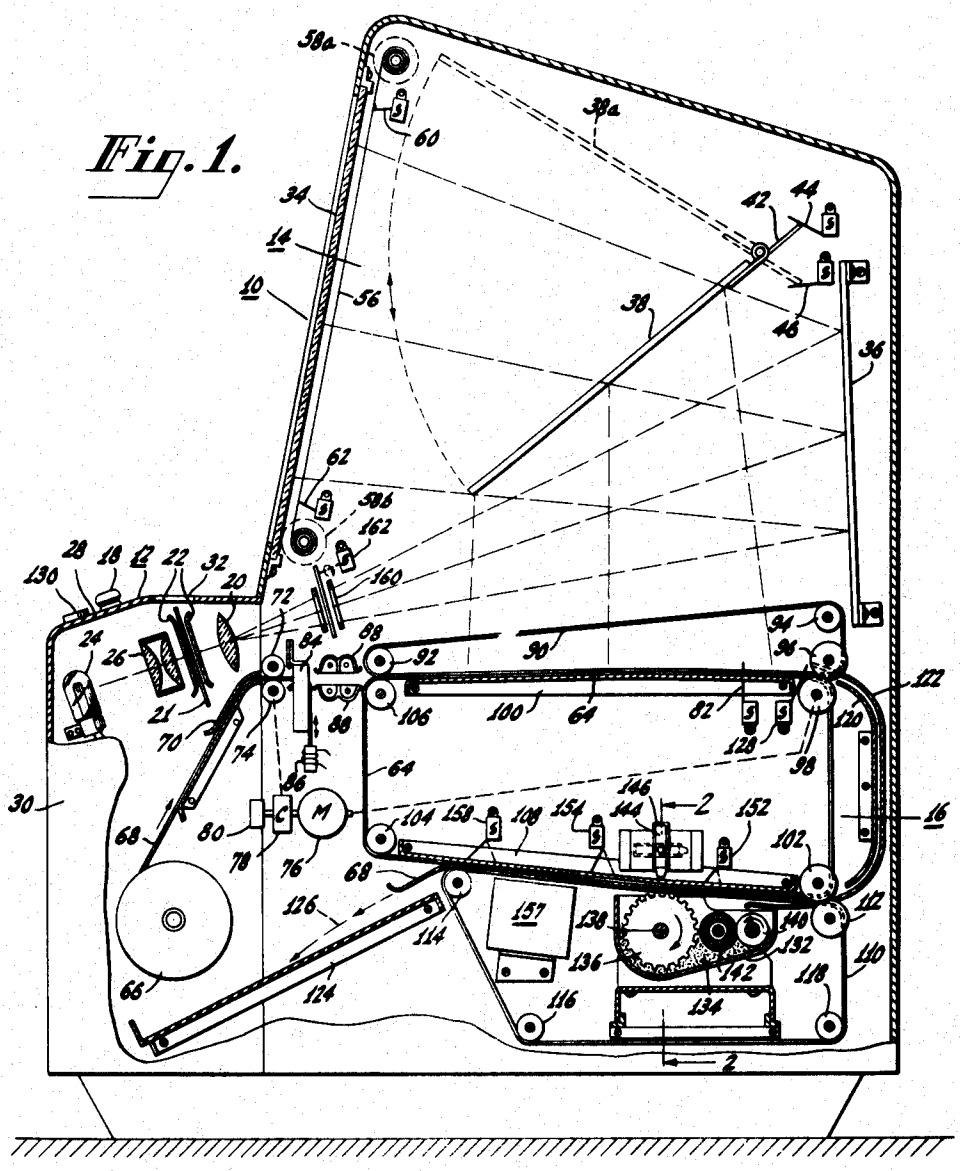
Oct. 3, 1961 H. G. REUTER, JR 3,002,434

FILM VIEWER AND REPRODUCER

Original Filed June 19, 1958 3 Sheets-Sheet 1

Fig. 1.



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Fig. 3.

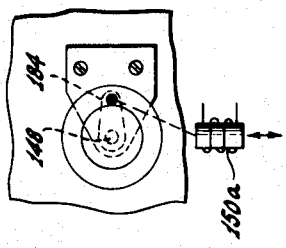


Fig. 2.

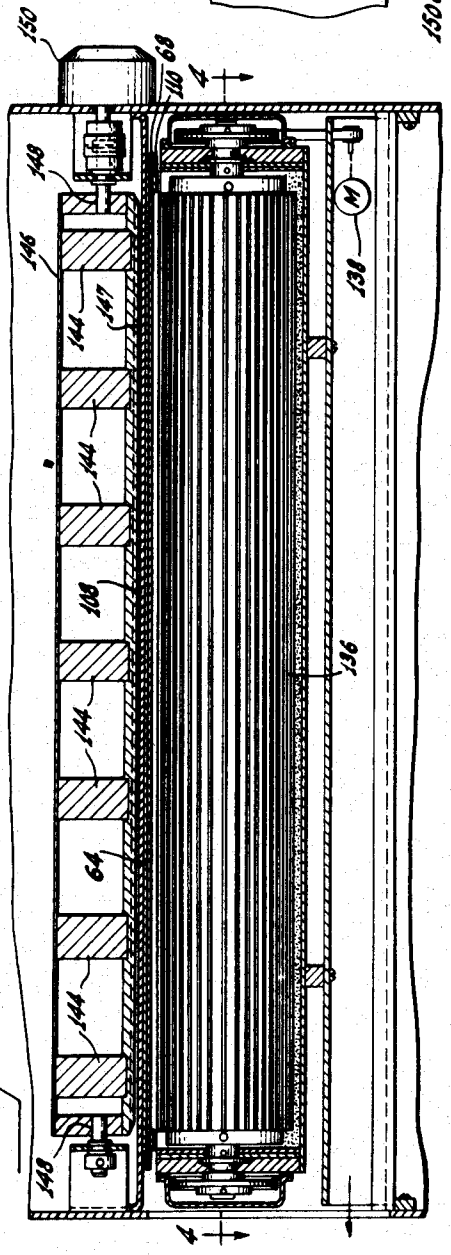
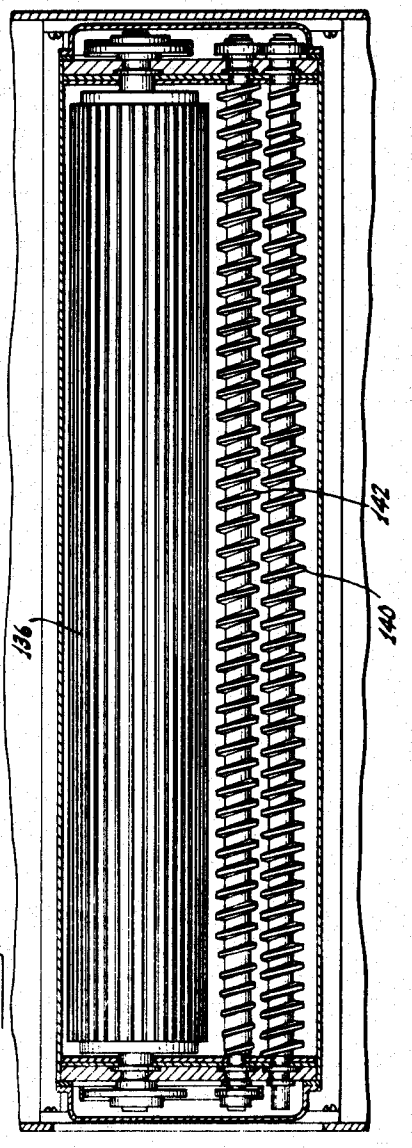


Fig. 4.



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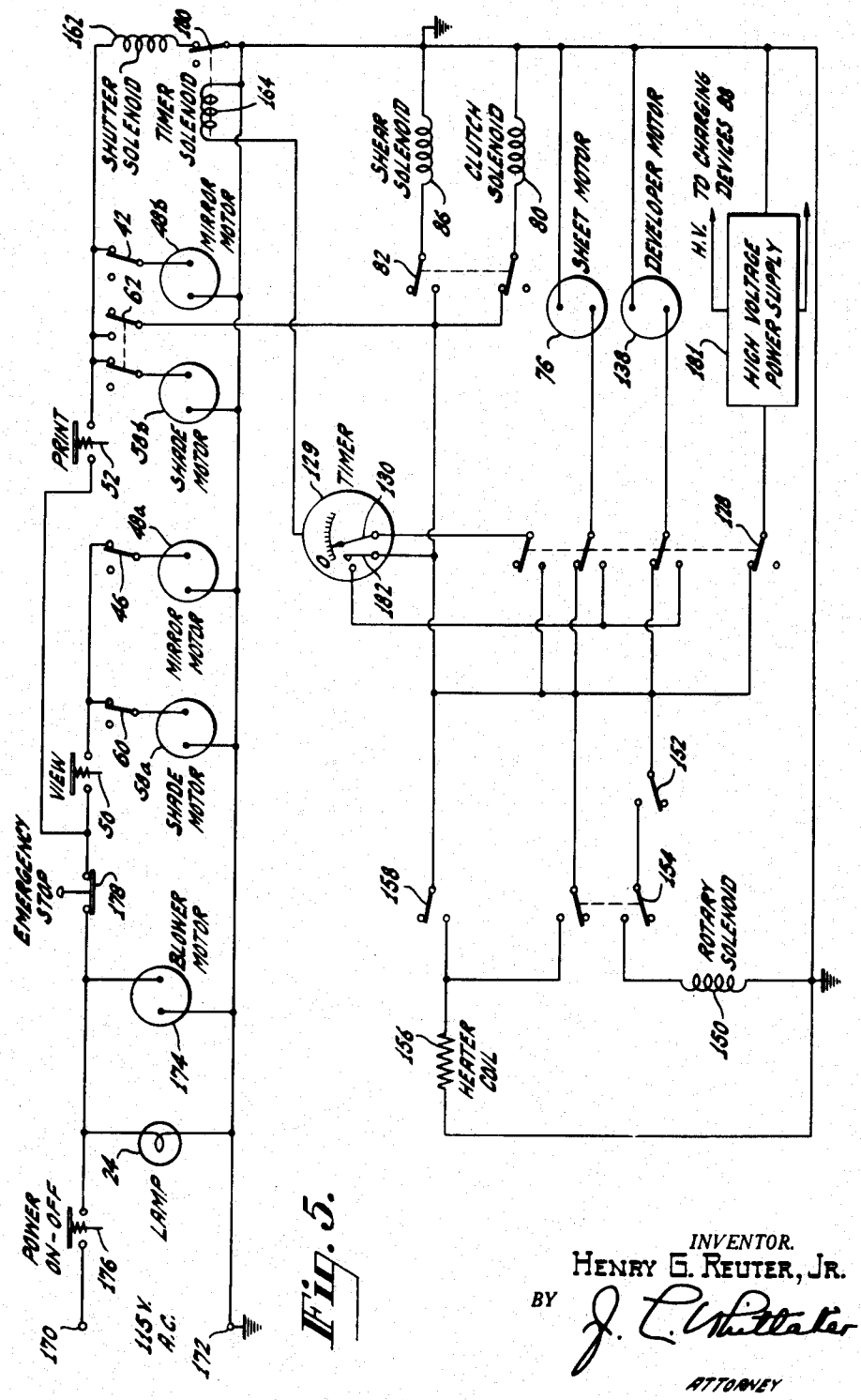


Fig. 5.

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3,002,434

FILM VIEWER AND REPRODUCER

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Original application June 19, 1958, Ser. No. 743,145. Divided and this application July 28, 1960, Ser. No. 45,925

9 Claims. (Cl. 95—1.7)

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. This application is a division of my copending application Serial No. 743,145 filed June 19, 1958.

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 accompanying 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 power, 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 actuate 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 **50** 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. Apparatus for reproducing an image on a photosensitive sheet comprising means for advancing said sheet along a predetermined path, means for projecting a radiant image onto said sheet at a first station along said path, means adjacent said first station actuated by movement of said sheet to stop said sheet at said first station for a time to expose said sheet and produce thereon a latent image, and developing means adjacent a second station along said path, said developing means including means actuated by movement of said sheet to cause said developer means to produce a visible image from said latent image.

2. Apparatus for reproducing an image on a sheet of material having a photosensitive layer thereon comprising means to advance said sheet along a predetermined path, switching means adjacent a station along said path, means to project said image onto said sheet at said station, means including said switching means actuated by the movement of said sheet thereover to stop said sheet for a time to expose said sheet with said image whereby to produce a latent image on said photosensitive layer, and developing means adjacent another station along said path, said developing means including switching means actuated by the movement of said sheet for developing said latent image thereon.

3. Apparatus for reproducing an image on a sheet having a photosensitive layer thereon, said apparatus comprising means to feed said sheet along a predetermined path, means to project said image to a first station along said path, timing means, means actuated by the movement of said sheet to stop said sheet at said first station and to expose said sheet with said image for a predetermined time fixed by said timing means, developer means including a source of developer material at a second station at one side of and adjacent to said path, means actuated by the movement of said sheet past said developer means to cause said developer means to contact said developer material to said photosensitive layer only when said sheet passes over said source, fixing means adjacent a third station along said path, and means actuated by the movement of said sheet to start operation of said fixing means by the time said sheet has reached said third station, said last-mentioned means being connected to stop operation of said fixing means when said sheet has passed said third station.

4. Apparatus for reproducing an image on a sheet of material having a photosensitive layer thereon, means to advance said sheet along a predetermined path, first switching means adjacent a first station along said path, means to project said image onto said sheet at said first station, said first switching means being actuated by the movement of said sheet thereover to stop said sheet for a time to expose said sheet to said image whereby to produce a latent image on said sheet, developing means adjacent a second station along said path, said developing means including second switching means actuated by the movement of said sheet thereover for developing a latent image thereon, a fixing mechanism adjacent a third station along said path, and third switching means actuated by movement of said sheet thereover, said third switching means being connected to said fixing mechanism to operate said mechanism in response to said movement of said sheet over said third switching means.

5. Photographic apparatus comprising means for moving an elongated strip of photosensitive sheet material along a predetermined path, means actuated by the movement of said strip to cut from said strip a sheet having a predetermined size, means to continue movement of said sheet along said predetermined path, means to expose said sheet to a light image for a predetermined time to form a latent image on said sheet, developer means positioned adjacent said path, means actuated by the leading edge of said moving sheet to initiate operation of said developer means to produce a visible image from

said latent image on said sheet, said last-mentioned means being actuated by the trailing edge of said moving sheet to stop operation of said developer means, and means actuated by further movement of said sheet to fix said visible image.

6. Apparatus for reproducing an image on a sheet of material having a photoconductive layer thereon comprising means to advance said sheet along a predetermined path, means to charge said sheet electrostatically adjacent a first station along said path, a first switching means adjacent a second station along said path, means to project said image onto said sheet at said station, means including said first switching means actuated by the movement of said sheet thereover to stop said sheet for the time necessary to expose said sheet with said image whereby to produce a latent electrostatic image on said photoconductive layer, and developing means adjacent a third station along said path, said developing means including switching means actuated by the movement of said sheet for developing said latent image thereon.

7. Apparatus for reproducing an image on a sheet having a photoconductive layer thereon, said apparatus comprising means to feed said sheet along a predetermined path, means to project said image to a first station along said path, timing means, means actuated by the movement of said sheet to stop said sheet at said first station and to expose said sheet to said image for a predetermined time fixed by said timing means, a source for a mixture of toner and magnetic particles at a second station at one side of and adjacent to said path, magnetic field producing means on the other side of said path opposite to said source, means actuated by the movement of said sheet between said source and said magnetic field producing means to increase said magnetic field adjacent to said sheet whereby to attract said mixture to said photoconductive layer only when said sheet passes over said mixture, heater means adjacent a third station along said path, and means actuated by the movement of said sheet to turn on said heater before said sheet has reached said third station, said last-mentioned means being actuated by the movement of said sheet to turn off said heater when said sheet has passed said third station.

8. Apparatus for reproducing an image on a sheet of material having a photoconductive layer thereon, means to advance said sheet along a predetermined path, means to charge said sheet electrostatically adjacent a first station along said path, a first switching means adjacent a second station along said path, means to project said image onto said sheet at said second station, said first switching means being actuated by the movement of said sheet thereover to stop said sheet for the time necessary to expose said sheet to said image whereby to produce a latent electrostatic image on said photoconductive layer, developing means adjacent a third station along said path, said developing means including second switching means actuated by the movement of said sheet thereover to cause development of said latent image thereon, a heater-blower mechanism adjacent a fourth station along said path, and third switching means actuated by movement of said sheet thereover, said third switching means being connected to said heater-blower mechanism to operate said heater in response to said movement of said sheet over said third switching means.

9. Electrophotographic apparatus comprising means for moving an elongated strip of photoconductive sheet material along a predetermined path, means for charging said strip positioned adjacent said path and actuated by the movement of said strip, means actuated by the movement of said strip to cut from said strip a sheet having a predetermined size, means to continue movement of said sheet along said predetermined path, means to expose said sheet to a light image for a predetermined time to form an electrostatic image on said sheet, magnetic field producing means, a source for a mixture of toner and magnetic particles, said path lying between said magnetic field producing means and said source, means actuated by the leading edge of said moving sheet to cause said magnetic field to increase in intensity in the region between said source and said image on said sheet and attract said mixture into contact with said sheet, said last-mentioned means being actuated by the trailing edge of said moving sheet to cause said magnetic field to diminish in intensity thereby terminating said attraction, and means actuated by further movement of said sheet along said path to fuse toner from said mixture onto said electrostatic image on said sheet.

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