

[54] **ELECTROSTATIC EXPOSURE TIME CONTROL**

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[58] Field of Search.....**355/3, 67, 69, 8, 14**

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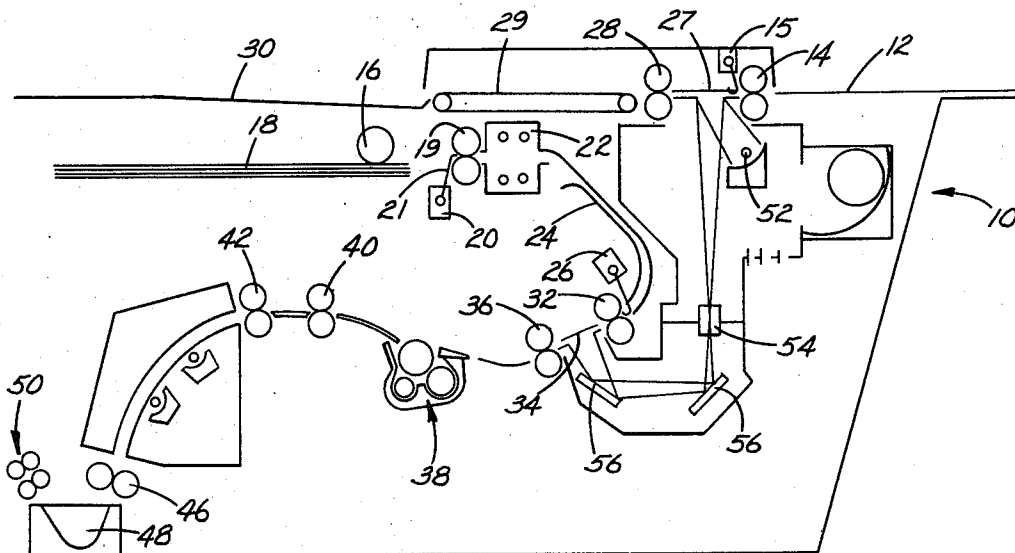
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[57] **ABSTRACT**

A copy sheet is driven from a supply stack through an electrostatic charging unit, and moved a substantial distance in a path to an exposure station. Mechanical detecting switches projecting into that path are avoided by using a solid state timing circuit which is activated with the charging unit to turn the exposure light on and off at the proper exposure time, and thus avoid the need for the light to be operating for excessively long periods of time.

3 Claims, 3 Drawing Figures



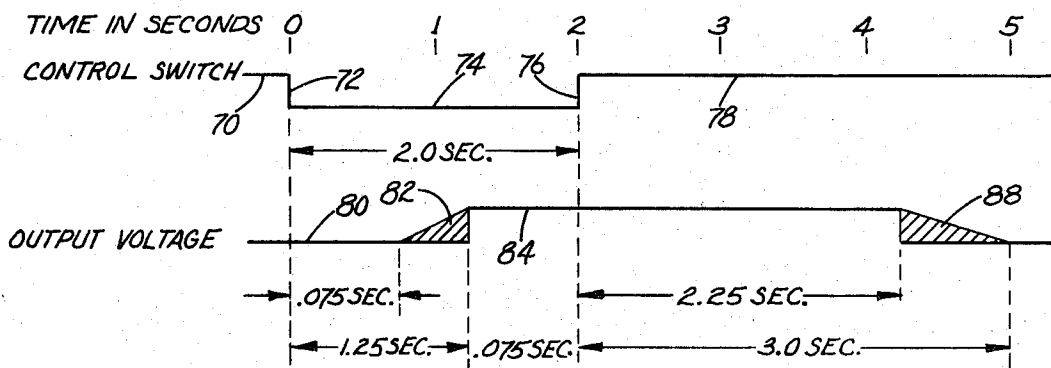
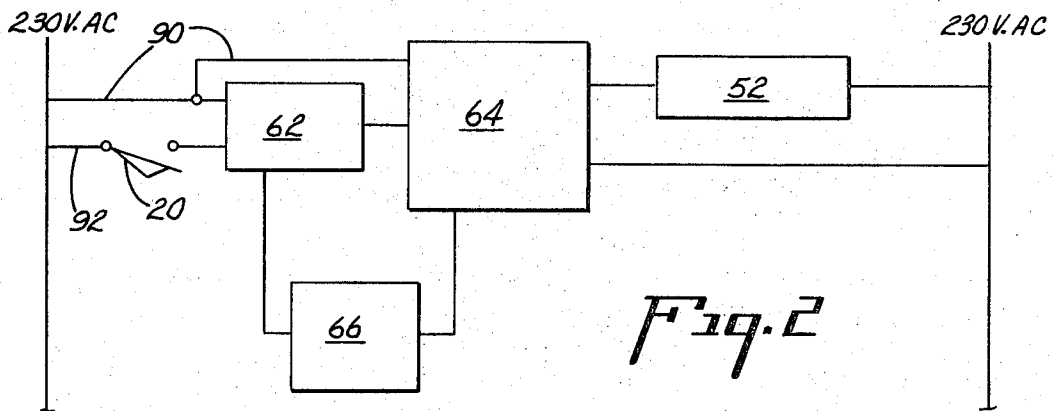
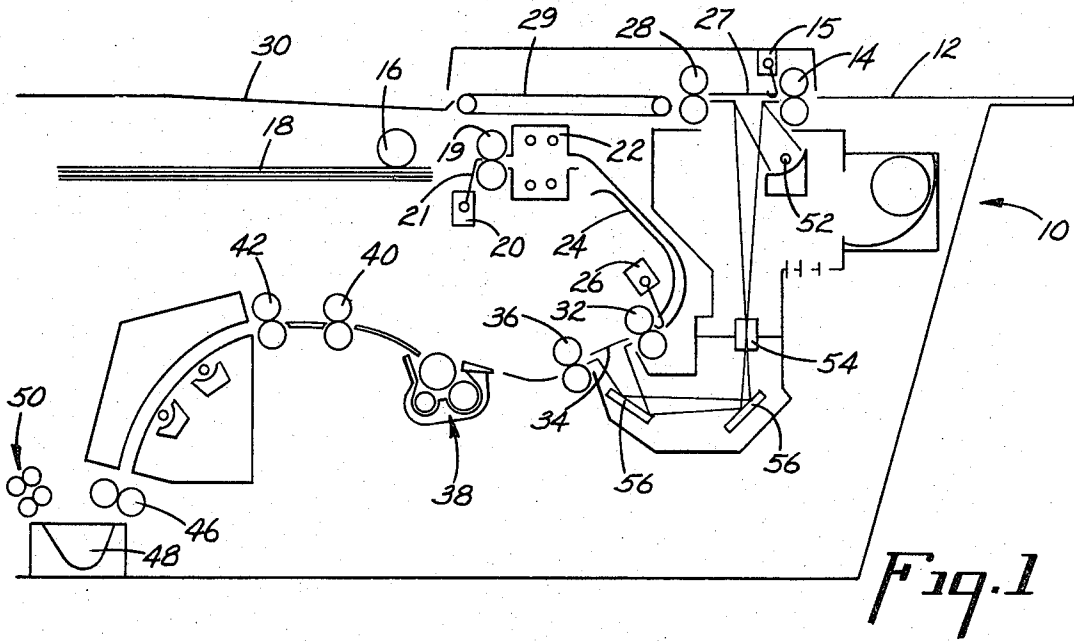


Fig. 3

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ELECTROSTATIC EXPOSURE TIME CONTROL

BACKGROUND OF THE INVENTION

Electrostatic duplicator and copying machines are being refined and developed to a high degree of reliability. As the refinement continues, it generally requires higher intensity lamp power for proper illumination of an original document being copied. High intensity lamps produce considerable heat output which causes additional problems of removing the heat from the machine cabinet in order to prevent high temperature malfunction of supplies and structure. Copy machines are becoming extremely popular for producing multiple copies of documents. As a result, it often occurs that the machine is called upon to accept original documents in rapid sequence and, consequently, the illuminating lamp is called upon to be in operation at maximum intensity for a considerable period of time. Any reduction of the lamp time, even a reduction in fractional seconds, is a distinct benefit to the machine per se, and additionally reduces power consumption and the necessity of extracting the excess heat by air conditioning equipment in modern office environments.

Accordingly there is every reason to reduce lamp operation time to just that period of time when the lamp is actually needed to illuminate an original document being scanned by the equipment for production of a copy.

Whenever the copy sheet of such a machine must traverse a relatively long path it is highly desirable that there be no obstructions in that path. A switch, even of the most delicate nature, is an obstruction which is a potential source of trouble. Furthermore, switches are subject to malfunction and the finding of the malfunction switch and its replacement is a source of potential service requirement and down time for the machine. In short, the elimination of switches from the path of travel for a charged electrostatic copy sheet is desirable.

The original copy machines did not require a switch in the path of the copy sheet because the illuminating source was simply energized when the original document was inserted, and stayed energized until the copy sheet was fully processed. The heat build up as such machines became more popular and used more frequently necessitated a consideration of the lamp time reduction.

Photocell and other detector systems are available, but expensive.

SUMMARY OF THE INVENTION

It is an advantage of this invention that an electrostatic copy sheet may be uniformly charged and transported to an exposure station with no switch or other sensing devices required between the charging and the exposure station until the exposure station is reached.

It is an object of this invention to eliminate the need for multiple numbers of sensing devices in the transportation conveyor of an electrostatic copy making machine.

It is an advantage of this invention, and a principal object, that in a copy machine the illumination lamp of high intensity is employed for a minimum effective operating time without the use of switches or sensing devices to sense the presence of the sheet along its route of travel.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic illustration of a master making portion in a copy duplicator machine of well known construction;

FIG. 2 is a schematic illustration of electronic circuitry which enables the elimination of at least two switches or switch means which would otherwise be required;

FIG. 3 is a time line diagram of the switch operation by the device of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 is a schematic representation of a successful commercial embodiment of a copy duplicating machine which produces electrostatic masters in reverse image of an original document, and processes that master through a conversion station, and then mechanically installs the master onto a direct lithographic printing head and produces lithographic copies in ink on bond paper.

Such a machine is highly popular and is used by one person after another when installed in an office or engineering department, and were it not for the limiting of the lamp "on" time to a minimum effective operating time, the heat build up within the machine would be intolerable.

The outer casing of the machine is indicated by the reference character 10, and is simply a decorative enclosure. However, that enclosure compounds the problem of heat build up. Nevertheless, machines of this nature are not acceptable in an office environment without a decorative enclosure.

An original document to be copied is placed on a table 12 and pushed to the nip of a set of rollers 14, where the activating arm of a switch 15 is encountered. The electrical circuitry which is operated by the switch 15 is conventional and is not illustrated. The switch 15, when thus activated by the original document causes a roller 16 to drive a master from the top of a master stack 18 forward from the stack into the nip of a pair of feed rollers 19. Rollers 19 have a central recess groove in order that a switch 20 may be positioned with the switch arm 21 thereof extending into the path of the master such that the master will strike the actuating arm 21 just as it enters the nip of the drive rollers 19. Striking the arm 21 will cause the switch 20 to activate several cooperating functions simultaneously. One is to shut off the drive to the roller 16 in order that no further masters will be fed from the stack until properly called for. Once the master has reached the nip of the rollers 19, drive is no longer required of the drive roller 16.

One of the functions commenced by the switch 20 is the energization of a corona charging unit 22. The master fed from the stack 18 is caused to traverse the corona charging unit and thus takes on a uniform electrostatic charge on its surface in the manner well known to electrostatic copy procedures.

A guide cage 24 will cause the master to turn and proceed to an exposure station under the drive of the feed rollers 19. The guide cage 24 and the drive created by the drive rollers 19 may be referred to as a sheet conveyor means for transporting a sheet of photosensitive material in a path from its source to the terminal,

which is the exposure station. Whereas it is conceivable that the drive from the conveyor means would be irregular, it is the intent of the preferred embodiment to feed the master at a uniform rate. Hence the drive rollers 19 turn at a uniform rate and move the master sheet to its destination at a uniform rate. In the illustrated embodiment, the distances are based upon a master travel rate of 7 inches per second. This speed is found to allow a proper charging of the master and a proper exposure time at a later exposure station. It is an arbitrary figure but one which is very proper and acceptable in the illustrated embodiment.

There are no switches or other sensing devices between the switch 20 and a switch 26 positioned just at the entry of the exposure station. The switch 26 is activated by the arrival of the lead edge of the master and causes a clutch in the drive rollers 14 of the original document feed device to operate. The original document is then caused to traverse a viewing or object station 27 to an exit drive roll set 28 at a known uniform rate of speed. The document is caused to enter the nip of roll set 28, which is also driven at a uniform speed. Thus, the document is pushed across the station 27 and then picked up and pulled across that station all at a uniform rate of speed. A conveyor 29 accepts the original document and transfers it to a table 30 where it can be recovered without having been exposed to any danger of mutilation.

In the meantime, the charged master is caused to enter into the nip of feed rollers 32 at the exposure station and to traverse an object exposure station 34 into the nip of a set of drive rollers 36. The rate of travel of the rollers 32 and 36 is identical to the rate of travel of the rollers 14 and 28, and the location of the switch 26 is such that the original document is caused to feed across the station 27 at the same time and in coordination with the travel of the master across the exposure station 34.

The master, after being exposed to a pattern of light and shadow in accordance with the original document, is processed through a conventional toner station 38 and driven by sets of rollers 40 and 42 into a fuser station, whereafter rollers 46 pick up the fused master and cause it to be converted in a conversion solution bath 48 and further driven onto a transport conveyor by means of rollers 50.

A high intensity lamp 52 is reflected onto the bottom of the object plane 27 in order that the image may be focused by a lens 54, with the aid of mirrors 56 onto the exposure station plane 34.

In order to achieve a minimum lamp usage by the use of switches, it would be necessary to place a switch in the conveyor guide 24 ahead of switch 26 a distance sufficient to assure the lamp 52 reaching peak operating capacity, and then another switch between the drive rollers 36 and the toner 38 to keep the lamps on for a period of time to assure that the master has completely left the exposure station. Otherwise, the lamp would have to be on the entire time from the beginning of the master feeding operation. But placing two extra switches in this conveyor path presents two additional service deterioration problems, and each switch that can be eliminated eliminates a mathematical probability of failure.

According to this invention a minimum effective operating time is achieved by the circuitry which is represented schematically in the FIG. 2. Because the selected components in FIG. 2 may be of selection and composition according to the desires of a particular engineer designer, within limits, and because such operating construction can be achieved, and literally was achieved, by giving objectives to a supply manufacturer, only the symbolic block symbols are used to show the electronic circuitry. The control includes a time delay control circuitry activated by the sensing means switch 20. This control circuitry is indicated by the box unit 62 and is referred to as a "first" time delay. The symbolic unit 64 includes a voltage regulator to provide approximately 180 volts to the lamp 52. The lamp and appropriate controls constitute the light source for the exposure station. The unit 62 is sometimes referred to as a time delay "on" circuit, because it is constituted to receive an energization signal from the switch 20, and then to delay a particular period of time before energizing the voltage regulator in the unit 64. Therefore, the unit 62 causes the lamp to become energized at a predetermined period of time after encounter of the sensing means switch 20 registering the presence of the master sheet.

The delay of energization of the lamp is provided in order that the master may traverse the distance between the drive rollers 19 and the switch 26 without the necessity of the lamp being energized. Because the particular illustrated embodiment of a photocopying machine employs a 14 inch long master, and the speed of travel is 7 inches per second, the time necessary to travel from the drive rollers 19 to the drive rollers 32 is exactly 2 seconds. Therefore, the unit 62 is designed to delay operation of the voltage regulator for 0.75 seconds, and then the lamp 52 requires an additional 0.50 seconds for reaching operating capacity. Therefore, there is an effective delay of 1.25 seconds before the lamp reaches full operating capacity. Then, the lamp operates for 0.75 seconds before the master reaches the exposure station in order to provide a margin of safety to assure against the master reaching the exposure station before the lamp is fully operable. The lamp continues to remain fully energized for a period of 2.25 seconds thereafter, which is a longer period of time than necessary for the master to traverse the exposure station, again assuring full lamp operation during the exposure period of time.

Refer to FIG. 3 of the drawings. Here a time line relationship is shown wherein a period of 5 seconds is depicted. Line 70 represents the normal condition of the master sense switch 20. See this switch in both FIGS. 1 and 2. At zero time, the master is sensed by the switch 20, and the shoulder line 72 represents that change in condition of switch 20. Line 74 depicts the condition of the switch for the 2 second period of time that a 14 inch master requires to traverse the switch position while traveling 7 inches per second. Then, the end of the master having passed the position of the switch 20, shoulder 76 depicts the return of the switch to its normal condition, and line 78 represents the fact that switch 20 stays in that condition throughout the balance of the interval of time that one particular master is being processed.

Then, the line 80 indicates the voltage condition as applied to the lamp 52. When the switch 20 is activated by the master arrival, power from a 230 volt source is passed through the switch 20 to the time delay circuit 62 which is designed to transmit full power after a period of 0.75 seconds. Note in FIG. 2 that there is a power line 90 connected directly to the time delay 62, and also to the voltage regulator 64. Power to the time delay 62 provides the operative power for the time delay circuitry. Then, a line 92 supplies power for the lamp operation. Power through line 92 is that which is timed by the time delay unit 62. At the end of 0.75 seconds, power is allowed to pass through the unit 62 to voltage regulator 64 and on to the exposure lamp 52. In FIG. 3, the area indicated by reference numeral 82 indicates the 0.5 second period of time necessary for the lamp to reach full operating capacity. Then, the lamp remains at full capacity for 0.75 seconds indicated by line 84 prior to arrival of the master.

When the time delay unit 62 is activated by switch 20, power is immediately supplied to a time delay 66, which begins timing a cancellation of power through voltage regulator 64 to the lamp 52. Unit 66 becomes operative to turn the power off from the regulator 64 to the lamp 52, 4.25 seconds after original activation of the switch 20. Thus the power begins to fade from the lamp 52 as indicated by the reference numeral 88. However, before the power decay indicated by line 88 can take place, there is more than sufficient time for the master to have traversed the exposure station. Therefore, although the lamp is actually on power at full illumination for a period greater than the minimum 2 seconds required for a master to traverse the exposure station, it is nevertheless on for a minimum period of time commensurate with good engineering safety limits. Furthermore, it is turned on, is held at capacity, and is then turned off without the need for any switch devices and using solid state circuitry which is contained in a completely separate unit. That unit is advantageously removable and replaceable as a plug-in unit, and therefore enables rapid restoration of service in the event of any failure. It is also well known that solid state circuitry is a longer lived type of regulation device than mechanically activated switches. Therefore, such a timing unit as illustrated in FIG. 2 will produce fewer service maintenance calls than comparable switch devices.

What is claimed is:

1. Apparatus for forming an electrostatic charge in a pattern on a sheet, comprising:

charging means for forming an electrostatic charge on sheet material;

first drive means for placing a sheet in charge receiving relationship to said charging means;

second drive means spaced a distance from said first drive means a distance greater than one half the length of a sheet to be serviced;

guide means for directing a sheet from said first to second drive means;

sensing means adjacent said first drive means for detecting the arrival of a sheet at said first drive means;

an exposure station located beyond said second drive means on the side of said second drive means opposite said first drive means, and means including

a light source for exposing a transported sheet to a pattern of light and shadow;

a first time delay control circuitry activated by said sensing means, a lamp and appropriate controls constituting said light source in said exposure station, said first time delay control circuitry causing said lamp to become energized a predetermined period of time after encounter of said sensing means by a sheet;

a second time delay control circuitry activated by said sensing means, said second time delay control circuitry causing said lamp to become deenergized a predetermined period of time greater than that of said first time delay after encounter of said sensing means by the sheet;

said period of time said lamp is energized being a minimum effective operating time;

whereby the sheet is fully exposed in the exposure station with a minimum of heat build up.

2. In a photocopying machine having a supply of photosensitive material and means for transporting sheets of said material into an exposure station wherein it is exposed to a pattern of light and shadow, the improvement in the control of a light source in said exposure station comprising:

a sheet conveyor means for transporting a sheet of said photosensitive material in a path from a sheet supply to an exposure station at a known rate of travel;

a sensing means in said path between said sheet supply and exposure station for sensing the arrival of a leading edge of a sheet;

a first time delay control circuitry activated by said sensing means, a lamp and appropriate controls constituting said light source in said exposure station, said first time delay control circuitry causing said lamp to become energized a predetermined period of time after encounter of said sensing means by a sheet;

a second time delay control circuitry activated by said sensing means, said second time delay control circuitry causing said lamp to become deenergized a predetermined period of time greater than that of said first time delay after encounter of said sensing means by the sheet;

said period of time said lamp is energized being a minimum effective operating time;

whereby the sheet is fully exposed in the exposure station with a minimum heat build up.

3. In a photocopying machine having a supply of photosensitive material and means for transporting sheets of said material into an exposure station wherein it is exposed to a pattern of light and shadow, the improvement in the control of a light source in said exposure station comprising:

a sheet conveyor means for transporting a sheet of said photosensitive material in a path from a sheet supply to the exposure station at a known rate of travel;

a sensing means in said path between said sheet supply and exposure station for sensing the arrival of a leading edge of a sheet;

a first time delay control circuitry activated by said sensing means, a lamp and appropriate controls constituting said light source in said exposure sta-

tion, said first time delay control circuitry causing said lamp to become energized a predetermined period of time after encounter of said sensing means by a sheet;
a second time delay control circuitry activated by said sensing means, said second time delay control circuitry causing said lamp to become deenergized a predetermined period of time after encounter of said sensing means by the sheet;
said first period of time before energizing said lamp being related to said conveyor means speed rate to

delay the lamp energization with substantially only sufficient time for stabilization at full output prior to said arrival at said exposure station; and
said second period of time before deenergization by said second time delay control circuitry being related to said conveyor speed to hold said lamp at full output until the sheet has fully traversed said station with a further period of time to assure against premature deenergization.

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