April 27, 1965 B. D. EISNER 3,180,313

APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGE

Filed Oct. 19, 1962 3 Sheets-Sheet 1

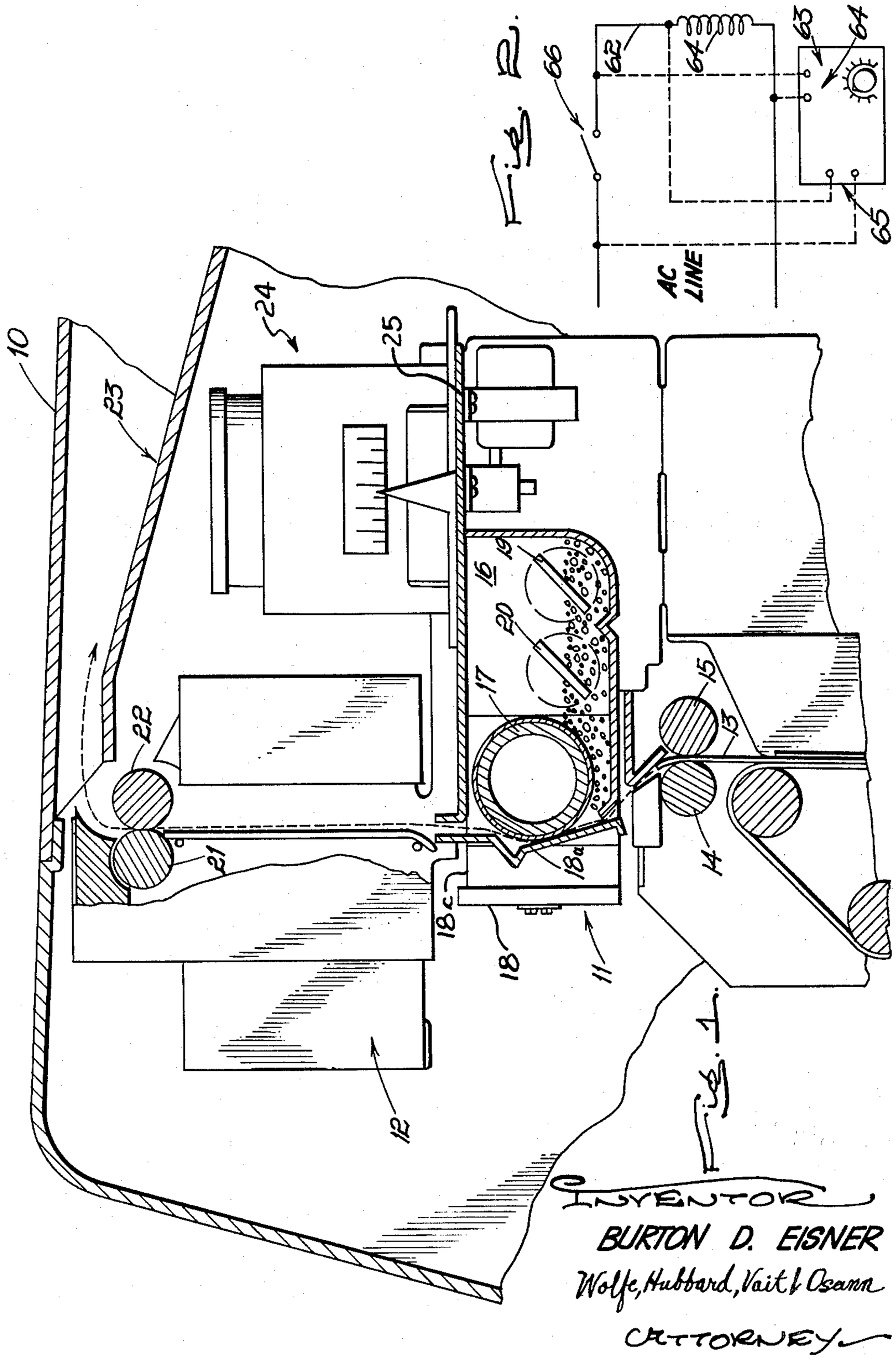

Fig. 1.

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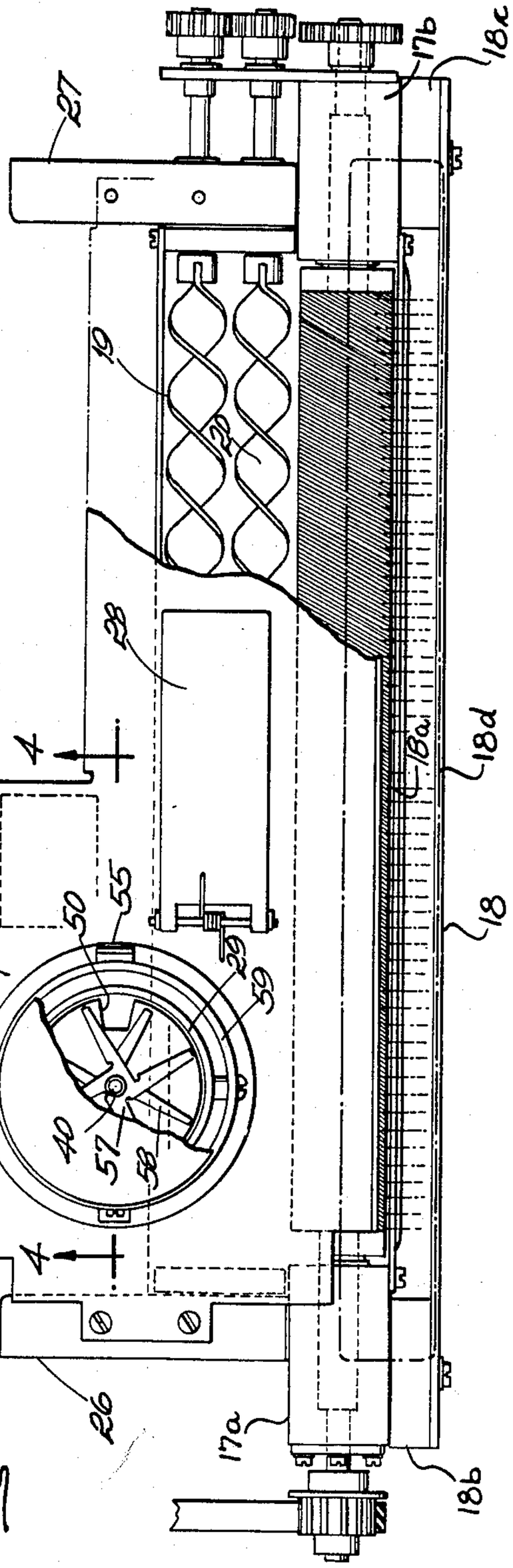

Fig. 3.

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Filed Oct. 19, 1962 3 Sheets-Sheet 3

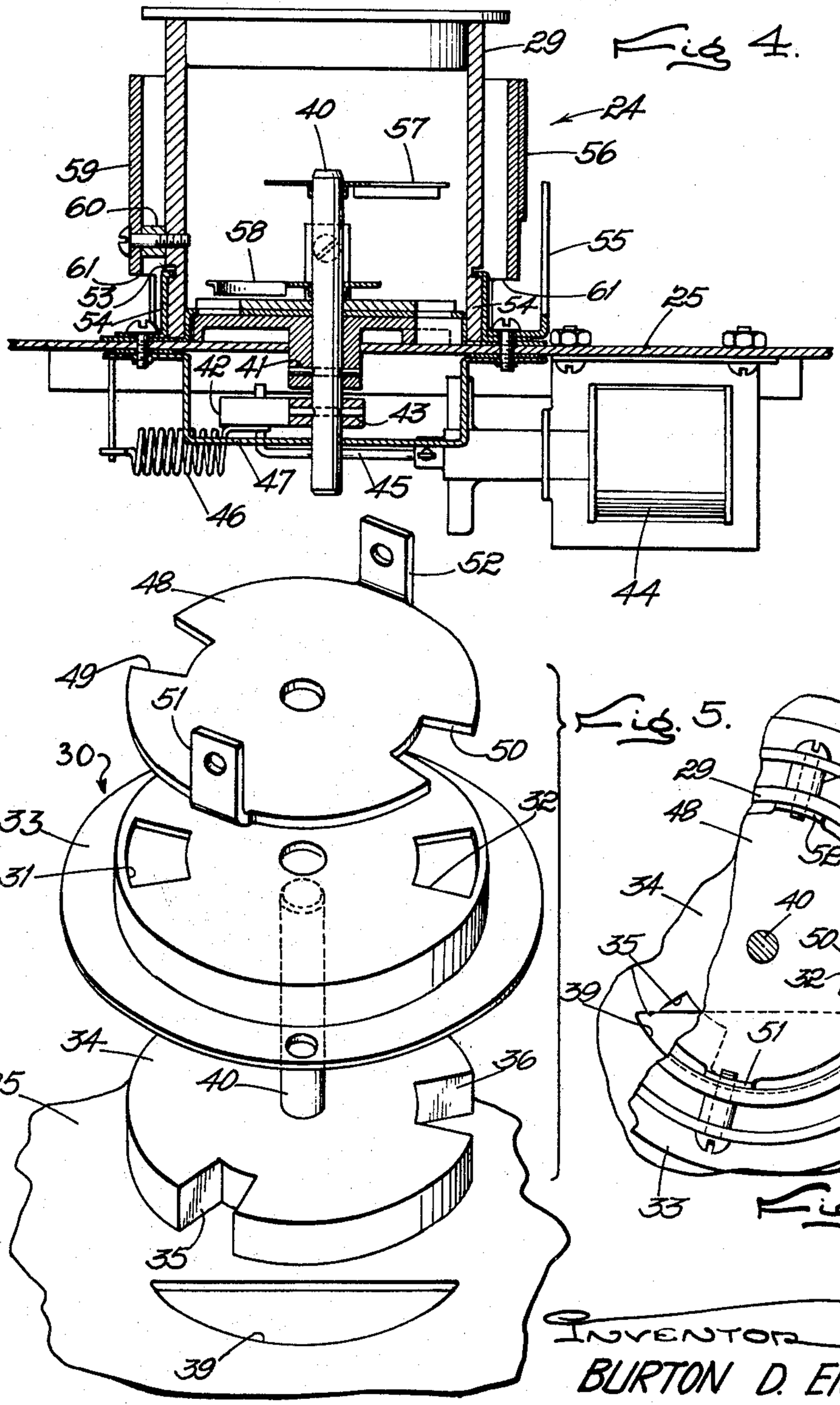

Fig. 4.

Fig. 5.

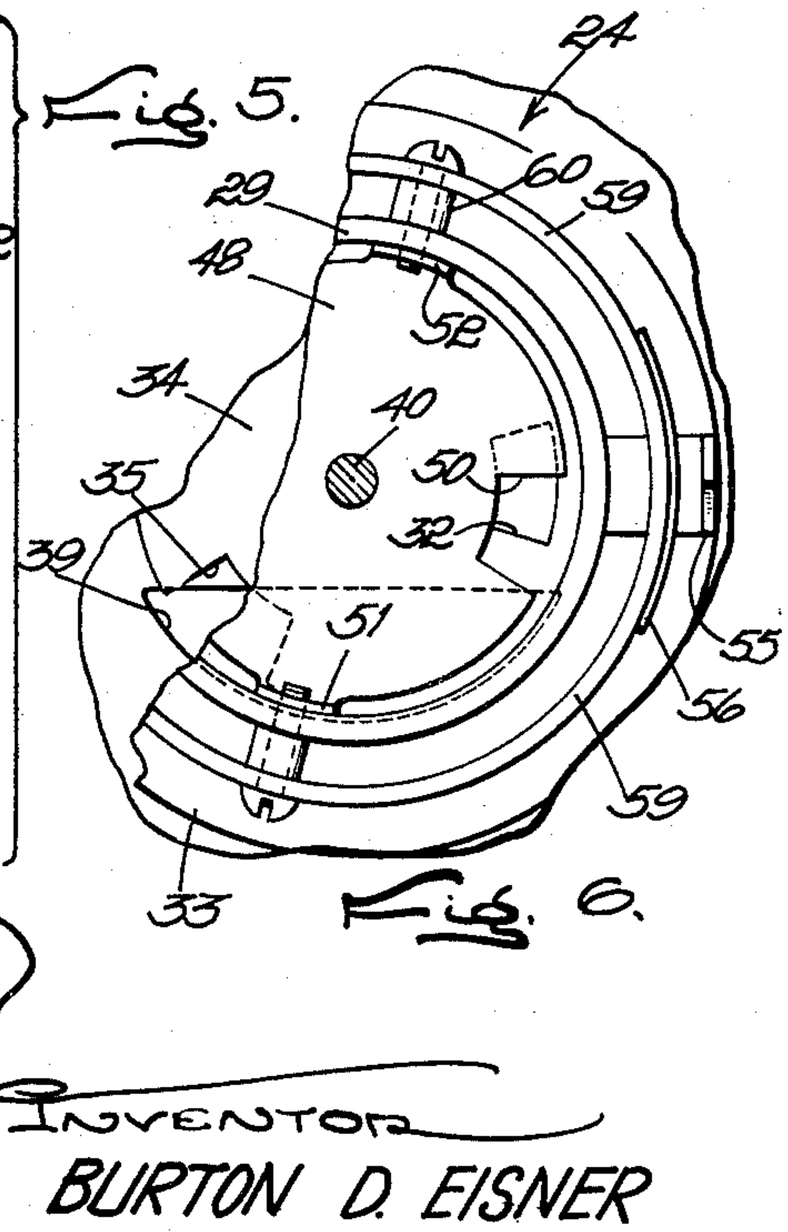

Fig. 6.

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APPARATUS FOR DEVELOPING ELECTROSTATIC IMAGE

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Filed Oct. 19, 1962, Ser. No. 231,771
4 Claims. (Cl. 118—637)

The present invention relates to electrophotographic printing and more particularly to means for replenishing developing powder in the developing unit of such a machine.

It is desirable in the electrophotographic printing process to use a powder or toner mix which is of fine grain. In the use of such toner mix, problems arise because the powder tends to pack or bridge the discharge opening. Furthermore, problems occur in metering the toner powder, especially in small quantities.

It is an object of the present invention to provide a replenishing or dispensing unit for periodically replenishing a toner reservoir and which is effective to positively discharge a predetermined amount of toner powder free of any packing or bridging of the powder in the discharge opening. Reliable discharge is assured even though toner powder is employed, which is much finer than that which can be accommodated by conventional replenishing devices.

It is a more specific object to provide a replenishing device which is capable of actually metering out predetermined quantities of powder in order to keep the reservoir up to rated level and in which the amount of powder, which is discharged at each operation may be actually adjusted over a wide range.

It is an overall object of the present invention to provide a replenishing unit which can be easily adapted for use in any of the several different types of electrophotographic printing machines and which is economical to manufacture and easy to maintain.

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

FIGURE 1 is a simplified vertical fragmentary section of a photocopy machine employing the present invention;

FIG. 2 is a schematic diagram of the portion of the control circuit for the replenishing unit;

FIG. 3 is a plan view, in partial section, of the developing unit which receives the toner from the replenishing unit;

FIG. 4 is a vertical section taken along 4—4 in FIG. 3 through the replenishing unit constructed in accordance with the present invention;

FIG. 5 is an exploded view of the dispensing or replenishing elements; and

FIG. 6 is a fragmentary section showing adjustment of the choke plate to vary the discharge of the replenisher.

While the invention has been described in connection with a preferred embodiment, it will be understood that it is not intended to limit the invention to the particular embodiment shown but it is, on the contrary, intended to cover the various alternatives and equivalent constructions, which may be included in the spirit and scope of the appended claims.

Turning now to FIGURE 1 of the drawings, a section of an electrophotographic copying machine intended for office use is shown having an outside cover 10 enclosing a developing unit 11 and a fixing unit 12. A sensitized copy sheet 13 is directed into the developing unit 11 by a pair of copy transporting rollers 14, 15. The part of the electrophotographic machine for transposing an image from the original sheet to the copy sheet is described

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in copending application, Serial No. 211,779, filed July 23, 1962. All that need be related for understanding of the present invention is that copy sheet 13, when it enters the developing unit, has an electric charge image established on it corresponding to the original.

In the developing unit 11 a bin 16 is provided for holding the toner mix so that a developing cylinder 17 can pick up the mix and brush it on the copy sheet 13. The toner will "stick" to the parts of the copy sheet which have an electric charge and thereby visually display the image on the copy sheet corresponding to the original. The full explanation of the developer cylinder 17 and the manner in which the toner mix is picked up and applied to the copy sheet is set forth in detail in the above-identified copending application. For present purposes, is suffices to explain that the toner mix consists of a mixture of pigmented toner particles and magnetizable particles, with the toner particles adhering to the magnetizable particles as a result of triboelectric effect and leaving the magnetizable particles when the toner particles are brushed in contact with the surface of the copy sheet. The toner mix is carried as tufts on the cylinder because of the magnetic field set up substantially at right angles to the cylinder 17 and through the copy sheet 13.

For establishing the magnetic field at right angles to the developing cylinder 17, bearing blocks 17*a*, 17*b* are made of magnetic material and are bridged by an elongated magnetic pole member 18 which extends parallel to the cylinder outside a guide member 18*a* and with permanent magnets 18*b*, 18*c* being provided in the circuits so that the developing cylinder is at one polarity and the cooperating pole piece at the opposite polarity. To achieve the latter, permanent magnets 18*b*, 18*c* are polarized in parallel with one another, i.e., with the same polarity so that the flux, indicated at 18*d* (FIG. 3) is distributed more or less uniformly to the surface of the cylinder 17. The guide member 18*a* is made of aluminum or other non-magnetic material so that it does not obstruct or distort the flux flowing to the cylinder. The desired level of toner mix in the bin 16 is maintained by oppositely rotating augers 19 and 20.

Following brushing of the copy sheet with the toner mix by cylinder 17, the sheet is directed through the fixing unit 12 and there the resinous portion of the toner mix is fused to the copy sheet to make the desired permanent image on the sheet. The fixing unit 12 is explained in detail in a copending application, Serial No. 853,123, filed Nov. 16, 1959, now Patent 3,088,386. Expeller rollers 21, 22 are provided to pull the copy sheet through and deposit it onto a tray 23 from which the finished copies can be removed.

In accordance with the present invention replenishing means are provided at the top of the developing unit for depositing measured amounts of toner from time to time concentrated at a single position at the rear of the augers for immediate longitudinal distribution by the augers. The replenishing unit 24 is preferably mounted upon a supporting or base plate 25 which forms the top plate for enclosing the toner bin and preferably secured to a pair of side members 26, 27 of the developing unit as shown in FIG. 3. A spring-closed inspection cover 28 is provided in the plate for checking the operational level of the toner bin when desired.

Mounted on the plate 25 is a magazine 29 in the form of a hollow vertical cylinder. At the bottom of the cylinder and secured to the plate 25 is a stationary disc 30 in the form of a shallow inverted cup having ports or openings 31, 32 and a mounting flange 33. For metering toner powder from the magazine a metering disc 34 having peripheral notches 35, 36 is interposed in the cup between the stationary disc 30 and the supporting plate 25, and a discharge opening 39 is angularly offset from

the ports 31, 32 of the stationary disc. Thus, rotating the disc serves to rotate a trapped quantity of toner into position for discharge.

To oscillate the metering disc 34 the disc is connected to a vertical shaft 40 to which it is secured by a pin 41. At the lower end of the shaft 40 an arm 42 is provided having a pin 43 which engages the shaft. The arm 42 is coupled to a solenoid 44 by a link 45, and a coil spring 46, anchored to the frame plate, which provides power for the return stroke. Outboard support for the shaft 40 is supplied by a bracket 47. The stroke of a solenoid is preferably such that on the forward stroke, the notch 36 of the metering disc rotates between a position under the port 32 of the stationary disc to a position over the discharge port 39 in the supporting plate. On the return stroke, the remaining notch 35 performs a similar function rotating from under the port 31 to a position over the discharge port. Thus, where both the notches 35, 36 are utilized, the replenisher is capable of depositing two measured doses of toner powder each time the solenoid is energized. In order to cut the discharge in half, one of the notches on the metering disc may simply be omitted.

In accordance with one of the aspects of the invention the size of the dose is made adjustable by providing a choke plate secured to the magazine and above the stationary disc and having ports which may be adjusted into register with the ports in the disc. The magazine is rotatable with respect to the mounted or base plate and provided with suitable calibrated indicia so that adjustment is effected simply by rotating the magazine. In the present instance, the choke plate indicated at 48 has openings 49, 50 which correspond to the openings 31, 32 in the stationary disc. For securing the choke plate to the magazine suitable tabs 51, 52 are provided. The magazine is made rotatable with respect to the supporting plate by forming the base portion with an annular groove 53 engaged by lugs 54. A stationary pointer 55 cooperates with a scale 56 which is rotatable with the magazine.

It will be apparent, then, that when the magazine is adjustably rotated relative movement will take place between the ports choking down the area through which toner may enter the notches in the metering disc and thereby determining the quantity of toner which is ejected during each operation.

For the purpose of agitating the finely divided toner and for thereby preventing packing or bridging, agitators 57, 58 are secured to the upper end of the shaft 40. The agitators are preferably spaced from one another as shown with the lowermost agitator being mounted more or less directly over the choke plate so that it tends to sweep toner into the metering space. It is found that this construction produces a high degree of reliability and metering accuracy even when used with toner powder having a particle dimension measured in terms of microns.

For the purpose of keeping the magazine 29 at a safely low temperature, a heat shield 59 is provided which is spaced from the wall of the magazine on posts 60. Windows 61 at the lower edge of the shield permit upward movement of cooling air. Thus, there is no possibility that the magazine will be heated to the point that fusion of the toner powder will tend to take place.

In spite of the fact that the toner is deposited in a concentrated dose at one point along the length of the developing cylinder, the action of the transporting augers, previously mentioned, is such that the added material is immediately distributed over the width of the cylinder so that addition of toner does not affect copy-to-copy uniformity.

In accordance with another of the aspects of the present invention means are provided for actuating the dispenser once for each copy made. The actuating signal is derived from a switch 66 responsive to the leading edge of the original and which is used in the overall control

circuitry disclosed in detail in copending application Serial No. 853,123, filed November 16, 1959. Referring to FIG. 2, a simple series connection 62 is made between the switch and the solenoid 44 of the replenisher. Since the replenisher may, because of its novel design, be adjusted for low consistent output per cycle, it is found that the toner is maintained at a desired level over long periods of time without further care or attention.

If desired, and without departing from the invention, means may be provided for actuating the replenishing unit 24 after a predetermined number of copies have been processed. Thus, a timer 63 may be used having input terminals 64 and output terminals 65. The timer 63 has been indicated diagrammatically since timers are well known to those skilled in the art capable of producing an output pulse upon receipt of a predetermined, counted, number of input pulses. When using the timer the regular lead (FIG. 2) 62 is broken. The input terminals are connected to the switch (not shown) and the output terminals are connected to the solenoid, just as shown by the dotted lines. Thus after a predetermined, preferably adjustable, number of counts, the counter 63 triggers an impulse to the solenoid to deposit a predetermined amount of toner powder in the bin.

It will be seen from the above description that a replenishing unit is provided which is easily adaptable to different electrophotographic printing machine developing units and is economical to manufacture and easy to maintain.

I claim as my invention:

1. In combination with a developing unit for a photocopy machine capable of developing a copy sheet having an electrostatic latent image thereon, a replenishing unit comprising, in combination, a mounting plate mounted on top of said developing unit, a toner magazine mounted on said plate and in the form of a vertical cylinder, a stationary disc spaced above the mounting plate, a metering disc between said stationary disc and said mounting plate, said stationary disc and said plate having ports angularly spaced from one another, said metering disc having notches formed therein and having means for oscillating the disc between a first position in which toner is received from the port in the stationary disc and a second position in which toner is discharged through said plate into the developing unit, said oscillating means including a solenoid responsive to development of copies so as to discharge a predetermined quantity of toner for a preselected number of copies, and a choke plate disposed adjacent said stationary disc for adjusting the size of said stationary disc ports to select the quantity of toner admitted to said metering disc notches.

2. In combination with a developing unit for a photocopy machine capable of developing a copy sheet having an electrostatic latent image thereon, a replenishing unit comprising, in combination, a base plate, a magazine on said base plate for containing toner powder, a stationary plate in said magazine spaced above the base plate and having first and second spaced peripheral ports, said base plate having a discharge port arranged angularly between the ports in the stationary plate, a metering disc interposed between the stationary plate and the base plate, a drive shaft extending axially within the replenishing unit for oscillating the metering disc over a forward and reverse stroke, said metering disc having first and second notches formed on the periphery thereof and so arranged that during the forward stroke toner is transported by the first notch from the first port to the discharge port in the base plate and so that upon the reverse stroke toner is transported from said second port to said discharge port, a choke plate disposed above said stationary plate and adjacent thereto having first and second ports coinciding with said stationary plate, first and second discharge ports, said choke plate adjustable to vary said stationary plate port sizes to select quantity of toner discharged in each of said strokes, and agitator means

secured to the upper end of said shaft for agitating the toner above said ports.

3. In combination with a developing unit for a photocopy machine capable of developing a copy sheet having an electrostatic latent image thereon, a replenisher for toner powder in the developing unit comprising, in combination, a mounting plate having a discharge port, a magazine in the form of a vertical cylinder on said mounting plate, a shaft extending axially through said mounting plate and into said magazine, a metering disc on said shaft for metering toner through said discharge port and into said developing unit, a choke member having a peripheral port and located above the metering disc, said choke member being secured to said magazine and said magazine being rotatable with respect to said mounting plate thereby to vary the amount of toner discharged in a cycle of the metering means, and indicia associated with the magazine for visually indicating the adjusted position of the latter.

4. In combination with a developing unit for a photocopy machine capable of developing a copy sheet having an electrostatic latent image thereon, a replenisher for toner powder in the developing unit comprising, in combination, a mounting plate mounted on top of said developing unit, a toner magazine mounted on said plate and in the form of a vertical cylinder, a stationary plate in said magazine spaced above the mounting plate and

having first and second spaced peripheral ports, said mounting plate having a discharge port arranged angularly between the ports in the stationary plate, a metering disc interposed between the stationary plate and the mounting plate, a drive shaft extending axially within the replenishing unit for oscillating the metering disc over a forward and reverse stroke, said metering disc having first and second notches formed on the periphery thereof and so arranged that during the forward stroke toner is transported by the first notch from the first port to the discharge port in the mounting plate and so that upon the reverse stroke toner is transported from said second port to said discharge port, a choke member being secured to said magazine and said magazine being rotatable with respect to said mounting plate thereby to vary the amount of toner discharged in a cycle of the metering means, and agitator means secured to the upper end of said shaft for agitating the toner above said ports.

References Cited by the Examiner

UNITED STATES PATENTS

2,446,582	8/48	Gopner	222—362 X
2,944,707	7/60	Steinmetz	222—363 X
3,088,386	5/63	Sugarman	95—1.7

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