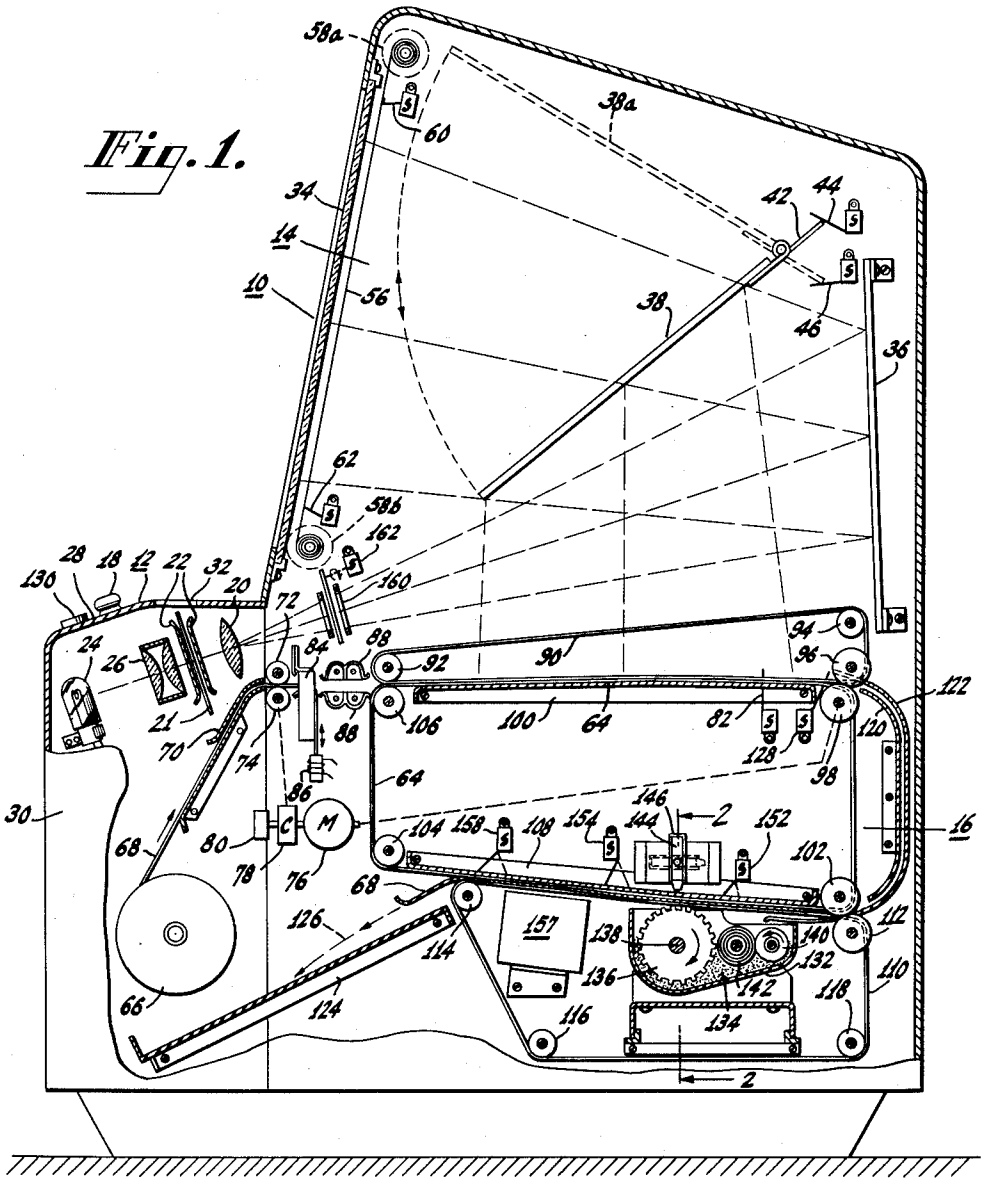
April 11, 1961 H. G. REUTER, JR 2,979,026

FILM VIEWER AND REPRODUCER

Filed June 19, 1958 3 Sheets-Sheet 1

Fig. 1.



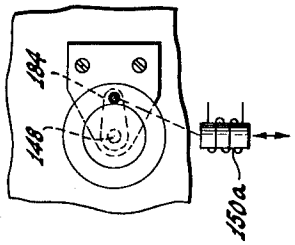
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FILM VIEWER AND REPRODUCER

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Fig. 3.



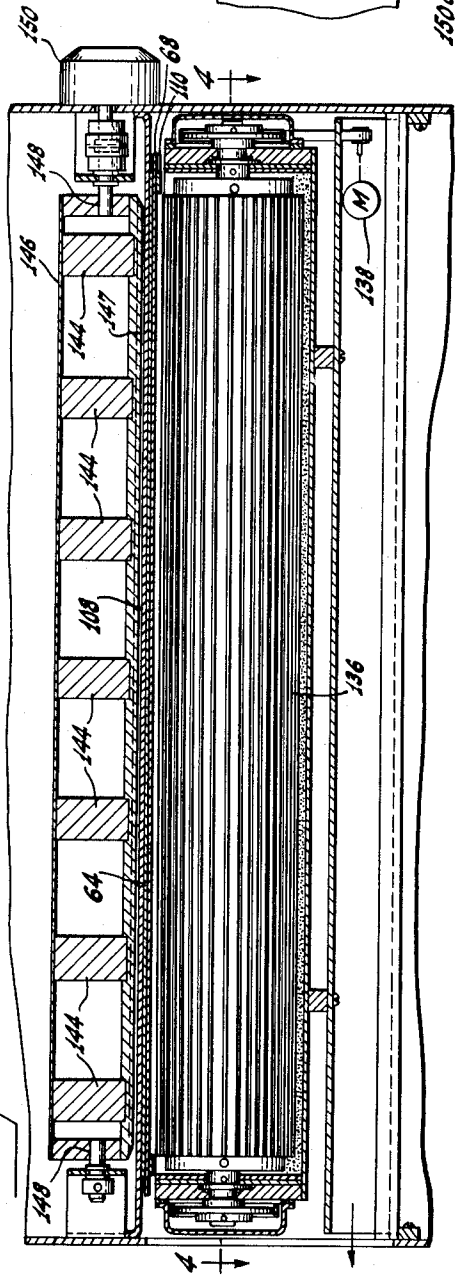
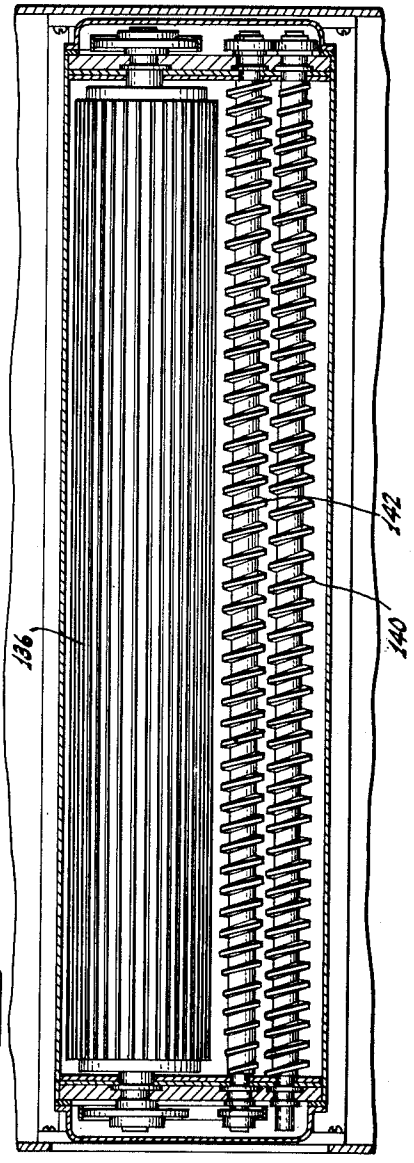


Fig. 2.

Fig. 4.



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FILM VIEWER AND REPRODUCER

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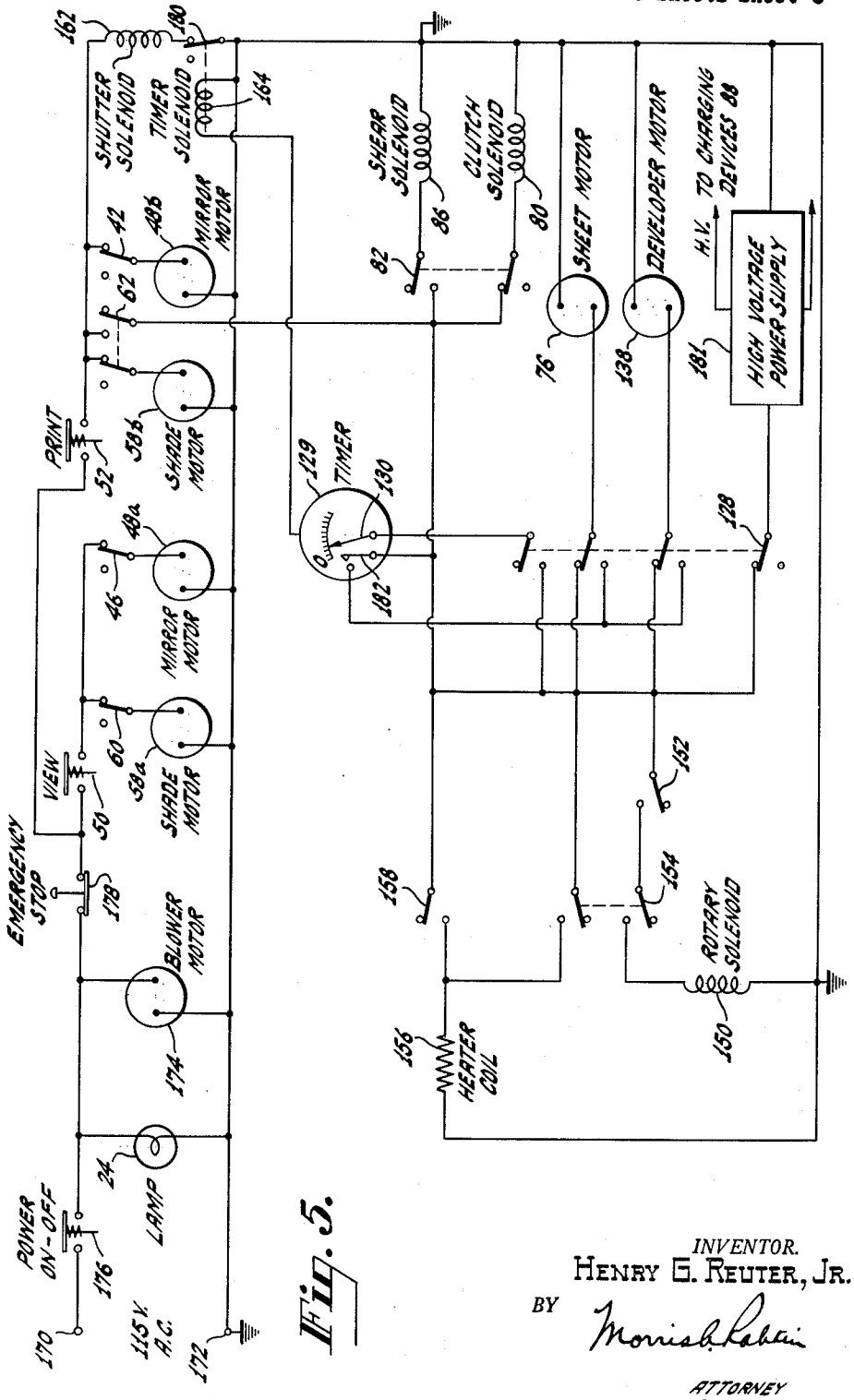


Fig. 5.

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FILM VIEWER AND REPRODUCER

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Filed June 19, 1958, Ser. No. 743,145

6 Claims. (Cl. 118—637)

This invention relates to film viewers and reproducers generally, and more particularly to apparatus for viewing microfilm and for making an enlarged print of the microfilm by an electrophotographic process.

It is an object of the present invention to provide improved apparatus for viewing enlarged images of microfilm and for reproducing these enlarged images by means of a direct electrophotographic process in a relatively short time.

Another object of the present invention is to provide improved apparatus for developing an electrostatic latent image on a sheet of photoconductive material in a manner whereby the sheet is caused to move along a predetermined path, and wherein the different steps in the electrophotographic process are initiated by switches in response to the movement of the sheet.

A further object of the present invention is to provide novel developing apparatus which can be changed from an inoperative condition to an operative condition as, for example, upon the approach of a sheet to be developed to a developing zone.

In accordance with the present invention, the foregoing objects and related advantages are attained in improved apparatus comprising an operator section, a viewer section, and a base section. The operator section houses the optical elements, the film-holding apparatus and the operator controls for normal operation. The viewer section houses the viewing screen and the mirrors required for the projection of the enlarged image of the film. The base section houses the transport mechanism for the sheet to be developed and the apparatus for the electrophotographic process.

One feature of the present invention is the novel apparatus for applying a toner, developer powder, to the latent charge image on a sheet by means of a magnetic field. The magnetic field is utilized in a manner whereby the toner is attracted to the sheet only during the time the paper passes over a tray containing the toner intermixed with magnetic particles.

Another feature of the invention is the novel arrangement of apparatus whereby the steps in the electrophotographic process are carried out in response to switches that are actuated by the movement of a sheet of photoconductive material along a predetermined path.

The novel features of the present invention, as well as the invention itself, both as to its organization and operation, will be understood in detail when considered in connection with the accompaying drawings in which similar reference characters represent similar parts, and in which:

Fig. 1 is a side elevational view of the film viewer and reproducer, in accordance with the present invention, with parts broken away to show some of the internal mechanisms of the apparatus;

Fig. 2 is a cross-sectional view taken along the plane 2—2 in Fig. 1, and viewed in the direction indicated by

the arrows showing a portion of the developing mechanism;

Fig. 3 is a fragmentary view, in side elevation, of an alternative solenoid mechanism for actuating a magnetic field producing mechanism;

Fig. 4 is a cross-sectional view of the developing mechanism taken along the plane 4—4 of Fig. 2, and viewed in a direction indicated by the arrows; and

Fig. 5 is a schematic diagram of the electrical system of the viewer and reproducer apparatus.

Referring now to Fig. 1 there is shown the film viewer and reproducer apparatus **10** comprising an operator section **12**, a viewer section **14**, and a base section **16**. The operator section comprises a focusing knob **18** for adjusting a lens system **20**, illustrated herein as a single lens. A film **21** to be viewed may be inserted between film guides **22** in the direct path of a beam of light from a lamp **24** and through an optical condenser **26**.

The operator section **12** also comprises a control panel **28** as a part of the general housing **30** of the apparatus **10**. The housing **30** is provided with a slot **32** adjacent to the film guides **22** for inserting the film **21** therethrough for viewing purposes.

An enlarged image of the film **21** may be viewed on a frosted glass screen **34** by first projecting the image onto a fixed mirror **36**, and then reflecting the image from the mirror **36** onto the screen **34**. A movable mirror **38** is in a raised position indicated by the dashed lines **38***a* when the film **21** is being viewed. A cam **42**, near the pivoted end of the mirror **38** actuates a limit switch **44** when the mirror **38** is in a "down" position, and actuates a limit switch **46** when it is in an "up" position. The movable mirror **38** is actuated by a motor **48***a* in response to a viewing switch **50** (Fig. 5) to raise the mirror **38**, and by a motor **48***b* in response to a print switch **52** (Fig. 5) to lower the mirror **38**, as shown in Fig. 5.

A shade **56**, actuated by a motor **58***a*, is raised in response to the closing of the viewing switch **50**. The upper position of the shade **56** is determined by an upper limit switch **60**. The shade **56** is lowered by a motor **58***b* to a position determined by a lower limit switch **62** when the print switch **52** (Fig. 5) is actuated. It will now be understood that to print the image viewed on screen **34** the print switch **52** is actuated so as to lower the mirror **38** and to shut out any light that may come through the screen **34**.

With the movable mirror **38** in its "down" position, as shown in Fig. 1, the image of the film **21** to be printed may be projected onto the fixed mirror **36**, reflected therefrom to the mirror **38**, and further reflected onto an endless belt **64** which will hold a sheet having a latent charge image thereon, as will be hereinafter explained. The movable mirror **38** is so positioned that when the film **21** is in focus on the screen **34**, with the movable mirror **38** in the "up" position, the image projected onto the belt **64** will be in focus with the movable mirror **38** in the "down" position. With this arrangement it is possible to focus the image of the film **21** onto the screen **34** for viewing with visible light, and to focus the image projected on the belt **64** with an ultraviolet component of the lamp **24** so that printing may take place with the ultraviolet component, if so desired.

A sheet **68** on which to reproduce the enlarged image of the film **21** may be cut from a roll **66** of special sheet material, such as paper having a photoconductive layer thereon. The sheet **68** is passed between input guide members **70** and between feed rollers **72** and **74**. The roller **74** is driven by a motor **76** through a suitable clutch **78**, as shown in Fig. 1. The clutch **78** is actuated by a solenoid **80**. The sheet **68** passes through a shear mechanism **84** that may be actuated by a solenoid **86**. The

sheet 68 then is passed between a pair of oppositely disposed charging devices 88 for charging the sheet 68 with a uniform electrostatic charge by a corona discharge, in a manner well known in the art. The path of the sheet 68 will now be between the belt 64 and a belt 90. The belt 90 is looped around pulleys 92, 94, and 96 in a manner whereby the lower portion of the belt 92 is in contact with the belt 64.

The pulley 96 may be geared (not shown), or otherwise mechanically coupled, to a pulley 98 which, in turn, is driven by the motor 76. The belt 64 rides on an exposure platen 100 that is very slightly convex in shape so as to force the upper portion of the belt 64 against the lower portion of the belt 90 and to clamp the sheet 68 therebetween. The belt 64 is supported by pulleys 102, 104, and 106, in addition to the pulley 98.

A lower, slightly convex, platen 108 is disposed between the pulleys 102 and 104 in a manner to put pressure against the belt 64 and a belt 110. The belt 110 is supported by four pulleys 112, 114, 116, and 118 in a manner whereby the upper portion of the belt 110 is pressed against the lower portion of the belt 64. It will now be understood that a sheet 68 can be made to move in a predetermined path between the belt 64 and the belt 90, through rear guides 120 and 122, and between the belt 64 and the belt 110. The sheet 68 may be ejected onto an exit plate 124, as indicated by the arrows 126 after it has been developed in a manner hereinafter to be explained.

It will be understood that the belt 64 may be as wide as the sheet 68. The belt 64 may actually comprise a series of narrow belts in a side by side arrangement. On the other hand, the belts 90 and 110 are relatively narrow and function to grip the sheet 68 along its edge. Another set of belts (not shown) similar to the belts 90 and 110 are disposed along the opposite edge of the sheet 68 to transport it along its predetermined path.

The uniformly charged sheet 68 will go through all of the steps in the electrophotographic process during its travel along its predetermined path. When the leading edge of the sheet 68 hits the limit switch 82 the clutch 78 will be disengaged and the solenoid 86 will be actuated so that the shear 84 will cut a single sheet 68 of paper from the roll 66. The sheet 68 will advance until its leading edge hits a switch 128. This switch 128 will stop the motor 76, engaged to the pulley 98, so that the sheet 68 will become stationary. The switch 128 will also start a timer 129 (Fig. 5) that has been previously preset, as by a timer control knob 130 on the control panel 28, in a manner hereinafter to be explained. After the timer 129 has exposed the sheet 68 for a preset time, the motor 76 is started again, and the sheet 68 moves over a developer tray 132. The developer tray 132 contains a mixture 134 of finely divided iron filings and a pigmented developer powder, hereinafter called toner.

A toothed roller 136 within the tray 132 is pivoted for rotation by a motor 138, as shown in Fig. 2. It will now be understood that if the roller 136 is rotated it will pick up the mixture 134 between its teeth and move this mixture adjacent to the sheet 68, when the latter is between the belts 64 and 110. A pair of conveyor type screws 140 and 142, as shown in Fig. 4, are coupled to the roller 136 in a manner whereby the screws rotate in opposite directions within the mixture 134 for the purpose of spreading the mixture 134 evenly. This action also tends to keep the ratio of toner to iron filings uniform.

Means are provided to pull the mixture 134 up against the exposed surface of the sheet 68 whereby the pigmented developer powder of the mixture 134 will adhere to the exposed surface for printing an image thereon. To this end, magnetic field means are provided. As shown in Figs. 1 and 2, the magnetic field means may comprise a plurality of permanent magnets 144 similarly oriented within a rectangular frame 146 that is pivoted for rotation around its longitudinal axis by means of pivots 148.

The frame 146 includes a lower bar 147 of magnetic material to form a pole piece for the magnets 144. A rotary solenoid 150 may be actuated by switches 152 and 154, connected in series with each other, to rotate the normally horizontally disposed magnets to a vertical position, in response to the actuation of the switches 152 and 154 by the leading edge of the moving sheet 68. This action brings a magnetic field close to the unexposed side of the sheet 68 so that the mixture 134 can be attracted onto the sheet 68 to print the latent image. It will be appreciated that when the trailing edge of the sheet 68 has passed the switch 152 it is no longer necessary to attract the mixture 134 upwardly. Consequently, when the trailing edge of the sheet 68 moves away from the switch 152, the rotary solenoid 150 is de-energized and the magnets 144 will rotate about the longitudinal axis of the frame 146, from the vertical position to a horizontal position, thereby removing the magnetic field from the proximity of the tray 132 and the mixture 134.

When the leading edge of the sheet 68 actuated the switch 154, it also turned on a heater 156 (Fig. 5) of a heater and blower mechanism 157 for fusing the toner onto the sheet 68. After the trailing edge of the sheet 68 has left the switch 154 and a subsequent microswitch 158, the heater 156 is turned off. The finished electrophotographically developed sheet 68 is then discharged onto the exit plate 124.

Referring again to Fig. 1 there is shown a shutter 160 that is normally open for viewing purposes. The shutter 160 may be closed by actuating a shutter solenoid 162 when the print switch 52 (Fig. 5) is closed. Also, as shown in Fig. 5, the switch 128, when actuated, causes the shutter 160 to open by means of a timer solenoid 164 until the timer 129 is automatically turned off.

Referring now to Fig. 5, there is shown the electrical system of the viewer and reproducer apparatus 10. The apparatus 10 may be operated from a power source of conventional alternating current (A.-C.) voltage, such as 115 volts A.-C., as available from terminals 170 and 172. The terminal 172 may be grounded. The exposure lamp 24 and a blower motor 174 are connected across the power source through a power on-off switch 176. A normally closed emergency stop switch 178 may be inserted in the ungrounded side of the power source. The shade motor 58*a* and the mirror motor 48*a* are connected across the power source through the viewing switch 50. The shade motor 58*b* and mirror motor 48*b* are connected across the power source through the print switch 52. The upper limit switches 60 and 46 are connected in series with the motors 58*a* and 48*a*, respectively; and the lower limit switches 62 and 42 are connected in series with the motors 58*b* and 48*b*, respectively. The lower limit switch 62 also serves to connect the power source to the timer 129 when the switch 62 is actuated. The shutter solenoid 162 is also connected across the power source through the print switch 52 and a normally closed switch 180. The switch 180 is mechanically linked to the timer solenoid 164 in a manner whereby it is opened when the timer solenoid 164 is energized. The clutch solenoid 80 and the shear solenoid 86 are connected to the power source through the serially connected switches 82 and 62. A high voltage power supply 181 for the electrostatic charging devices 88 and the motors 76 and 138 are connected to the power source through the switches 62 and 128.

The timer solenoid 164 is connected in series with the timer 129 and the switches 128 and 62. The timer 129 may be preset for any given exposure time. After the preset time has expired, the timer 129 will actuates a normally open switch 182 to energize the motors 76 and 138.

The rotary solenoid 150 is connected in series with the switches 154, 152, and the switch 62. The heater 156, in the heater-blower mechanism 157, is connected in series with switches 158 and 62. The switch 154 is connected in parallel with the switch 158. It will be understood that

the switches **82**, **128**, **152**, **154**, and **158** are switches of the type that have an actuating portion projecting in the predetermined path of the moving sheet **68** so that they may be actuated by the moving sheet **68**.

The operation of the viewer and reproducer apparatus **10**, in accordance with the present invention, will now be explained. The lamp **24** and the blower motor **174** are energized by closing the on-off switch **176**. To view the film **21**, the viewing switch **58** is closed. The shade **56** is now raised by the motor **58** until the limit switch **60** is actuated. At the same time the movable mirror **38** is raised by the motor **48***a* until the cam **42** opens the limit switch **46**. The film **21** may now be viewed on the frosted screen **34** and focused thereon.

To make an electrophotographic print of the image viewed on the screen **34**, the print switch **52** is closed. This action causes the motor **58***b* to lower the shade **56** until the lower limit switch **62** is actuated. The switch **62** will disconnect the motor **58***b* from the power source and supply electrical energy to the motors **76** and **138**. The charging devices **88** will also be energized from the high voltage power supply **181**. The sheet **68** will now be pulled through the charging devices **88** so that the photoconductive layer on the sheet **68** is uniformly electrostatically charged.

The sheet **68** will be pulled between the belts **64** and **90** until the leading edge of the moving sheet **68** actuates the switch **82**. The clutch solenoid **80** will now be actuated so that the feed rollers **74** will cease to pull additional sheet material. The shear solenoid **86** will also be actuated by the switch **82**, and the sheet **68** will be cut and separated from the roll **66**. The sheet **68** will advance until its leading edge actuates the switch **128**. The motors **76** and **138** will now be disconnected and the timer **129**, preset to a predetermined exposure time, will now be actuated. Such actuation causes the timer solenoid **164** to open the normally closed switch **180** and permits the shutter **160** to open. Light from the lamp **24** will now expose the sheet **68** for a predetermined time in order to produce a latent charge image of the film **21** on the photoconductive surface of the sheet **68**. After the preset time of exposure, the timer **129** will cause the normally open switch **182** to close, the timer solenoid **164** will become de-energized, the normally closed switch **180** will now close and the shutter solenoid **162** will cause the shutter **160** to close.

The motors **76** and **138** will be energized again, through the switch **182**, and the sheet **68** will proceed along its predetermined path through the rear guides **120** and **122**, and thence between the belts **64** and **110**. When the leading edge of the sheet **68** actuates both of the switches **152** and **154**, the normally horizontally disposed magnets **144** will be rotated 90° to a vertical position by means of the rotary solenoid **150**. This will cause the mixture **134** of magnetic carrier and toner to be attracted to the charged surface of the sheet **68**. It is also noted that the closing of the switch **154** will cause the heater coil **156**, within the heater-blower mechanism **157**, to heat up. Thus, when the trailing edge of the sheet **68** leaves the switch **152** the rotary solenoid **150** is de-energized, the magnets **144** will again assume a horizontally disposed position.

When the sheet **68** passes over the heater **156**, the toner that has adhered to the latent charged image is fused to the sheet **68**. When the trailing edge of the sheet **68** leaves the switch **158**, the heater **156** is shut off and the sheet **68** is discharged onto the exit plate **124** as a finished electrophotographic reproduction.

Referring to Fig. 3, there are shown alternative means to the rotary solenoid **150** for rotating the magnets **144** through an angle of 90°. A solenoid **150***a* is connected to one end of a lever arm **184**. The other end of the lever arm **184** is fixed to one of the pivots **148**. It will now be understood that actuating the solenoid **150***a* will cause the rectangular frame **146**, containing the magnets **144**, to be rotated through an angle of 90°, from a normally horizontal position to a vertical position.

What is claimed is:

1. In apparatus of the type wherein a sheet of photoconductive material has been uniformly electrically charged and exposed to a light image to provide a charge pattern on said sheet, means to develop said charge pattern comprising a source for a developer mixture, said mixture comprising a toner powder and magnetic particles, magnetic field producing means spaced apart from said source, means to move said sheet along a predetermined path between said source and said magnetic field producing means with its exposed surface exposed to said mixture in spaced relationship thereto, means actuated by the leading edge of said moving sheet to intensify said magnetic field in the region between said source and said charge pattern on said sheet to cause said mixture to contact said charge pattern and to develop said charge pattern, said last-mentioned means being actuated by the trailing edge of said moving sheet to diminish said magnetic field, heat producing means disposed along said path of movement of said sheet, and switching means actuated by the movement of said sheet to turn said heat on before said sheet passes said heat producing means and to turn said heat off after said sheet has passed said heat producing means.

2. In apparatus of the type for developing an electrostatic latent image on a sheet of material, a source for a mixture of toner and magnetic particles, means to develop a magnetic field adjacent said source, means to move said sheet over said source with said image adjacent thereto and between said source and said magnetic field developing means, means in the path of movement of said sheet including a switch connected to said magnetic field developing means and actuated by the movement of said sheet for producing a strong magnetic field adjacent said sheet whereby to attract said mixture to said latent image to develop said latent image, said last-mentioned means comprising means to diminish said magnetic field when said sheet has moved away from said source.

3. Apparatus for developing a latent electrostatic image on a record receiving member through the use of a developer mix including carrier particles of magnetic material intermixed with electroscopic developer powder, said apparatus comprising a source for said developer mix, magnetic field producing means for attracting said developer mix, means for supporting said magnetic field producing means for movement from an inoperative position to an operative position, means for moving said record receiving member along a path between said source and said magnetic field producing means, and means for moving said magnetic field producing means into said operative position to bring said developer mix into contact with said record receiving member.

4. Apparatus for developing an electrostatic image on one surface of a sheet with a finely divided toner; said apparatus comprising: a source for a mixture comprising said toner and magnetic carrier particles; magnetic field producing means spaced apart from said source; means for moving said sheet between said source and said magnetic field producing means; and means actuated by said moving sheet to intensify said magnetic field in the region between said source and said image on said sheet to attract said mixture to said sheet to develop said electrostatic image, said last named means being actuated to diminish said magnetic field in said region when said electrostatic image has been developed.

5. Apparatus for developing an electrostatic image on one surface of a sheet with a finely-divided toner; said apparatus comprising: a source for a mixture comprising said toner and magnetic carrier particles; magnetic field producing means spaced apart from said source; means for moving said sheet between said magnetic field producing means and said source with said one surface ex-

posed to said source; means associated with said magnetic field producing means and actuated by the leading edge of said sheet to initiate attraction of said mixture toward said one surface and actuated by the trailing edge of said sheet to terminate said attraction.

6. Apparatus for developing an electrostatic image on a sheet of material, said apparatus comprising: a source for a mixture of toner and magnetic particles, a plurality of similarly oriented magnets secured in a frame adjacent said source, means for moving said sheet along a path of travel between said source and said frame, means for rotating said frame from a first position wherein the poles of said magnets are aligned in parallel relation with respect to said path to a second position wherein said poles are aligned normal to said path, switching means for controlling rotation of said frame, said switching means being disposed along said path and actuated

by movement of said paper thereover to cause said frame to be maintained in said second position only while said sheet is between said source and said frame, said mixture being attracted to said electrostatic image and toner caused to adhere thereto while said frame is in said second position.

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