every time a certain number of copying paper sheets are developed, so as to cause a lever connected to the solenoid 12 to actuate a toner valve 22 through levers 7, 8, a gear 1, a disk 5, a microswitch 3 controlled by the disk 5, and a valve solenoid 18 regulated by the microswitch 3. Thus, the concentration of the toner in the developer can be kept above a certain level. The aforesaid number of sheets for actuating the lever solenoid 12 can manually be selected by an eccentric cam 16 which controls the initial angular position of the gear 1.

Although the present invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. An automatic toner feeding device for electronic copying machines, comprising a gear rotatably mounted on a shaft secured to the framework of a copying machine, a disk having a notch and coaxially secured to the gear, an annular lever coaxially secured to the gear in a relatively movable manner and having a long lever and a short lever, the long lever operatively engaging selected one of gear teeth of the gear, a lever solenoid operatively connected to the short lever, an eccentric cam rotatably mounted on the framework so as to engage said long lever for determining the magnitude of operative angular movement of the gear, a microswitch having an actuating lever engageable with said notch of the disk, a toner feeding valve means, and a valve solenoid operatively connected to said toner feeding valve means, said valve solenoid being controlled by the microswitch.

2. An automatic toner feeding device according to claim 1 and further comprising a stopper pin secured to the framework of the copying machine, so as to limit the operative movement of the gear from an initial position determined by the eccentric cam to the stopper pin by causing the long lever to engage the stopper pin at the end of the operative movement.

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