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Cherian

[11] **3,834,592**

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[54] **TONER REPLENISHER WITH MANUAL ADJUSTMENT OF DISPENSING RATE**

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[52] **U.S. Cl.** **222/277,** 222/287, 222/DIG. 1

[51] **Int. Cl.** **G03g 15/08**

[58] **Field of Search** ..... 222/221, 277, 267, 275, 222/285, 287, 308, DIG. 1

[56] **References Cited**

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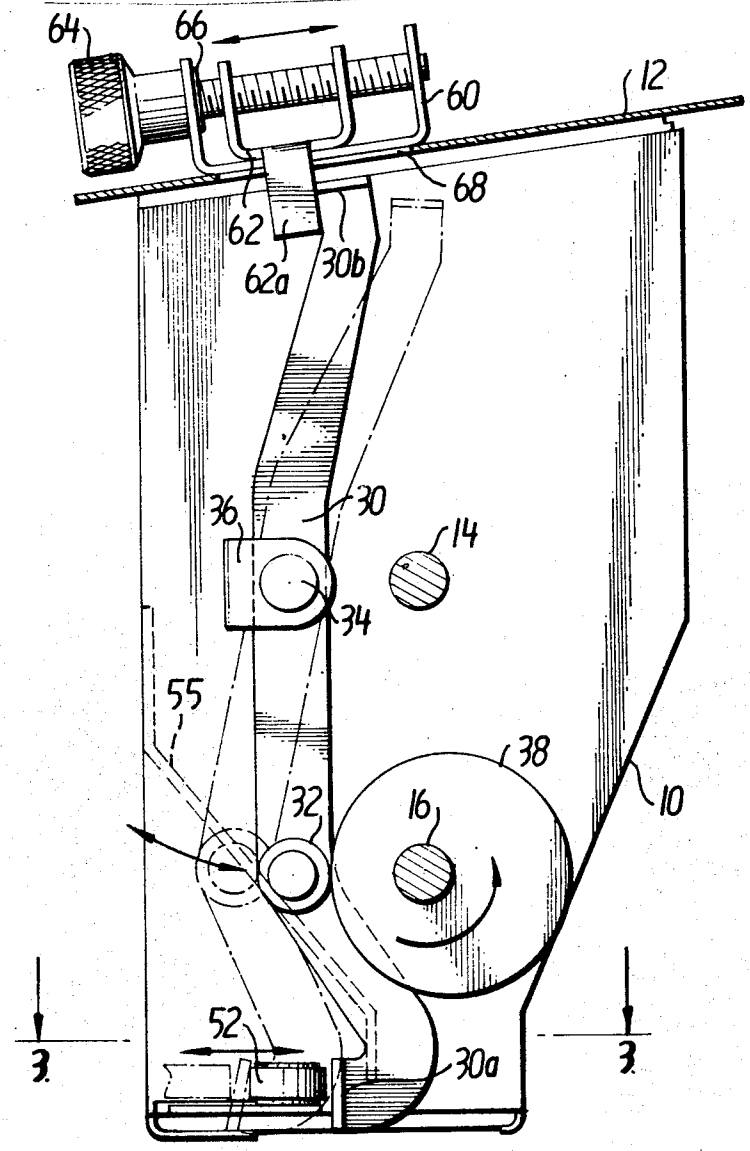
Primary Examiner—Robert B. Reeves
Assistant Examiner—Thomas E. Kocovsky
Attorney, Agent, or Firm—Griffin, Branigan and Butler

[57] **ABSTRACT**

A plurality of finger-like dispensing arms are mounted for pivotal movement back and forth along a path over a slot in the bottom of a toner dispenser hopper. The degree of pivotal movement controls the amount of toner dispensed. A linkage including a cam follower arm is provided for driving the dispensing arms in one direction in response to rotation of a continuously rotating cam. Springs provide the force for driving the dispensing arms in the opposite direction and for holding the cam follower against the cam. A manually adjustable stop element is provided for limiting the movement of the cam follower arm as it attempts to follow the cam in response to the force exerted by the springs. By adjusting the stop element, the degree of pivotal motion of the dispensing arms may be adjusted to any value throughout a continuous range extending from no motion to some predetermined maximum degree of motion, thereby adjusting the dispensing rate.

6 Claims, 7 Drawing Figures



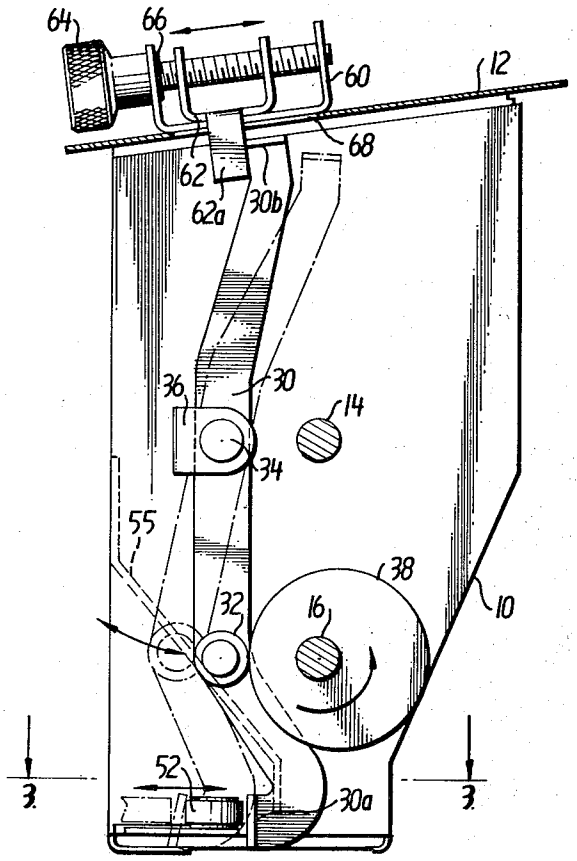


FIG. 1

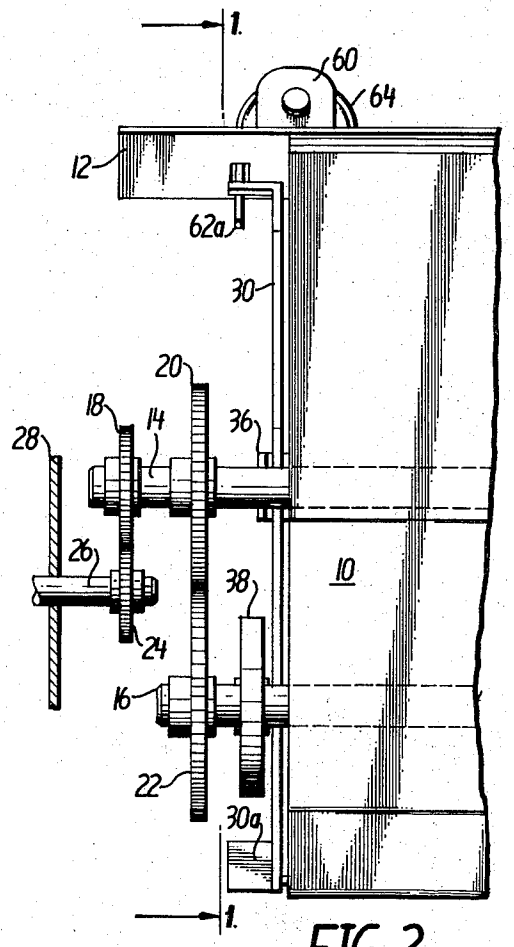
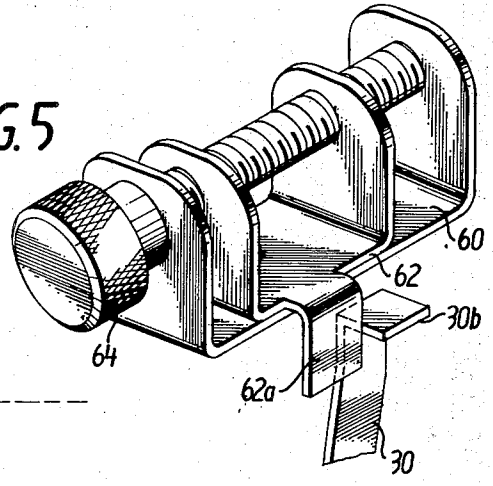


FIG. 2

FIG. 5



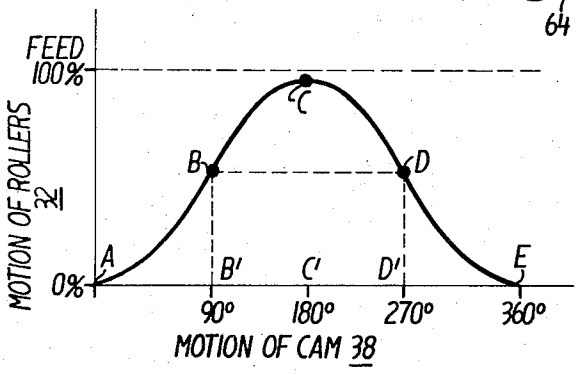


FIG. 7

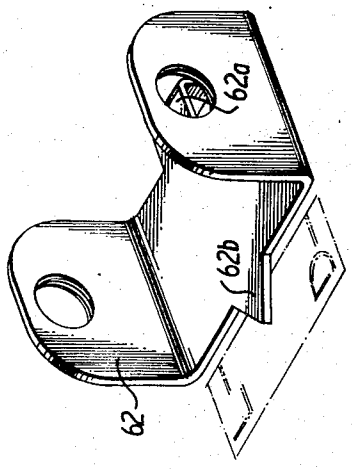


FIG. 6

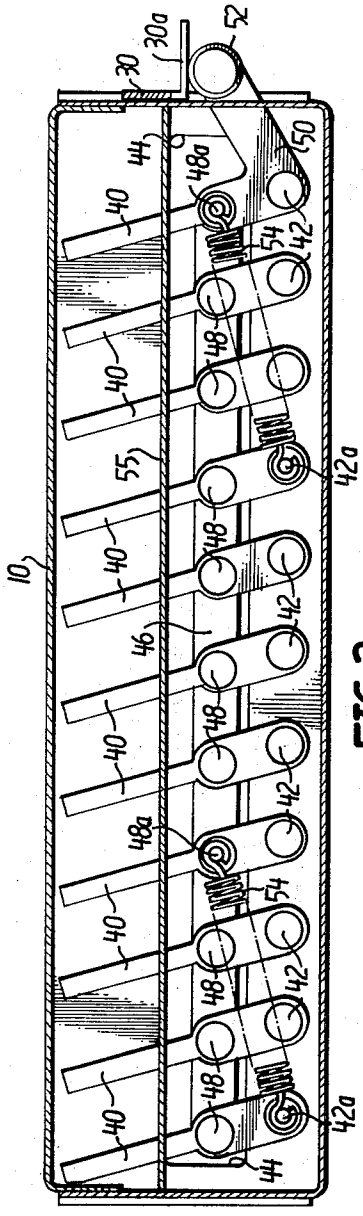


FIG. 3

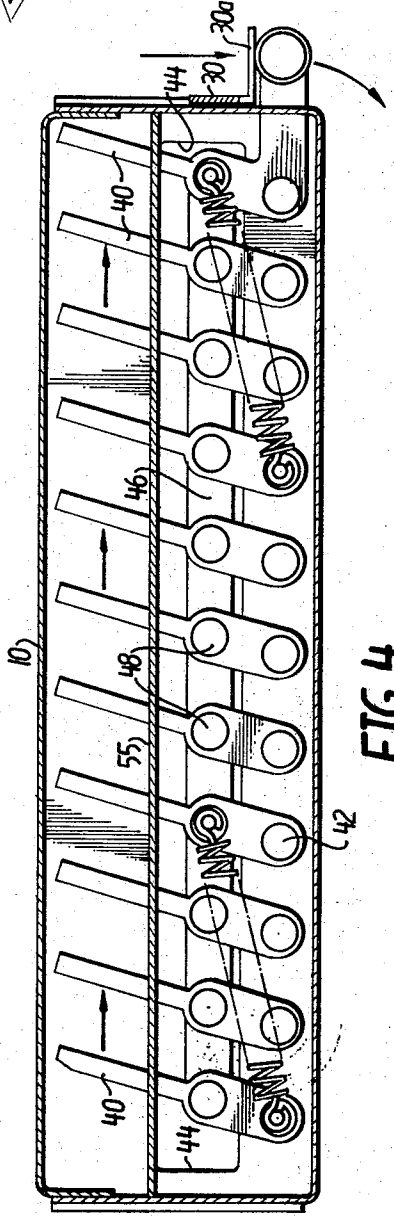


FIG. 4

TONER REPLENISHER WITH MANUAL ADJUSTMENT OF DISPENSING RATE

BACKGROUND OF THE INVENTION

The present invention relates to xerographic toner dispensers suitable for use in xerographic reproduction apparatus. More particularly, the present invention provides a toner dispenser having a manual adjustment for selecting the desired dispensing rate. The dispensing rate may be selected from a continuous range of dispensing rates extending from zero to the maximum dispensing capability of the apparatus.

U.S. Pat. No. 3,424,131 discloses one form of a prior art xerographic reproduction system wherein a photoconductive layer formed on the surface of a rotating drum is moved past a charging station, an exposure station, a developing station, and a transfer station. At the charging station a uniform electrostatic charge is placed on the photoconductive layer of the drum. The drum is then rotated to the exposure station where light from a document to be reproduced is imaged on the photoconductive layer thereby forming on the surface of the drum a latent electrostatic image of the document. The drum then rotates past the developing station where the electrostatic image is converted into a visible image by the attraction of pigmented material or toner contained in a developer supplied to the developing station. Subsequently, the drum rotates past the transfer station where the visible image is transferred to a suitable medium such as a sheet of paper.

The developer supplied to the developing station comprises a finely powdered pigmented material called toner, mixed with a carrier in the form of larger particles or beads exhibiting the tribo electric effect. A supply of the developer, usually containing about 1 percent by weight of toner, is maintained in a sump where the toner particles are attracted to the beads. A series of buckets, driven about a closed loop path, dip into the mixture and transport it to a point at the developing station where the mixture is dumped onto the drum and allowed to cascade downwardly over the surface of the drum at the developing station. As the mixture cascades downwardly over the drum, the electrostatic charge remaining on the drum after exposure attracts the toner particles away from the beads and onto the drum surface to thereby form the visible image. The carrier beads and any excess toner are then returned to the sump where the beads again attract more particles of toner before being recirculated again.

Since the ratio of toner to carrier beads in the developer material should be maintained constant, a toner replenisher or dispenser is provided for dispensing into the sump sufficient toner material to replace the toner which adheres to the drum surface. Furthermore, since the amount of toner required to form a visible image of a document increases as the dark area of the document increases, it is evident that the toner dispenser should be manually adjustable so as to vary the rate at which toner is dispensed into the sump. Such an adjustment might be required if, for example, a large quantity of documents is to be reproduced, each document having larger (or smaller) dark area than an average document.

In the prior art, this adjustment has been accomplished by the provision of a special motor for driving the toner dispenser, and timer for controlling the duration of a dispenser cycle. The timer is controlled by a switch having two positions (light and dark) or at best three positions (light, medium and dark).

SUMMARY OF THE INVENTION

An object of the present invention is to provide a toner dispenser which does not require electrical circuits nor a special motor for driving it.

An object of the present invention is to provide a toner dispenser which may be driven through gearing by the same motor which drives the buckets in a cascade development system.

Another object of the invention is to provide a toner dispenser which may be readily removed from, and replaced in the photocopy machine, without regard for timing considerations.

A further object of the present invention is to provide a toner dispenser having a continuous range of dispensing rates any of which may be manually selected.

A further object of the invention is to provide a toner dispenser including a hopper having an opening in the bottom thereof, dispensing arms mounted for movement over said opening between first and second limits of travel, a rotatable cam, cam follower means responsive to rotation of the cam for driving the dispensing means toward the first limit of travel, bias means tending to urge the dispensing means toward the second limit of travel, and manually adjustable stop means for limiting movement of the dispensing means so that the dispensing means moves back and forth between an intermediate position and the second limit of travel.

Another object of the invention is to provide a toner dispenser having various selectable dispensing rates, said dispenser being wholly mechanical in nature.

In accordance with the principles of the present invention a toner dispenser comprises a hopper having a slit or elongated opening in the bottom thereof, a plurality of dispensing arms mounted inside said hopper for movement back and forth over the slot, a drive cam, a manually adjustable stop element, and a mechanical linkage including a cam follower means acting against said cam for driving the dispenser arms in one direction. Bias means is provided for driving the dispenser arms in the opposite direction, and for urging the cam follower toward the cam. The cam follower is pivoted and the adjustable stop means may be positioned to engage the cam follower and thus limit the degree to which the cam follower may follow the cam surface. By adjusting the position of the stop means, an operator may adjust the distance traveled by the dispenser arms during each cycle, thereby adjusting the rate at which toner is dispensed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a right side view, partly in section, showing the drive cam and cam follower at two points during a cycle of operation;

FIG. 2 is a partial rear view;

FIGS. 3 and 4 are top sectional views taken along the line 3—3 of FIG. 1 and showing the position of the dispensing arms at two points during a cycle of operation;

FIG. 5 is an isometric view of the manually adjustable stop assembly;

FIG. 6 is an isometric view of the stop element; and,

FIG. 7 is a diagram used in explaining the principles of the invention.

DETAILED DESCRIPTION OF THE INVENTION

As illustrated in FIGS. 1 and 2, a preferred embodiment of the invention includes a toner dispenser hopper **10** having secured thereto a cover plate **12.** The hopper is adapted to be inserted into, and suspended inside of, the developer housing of a xerographic reproduction machine as illustrated in U.S. Pat. No. 3,424,131. Therefore, the top cover plate **12** is made larger than the top of the hopper **10** and serves to cover not only the hopper **10** but also the opening in the top of the dispenser housing through which the toner replenisher assembly extends.

An upper agitator shaft **14** and the lower agitator shaft **16** extend through the toner hopper. These shafts are supported in suitable journals in the sidewalls of the hopper and each shaft carries fingers or other suitable agitating means (not shown) for agitating the toner material contained in the hopper. The upper shaft **14** carries a drive gear **18** and an intermediate gear **20.** The gear **20** meshes with a drive gear **22** which is mounted on, and drives, the lower agitating shaft **16.**

In a preferred embodiment the gear **18** is adapted to mesh with a further gear **24.** The gear **24** is mounted on a shaft **26** which extends through the sidewall **28** of the developer housing. The shaft **26** may be driven through suitable gearing means by the same motor which drives the buckets to transport developer from the developer sump to the developing station.

No particular timing considerations are involved when meshing gear **18** with gear **24.** Therefore, the entire toner replenisher assembly may be removed or replaced merely by raising or lowering the entire assembly through the opening in the top of the developer housing. As the toner replenisher assembly is replaced, all that is required is that the gears **18** and **24** mesh.

The toner replenisher assembly is provided with a cam follower means including a cam follower arm **30** and a cam follower roller **32.** The cam follower arm **30** is mounted for pivoting motion on a pivot **34.** A bracket **36** is attached to the side of the toner hopper and the outer arm of this bracket both supports the pivot **34** and prevents sidewise movement of the cam follower arm along the pivot. The cam follower roller **32** rolls along the surface of a radial cam **38** which is mounted on the lower agitating shaft **16.** Spring means, subsequently described, provides a force which biases the cam roller **32** toward the cam **38** so that the roller tends to follow the cam surface.

FIG. **3** is a sectional view taken along the line **3—3** of FIG. **1** and shows the dispensing means disposed in the bottom portion of the dispenser hopper **10.** The dispensing means includes a plurality of dispenser arms **40** attached to the bottom plate of the dispenser hopper by a plurality of pivots **42.** The bottom plate of the hopper has an elongated opening or slot **44** therein. An elongated linkage member **46** is attached to the underside of each of the dispenser arms **40** by means of a pivot connection **48,** the arrangement being such that the member **46** is supported within the opening **44** and generally in the plane of the bottom plate of the toner hopper **10.** As viewed in FIG. **3,** the rightmost dispensing arm **40** comprises one arm of a lever, the second arm being designated **50.** The arm **50** extends through a slot in the side of the hopper and a roller **52** is pivotally mounted at the end of the arm.

Bias means in the form of two tension springs **54** are provided for supplying a bias force tending to pivot the dispensing arms **40** in the counterclockwise direction. Each of the springs is stretched between an extension or stud **42***a* on one of the pivots **42** and an extension or stud **48***a* on one of the pivots **48.** The force exerted by the springs on studs **48***a* is transmitted to the linkage member **46** and then through the pivots **48** to each of the dispensing arms **40** and the lever arm **50.**

The cam follower arm **30** is provided with a laterally extending portion or ear **30***a* in proximity to the roller **52.** As the springs **54** tend to pivot the lever **50** in the counterclockwise direction, the roller **52** engages the ear **30***a* thereby tending to pivot the cam follower arm **30** (see FIG. **1**) counterclockwise about the pivot **34.** Thus, the springs **54** comprise spring bias means tending to move the cam follower roller **32** against the cam **38.**

Flg. **3** illustrates the position of the dispenser arms **40** when the cam follower roller **32** rests on the lowest portion of cam **38.** This corresponds to the condition illustrated in solid outline in FIG. **1.** As the cam **38** is rotated the roller **32** rides up on the cam surface thereby pivoting the cam follower arm **30** clockwise about the pivot **34.** The ear **30***a* at the lower end of the cam follower arm presses against the roller **52** thereby rotating the lever arm **50** (FIG. **3**) in a clockwise direction about the pivot **42** against the tension exerted by the springs **54.** The motion of the lever arm **50** is transmitted through a pivot **48** to the linkage member **46** and then to each of the dispensing arms **40.** The dispensing arms are pivoted clockwise about the pivots **42** and this motion continues until the high level of the cam is engaging the roller **32.** At this time the cam **38** has rotated 180°, the dispenser arms have been moved to the position shown in FIG. **4,** and the cam follower arm **30** and the cam follower roller **32** have assumed the position shown in phantom outline in FIG. **1.**

Upon further rotation of the cam **38** the tension springs **54** act in the manner described above to bias the roller **32** towards the surface of cam **38** and in doing so tend to pivot the dispenser arms **40** back toward the position shown in FIG. **3.**

If the cam **38** is continuously driven then the dispensing arms **40** continuously oscillate or pivot back and forth between the positions shown in FIGS. **3** and **4.** The dispensing arms move back and forth across the bottom of the toner hopper and with each motion scrape or push toner particles under the lower edge of a deflector shield **55** so that the particles fall through the opening **44** in the bottom of the hopper and into the developer housing, where they eventually mix with the beads.

The deflector **55** may be a piece of sheet material formed substantially as shown in FIG. **1.** At its upper extent the deflector is attached to a wall of the toner hopper and at its lower extent it terminates in a plane just above the plane of movement of the dispenser arms **40.** The deflector serves to direct toner loaded into the hopper toward that bottom portion of the hopper where the dispenser arms move. The deflector also serves to prevent toner dumped into the hopper from passing directly through the opening **44** in the bottom of the hopper.

As described above, continuous rotation of the cam **38** oscillates the dispenser arms **40** back and forth between first and second limits of travel shown in FIGS. **3** and **4**, respectively, so that the same amount of toner is scraped or pushed under deflector **55** and through the opening **44** on each cycle. Since the amount of toner dispensed is dependent upon the degree of pivotal movement of the dispenser arms **40**, and since FIGS. **3** and **4** represent the two ultimate limits of travel of the dispenser arms in response to rotation of the cam **38**, it is obvious that the maximum dispensing capability of the apparatus is represented by oscillation back and forth between the position shown in FIGS. **3** and **4**.

In accordance with the present invention means are provided for limiting the degree of pivotal movement of the dispensing arms **40** to thereby limit the rate at which toner is dispensed to some rate less than the maximum capability of the apparatus. This means is illustrated in FIGS. **1, 5** and **6** and comprises a manually adjustable stop means including a bracket **60**, a stop element **62**, and a thumb screw **64**. The bracket **60** is generally U-shaped and is attached by means (not shown) to the cover plate **12**. Two arms of the bracket extend upwardly and a manually controllable thumb screw **64** extends through an opening in each of these arms. The thumb screw is provided with shoulders to permit free rotation of the screw in the holes in the arms while maintaining the screw in a fixed location axially in the bracket **60**. A C-clip or other suitable means **66** is provided for preventing axial movement of the thumb screw. The stop element **62** is also generally U-shaped with two upwardly extending arms and each of these arms has a threaded opening therein through which passes the threaded portion of the thumb screw **64**. The stop element includes an arm or downwardly depending ear **62*a*** which extends through a slit or opening **68** in the cover plate **12**. The ear of the stop element extends downwardly into the plane of movement of an ear **30*b*** provided at the upper end of the cam follower arm **30**. An indicator or pointer **62b** (FIG. **6**) is provided on the stop element for providing to the machine operator an indication of the position of the stop element.

As long as the stop element **62** is no further to the right than the position shown in FIG. **1**, the apparatus operates at maximum dispensing capability as previously described. Under these circumstances the curve A, B, C, D, E of FIG. **7** depicts the movement of roller **32** during one complete revolution of the cam **38**. At point A, the roller **32** is at the high point of the cam **38**. As the cam is rotated 180° the tension springs **54** bias the roller **32** toward the cam **38** hence the motion of roller **32** from point A to point C on the curve is caused by the tension springs **54**. The point C′ represents the lowest point on the cam **38**. As the cam rotates another 180° the motion of roller **32** is illustrated by the curve CDE and during this interval the roller **32** is driven by the cam **38**.

Assume now that the thumb screw **64** is turned so that the stop element is moved to the right thereby bringing the ear **62*a*** into the path of the ear **30*b*** on the upper end of the cam follower arm **30**. In FIG. **7**, the motion of roller **32** again starts at point A on the curve corresponding to the highest point on the cam **38**. As the cam is rotated the motion of roller **32** follows the curve, the roller being driven by the springs **54** as previously described. However, at point B on the curve, which corresponds to point B′ on the cam **38**, the ear **30*b*** on the cam follower arm engages the downwardly depending ear **62*a*** on the stop element **62**. This prevents further counterclockwise rotation of the cam follower arm thereby stopping the motion of the roller **32**. As the cam **38** continues to rotate from the point B′ towards the position where its low dwell (point C′) is adjacent roller **32**, the roller **32** and the cam follower arm remain stationary. As the cam continues to rotate the roller **32** remains stationary until, at point D′ of the cam revolution the cam surface again engages the roller **32**. The cam then drives the roller **32** thereby rotating the cam follower arm clockwise until the cam again reaches its high point. Thus, as the cam **38** is rotated one complete revolution the motion of roller **32** follows the curve ABDE. Since the roller **32** moves only one-half the distance it moves during maximum dispensing, the dispensing arms **40** also move only one-half the distance they would normally move for maximum dispensing rate. That is, as the cam **38** rotates the dispensing arms **40** pivot back and forth between the position illustrated in FIG. **4** and the position in which the arms are one-half the way between the positions illustrated in FIGS. **3** and **4**.

From the foregoing description it is believed obvious that by turning the thumb screw **64** one may select any desired dispensing rate throughout the continuous range of dispensing rates extending from zero to the maximum dispensing capability of the apparatus. As the thumb screw is turned to move the stop element further to the right, (FIG. **1**), the points B and D (FIG. **7**) move closer to the points A and E. This corresponds to less motion of the roller **32** as a result of contact with the cam surface, and consequently a lower dispensing rate. If the stop element **62** is moved far enough to the right, the point B will coincide with the point A and the point D will coincide with the point E. This corresponds to the condition where the ear **62*a*** engages the ear **30*b*** at such a position so as to hold the roller **32** away from engagement with the cam **38** throughout the complete 360° revolution of the cam **38**. That is, there is no motion of the roller **32** and hence no motion of the dispensing arms **40** so there is no toner dispensed from the hopper.

From the foregoing description is it seen that the present invention provides a wholly mechanical yet very simple means for manually adjusting the rate at which toner is dispensed from a hopper. The dispensing rate may be selected from a continuous range of dispensing rates extending from zero to the maximum dispensing capability of the apparatus. Furthermore, the dispensing apparatus is wholly contained and may be easily removed from the xerographic reproduction apparatus with which it is associated and no timing considerations need be given when reinserting the dispenser into the reproduction apparatus. The dispenser may be driven through suitable gearing by a motor usually present in xerographic reproduction machines.

While the preferred embodiment of the invention has been described in detail, various modifications and substitutions therein will be evident to those skilled in the art. For example, the manually adjustable stop means may take the form of an adjustable stop screw with a slotted head so that manual adjustment of the dispensing rate may be effected only by experienced personnel with the aid of a screwdriver. Therefore, it is intended

to be limited only by the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A toner dispenser comprising:

a toner hopper having a dispensing opening in the bottom thereof;

a dispensing means mounted for movement over said opening between first and second limits of travel;

a rotatable cam;

cam follower means responsive to rotation of said cam for driving said dispensing means toward said second limit of travel;

bias means tending to urge said dispensing means toward said first limit of travel and said cam follower means toward engagement with said cam;

manually controlled stop means for blocking movement of said dispensing means in response to said bias means at a position intermediate said first and second limits of travel, whereby said dispensing means moves between said second limit of travel and an intermediate position determined by the adjustment of said stop means;

said dispensing means comprising a plurality of dispensing arms pivotally mounted at one end,

linkage means connected to each of said dispensing arms intermediate the ends thereof;

said linkage means being responsive to said bias means and said cam follower means for moving said dispensing arms back and forth along an arcuate path to thereby push toner into said opending, and,

deflector means in said hopper for deflecting toner loaded into said hopper toward the region of said dispensing arms, said deflector means extending over said opening from a side of said hopper to prevent toner loaded into said hopper from passing immediately through said opening.

2. A toner dispenser as claimed in claim **1** wherein:

said cam follower means comprises a cam follower arm pivoted intermediate first and second ends; and,

a cam follower roller mounted on said follower arm intermediate the follower arm pivot and said first end;

said first end engaging said linkage means when said cam moves said follower roller to thereby move said dispensing arms in one direction,

said second end engaging said stop means to thereby block movement of said linkage means and dispensing arms in response to said bias means.

3. A toner dispenser as claimed in claim **2** wherein said bias means comprises spring means, said spring means acting through said linkage means to bias said cam follower arm toward said cam and said stop means.

4. A toner dispenser as claimed in claim **3** wherein said controlled stop means comprises fixed bracket means, a threaded adjusting screw extending through said bracket, and a stop element having an arm extending into the path of movement of said second end of said cam follower arm, said stop element being threaded and mounted on said screw whereby rotation of said adjusting screw changes the position of the stop element arm in the path of said cam follower arm.

5. A toner dispenser as claimed in claim **4** wherein adjustment of said screw adjusts the number of degrees of a cycle of rotation of said cam during which said cam follower roller follows the surface of said cam, said adjustment being variable throughout a continuous range from 0° to 360°.

6. A toner dispenser as claimed in claim **5** wherein the rate at which toner is dispensed through said opening is directly related to the number of degrees of cam rotation during which said cam follower roller follows the surface of said cam, 0° representing the condition of no toner dispensing and 360° representing the maximum rate of toner dispensing.

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