CONTROL LOGIC FOR TROUBLE DETECTION AND RECOVERY

Inventor: Louis J. Fantozzi, Penfield, N.Y.
Assignee: Xerox Corporation, Stamford, Conn.
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ABSTRACT

In a copier/duplicator machine, an improved control circuitry is provided for handling the situations involving the interruption of the machine operation. The circuitry includes means for detecting abnormal conditions such as jamming, or paper supply run out conditions during a copy run for a predetermined number of copies and means for maintaining the integrity of the counts of the copies being made according to a differentiated billing schedule notwithstanding the interruptions of the machine operation during the copy run. In addition, the circuitry includes means for detecting paper run out conditions artificially induced to tamper with the differential billing meters and means to stop the machine and condition the billing meters so that they are returned to higher billing mode.

11 Claims, 27 Drawing Figures
FIG. 9A
### FIG. 10

<table>
<thead>
<tr>
<th>Normal Operation</th>
<th>Print Button Not Pressed</th>
<th>Interlock Open</th>
<th>Interlock Closed &amp; Print Button Pressed</th>
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### FIG. 11
CONTROL LOGIC FOR TROUBLE DETECTION AND RECOVERY

BACKGROUND OF THE INVENTION

This invention relates to a control circuitry for a machine and more particularly to an improved electronic control circuitry for a copier/duplicator apparatus. Copier/duplicator apparatuses based on a principle discovered by Chester F. Carlson as described in the U.S. Pat. No. 2,297,691 have become an important part of tools used in daily activities of business. With the advancing technology in the copier/duplicator art, and more sophisticated functions have been introduced to the basic machine to automate and enhance its functions. The increasing sophistication and complexity demanded by the more advanced copier/duplicator apparatus has resulted in the need for a more precise, reliable and faster control circuitry for controlling the operation of various machine elements of the apparatus and synthesizing various diverse machine functions.

One of such functions is a differentiated billing scheme provided in the machine which is designed to charge the customers for the use of the machine wherein when a fewer number of copies is made per start-up or copy run than a certain break point number, then the charge per copy is more than that charged when the number of copies made per copy run exceeds the break point. In such a situation it is desirable that the integrity of the total copy count as well as the differentiated copy count is maintained so that the customer is not charged for a higher billing rate. This especially the case where the machine operation is interrupted in the middle of a copy run after a start-up wherein the interruptions may occur due to any number of conditions such as jamming of the paper, running out of the paper supply or tampering with the differentiated billing meters.

SUMMARY OF THE INVENTION

It is a general object of the present invention to provide an improved control circuitry in a reproducing machine.

It is a further object of the present invention to provide an improved control circuitry for use in combination with jam detection means in a copier/duplicator apparatus.

It is another object of the present invention to provide an improved logic control circuitry for use in combination with an out-of-paper supply detection means in a copier-duplicator apparatus.

It is still another object of the present invention to provide an improved control circuitry for use in combination with any combination of jam or out-of-paper supply conditions and tampering with the counting means provided in a copier/duplicator apparatus.

It is still another object of the present invention to provide an improved control circuitry for maintaining the integrity of the copy counts of the copies made notwithstanding the interruption of the machine after a start-up but before the copying operation of a predetermined number of copies set by the operator is completed.

It is a further object of the present invention to provide an improved circuitry that maintains the integrity of copy count in a differentiated billing means in a copier duplicator apparatus in spite of an interruption of the copying operation during the copy run.

The foregoing and other objects of the present invention are achieved, in accordance with the present invention, by providing means in the control circuitry for stopping the copy counting means from counting when the machine operation stops due to a jam or an out-of-paper supply condition and means enabling the counter means to resume the count after the trouble conditions are removed and the copying operation is re-started and means for assuring that the copy count is correctly made in spite of the interruption.

A feature of the present invention resides in the provision of means for maintaining the integrity of the copy counts in a differentiated billing meters of the copier/duplicator apparatus.

Another feature of the present invention is in the provision of means in the control circuitry which actuates the counting means to count up to and including the count corresponding to a jam condition causing an additional erroneous count, means for prohibiting the counting means from counting the first copy made by the apparatus after the trouble condition is cleared and the apparatus is re-started to complete the copy run.

Still another feature of the present invention is in the provision of means which detects and differentiates whether or not the out-of-paper supply condition during a copy run is due to the tampering with the paper supply as opposed to the condition where the running out of paper supply actually occurs.

The foregoing and other objects and features of the present invention may be more clearly understood from the detailed description of the illustrative embodiments of the present invention herein below described in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a perspective view of a copier/duplicator machine in which the control circuitry of the present invention may be used.

FIG. 2 shows schematically the operative elements involved in a xerographic copier/duplicator apparatus which may be a part of the machine shown in FIG. 1 and in conjunction with which the control circuitry of the present invention may be used.

FIG. 3 shows schematically a certain of the internal machine elements of the control circuitry of the present invention.

FIG. 4 shows a schematic drawing of an interlock switch shown in FIG. 3 which is used for turning off the power supply to certain parts of the apparatus so that the operator can open the machine safely to remove the jam condition.

FIG. 5 shows a schematic end view of a scanner used in a xerographic copier/duplicator apparatus shown in FIGS. 1-3.

FIG. 6 shows schematically various input and output signals which with the control circuitry interact and a grossly generalized block diagram showing major functional elements of the control circuitry.

FIGS. 7A-7C show certain type of circuits used in the control circuitry of the present invention.
FIGS. 8A-8C show an example of a timing signal generating circuitry used in the control circuitry. FIGS. 9A-9B when connected as shown in FIG. 10 show a detailed block diagram of the control circuitry of the present invention. FIG. 11 shows a truth table that is helpful to the understanding of the circuitry of the present invention in its jam mode of operation. FIGS. 12A-12D show timing wave forms involving the out-of-paper supply condition encountered by the control circuitry. FIGS. 13A-13G show timing wave forms that show the ability of the present control circuitry to discriminate the difference between the out-of-paper supply condition and tampering of the apparatus.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

In order to facilitate a better understanding of the control circuitry of the present invention, its operative environment will be described briefly in conjunction with a xerographic copier/duplicator machine, a perspective view of which is shown in FIG. 1. Referring to FIG. 2, the machine may be a xerographic apparatus of the type which includes a drum 1 having a photosensitive insulating outer layer 3 around which various operative elements such as a cleaning blade 4, charging corotron 9, means 10 including a scanning means 13 and an optic means 14 for applying a scanned image of an original 11 onto the photosensitive insulating layer and means 15 for applying toner particles to the photosensitive insulating layer, transfer corotron 17, a paper detack corotron 18, a pre-clean corotron 22 and detecting means 23 are positioned to provide their usual xerographic functions. In operation, as it is generally well known, these operative elements are used to charge the photosensitive insulating layer uniformly, imagewise expose it to form a latent electrostaticographic image in the layer, develop the image with toner particles and transfer the developed image onto a paper being advanced into engagement with the drum. The imageed paper is then removed and the image if heat fused onto the paper by a suitable means 26 and the paper is then forwarded into a receptacle 27.

The xerographic apparatus of the foregoing type generally includes a number of detecting means to indicate certain operative conditions. Thus, for example, as shown in FIG. 2, a suitable detecting means schematically designated as 31 is used to detect the paper jam condition as the paper advances through a path. The apparatus may also include means 23 to detect the paper still adhering to the drum in spite of the removal or detack step implemented by the detack corotron 18. More generally, the trouble condition may be the failure of the operative elements such as the scanning means 13 as it fails to complete its normal scan and retrace cycle during a copying operation. Referring to FIGS. 3 and 5 the trouble condition of the scanning means to complete its scanning and retrace operation may be detected as follows: The apparatus may include a scanning or homing switch 33 having a switching means. The switching means may include contacts 35 and 37 which closes momentarily at the beginning of each start of the scanning cycle as the scanning means 13 touches it momentarily (FIG. 5).

In accordance with an aspect of the present invention, the fact of the scanning means 13 closing and opening the homing switch at the regular time interval in synchronization with each scan cycle is utilized to key the timing signals for monitoring or controlling various elements of the control circuitry and thereby various operating elements of the machine. Thus, when the scanning means fails to close the homing switch 33 at the expected regular time interval, this is construed by the control circuitry as indicative of a trouble condition of the machine. Certain logical networks provided in the control circuitry then interprets the failure and interrupts the machine operation.

For convenience and for the reasons stated above, the paper jam condition or detack failure condition or, more generally, the failure of the scanning means will be lumped together and regarded as a jam condition of the apparatus in general. Thus, in the description hereinafter whenever a jam condition is mentioned, it is intended not only to cover the paper jam or the detack jam condition but also other inoperative or abnormal operations that result in the failure of the scanner to scan and retrace and thereby complete the scan cycle.

In the context of this application, a "copy run" refers to a complete cycle of starting the machine, running off a number of copies and shutting down the machine. In the context of the present apparatus, this means the operator turning the copy number selector dials to a number and pressing the print button and obtaining the number of copies. The machine shuts down automatically after the copy run.

Differentiated billing scheme referred to in this application refers to a suitable arrangement whereby record is made of the number of copies made in successive copy runs and different billing rate is applied for the copies based on the number of copies made per copy run. One such scheme is disclosed in a copending application Ser. No. 338,808 filed Mar. 21, 1973 and assigned to the same assignee. The scheme includes a number of billing meters. A first meter is used to record the total of the copies made in successive copy runs cumulatively. The second meter is used to record cumulatively the number of copies made up to a break point, for example, up to six copies. A third meter is used to record cumulatively the counts of the copies in excess of the break point, i.e., seven copies or more in the above example. Suitable billing rate is applied to the counts up to the first break point and a cheaper billing rate is applied for the counts above the break point.

The apparatus is provided with an interlock 41 (FIG. 3) for use by the operator to open the machine. The interlock includes an interlock switch 42 interposed between an AC power supply and certain parts of the machine so that the operator can safely open the machine to remove the troubled condition. Referring to FIG. 1, the operator console may include a number of manually operated push buttons such as a print button 51, a stop button 52 and a display window 54 where suitable information may be lit to provide visual indication of the machine conditions. The console may also include an arrangement 43 having a certain number of separate count dials such as dials 47 and 48 for decade and unit counts respectively that the operator can use in setting the machine in making the number of copies desired. The machine is also provided with a billing count display means having a plurality of meters 57, 58 and 59 associated with a differentiated billing arrangement of the machine.
The control circuitry of the present invention is designed to interact with various input and outputs mentioned above and various machine elements involved in the operation of the machine. Generally, as shown in FIG. 6, manual input signals to the control circuitry may include the start or print and stop signals 62 and 63 provided by the operator and a copy number signal 65 coming from the count dial. The control circuitry is designed also to interact with the signals indicative of trouble conditions and provide the appropriate output signals to the operator. For example, the machine may provide a trouble condition signal 66 indicative of the paper jam or detect a jam condition or the failure of the scanner to function properly, more generally, signifying the failure of the machine to function properly. Still another type of input signal for trouble condition is an out-of-paper supply signal 67 when the paper supply in the paper tray 68 (FIG. 1) runs out while the machine is in the process of making a predetermined number of copies set by the copy count dial. Still another type of input signal that the control circuitry interacts with is a signal 67 indicative of a tampering situation when an operator pulls down a lever (not shown) associated with the paper tray thereby simulating the out-of-paper supply condition to get the benefit of the lower reading of differentiated billing meters 57, 58 and 59.

Upon detection of the trouble conditions, the control circuitry of the present apparatus is designed to interrupt the machine operational cycle. During the interruption, the circuitry is designed to allow the machine to light up the visual indicating means 54 which may include separate lights identifying the types of trouble conditions, e.g., paper run out or jam condition. The apparatus is designed so that when the jam condition is detected, the operator must remove the jam condition and, when the out-of-paper supply condition is detected, he must replenish, before the control circuitry will permit restart of the machine. More specifically, in the jam condition the circuitry is so designed that the operator must open up the interlock latch 41 (FIG. 3), open the machine, remove the trouble condition, and then close. Only after this, will the machine re-start upon command or pressing of the print button. The control circuitry is designed so that during the interruption due to the jam and or the out of paper supply condition, energy will continue to be supplied to certain parts of the machine, such as the counting means 89 so that the count being in progress at the time of the interruption is not erased. This assures the integrity of the billing scheme.

There are a number of subsidiary features of the present control circuitry which will now be described in that their understanding will assist one in understanding the overall control circuitry. First of all, the control circuitry utilizes many logic elements arrayed in a number of logic networks. Many of the logic elements are shared by different logic networks. The logic elements may be of the conventional types such as AND, OR, and NAND gates and latch or flip flop circuits. They are used in a conventional manner. Some of the logic circuit, though shown as a single block as in FIG. 7A for convenience, is meant to include many conventional logic or circuit elements combined in a manner that provides specific functions described. FIGS. 7B and 7C illustrate other examples of the logic circuits. Thus, for example, an AC switch for switching AC power supply on and off XO motor, an optical coupler (light emitting diode and a photo-darlington transistor) and triac combination may be used advantageously as shown schematically in FIG. 7B. Such a circuit is disclosed in the copending application Ser. No. 344,321 filed on Mar. 8, 1973 by the present inventor and assigned to the same assignee. A light-emitting diode and photo-darlington transistor configuration may also be used to act as a photo-coupler between the various detecting elements such as jam sense or interlock sense and logic elements such as latch circuit or flip flop as illustrated in FIG. 7C.

Various pulse trains used as copy count pulses for the copies being made or for timing of the operations of certain of the logic networks and the like are provided by the timing signal generating means 82. In general, the timing signal generating means is designed to provide pulse trains the generation of which is keyed to the operation of the scan switch 33 and/or certain other circuit elements and time delayed by a predetermined amount from the operation of the keyed elements. FIG. 8A shows a illustrative example of a pulse generating means used in the timing signal generating means. It includes generally a binary counter made of a number of flip-flops a-h connected in a chain to count pulses from a timing clock source. For example, in generating copy count pulses (FIG. 8C) representing the number of the copies being made, the outputs a, c, d, and h from the Q leads of the first (a), third (c), fourth (d), and the last (h) flip-flops are applied to a NAND gate 101 to provide the pulses. In operation, all of the flip-flops a, b, c, d, e, f, g and h are reset each time by a scan pulse from the scan switch is applied. The flip-flops count the 60 Hz. clock pulses after each reset and generate Q pulse as a count pulse. The last two flip-flops g and h are also placed under the control of the jam signal applied to their reset leads via an OR gate 103 from a jam signal lead 104. The flip-flops are driven by the 60 Hz. clock and the outputs of the flip-flops a, b, c, d, e, f, g, and h switch to logical 1 when set in succession in response to the clock pulses. When a jam condition occurs, the jam detecting means detects this and applied the jam signal to the flip-flop g and h via the OR gate 103. In response, the flip-flops g and h are reset and remain clamped in the reset state as long as the jam signal continues. With h and g clamped by the on going jam signal the input h to the NAND gate 101 remains in logical 0. Hence, so long as the jam signal stays at the lead 104, the NAND gate 101 is prevented from generating a clock pulse, although the inputs a, c, and d become logical 1 as the 60 Hz. clock increments and sets the flip-flops a, c, and d.

The foregoing is illustrated in FIGS. 8B and 8C. Referring to FIGS. 8B-8C, after a warm up time Δw after the print button is pressed, the scanner 13 scans in succession at a regular time interval. In response, the scan switch 33 generates a train of scan pulses S1, S2, S3, (FIG. 8B). In response to each of the scan pulses, the flip-flops are reset. After being reset, the flip-flops a, b, c, d, e, f, g and h are set in successive chain in response to the incoming pulse train from the 60 Hz. clock pulse of the AC power supply. After a certain of the 60 Hz. pulses, e.g., 141 pulses are counted from the time the flip-flops are reset, all of the inputs a, c, d and h to the NAND gate 101 are set to logical 1. In response, the NAND gate generates a count pulse C1, unless a jam condition exists whereby flip-flop g and h are held in the reset mode preventing generation of count pulse
C1. The foregoing is repeated to provide a chain of count pulses C1, C2, C3 . . . (FIG. 8C) in response to the scan pulses S1, S2, S3 etc.

Thus, in effect, the NAND gate 101 is used to function as a time delay circuit wherein the amount of time delay between an input scan pulse and an output count pulse, for example, between pulses S1 and C1, is dependent upon which ones of the outputs of the flip-flops a-h are used as the inputs to the NAND gate 101. Also, it is evident from the circuit that the pulses can be inhibited at any predetermined time interval after the start of the count of the 60 Hz. clock pulses by clamping off, that is, by holding selected ones of the flip-flops in a reset state so that they are prevented from being set by the 60 Hz. clock pulses. This is illustrated in the circuit described above where the jam signal, in the form of logical 1, is applied to the flip-flops g and h to reset them so that the 60 Hz. clock pulses are prevented from clocking flip-flops g and h and thereby prevent the NAND gate 101 from generating the count pulse.

BRIEF DESCRIPTION OF THE FUNCTIONAL AND OPERATIONAL CHARACTERISTICS OF THE CONTROL CIRCUITRY

The functional and operational characteristics of the control circuitry in accordance with the present invention will be briefly described in conjunction with FIG. 6. As shown in FIG. 6, broadly, the control circuitry includes, in a functional sense, a clock 81 which derives the basic timing information from the 60 Hz. AC power supply, although a frequency other than 60 Hz. could be utilized. The circuitry includes a timing signal generator logic 82 which utilizes generally the basic clock signal from the clock 81 and the scan signal 78 in deriving a plurality of different timing signals 83 for normal machine operation. The circuitry includes an interrupt logic network 84. The network 84 responds, to certain trouble conditions mentioned before and will interrupt the normal operation of the various machine elements 87 via a suitable interface 85. The timing signal generating means 82 enables, via the interface logic 85, the copy counting means 89 to increment billing meters 90. In response to the trouble signal the interrupt logic 84 stops the copying operation and holds the counting means 89 and billing meters in a static state so that upon elimination of the trouble condition, operation of the billing meters can continue as if no interruption occurred during the copy run. This is designed to assure the integrity of the copy count and give lower billing rate to which the customer is entitled. The machine resumes the copying operation, provided that the trouble is cleared. The logic means 82, 84 and 85 make sure that the counting means 89 and the counters in billing means 90 indicate the correct number that corresponds to the copies actually outputted to the operator and that they are counted according to the differentiated billing scheme. The logic means are also designed to detect tampering and in response stop the machine and condition the counting means and the differentiated billing meters so that the charge made for the additional copies upon re-start of the machine to complete the original copy run reverts to the higher mode of billing.

DETAILED DESCRIPTION

Now going to the details, FIGS. 9A and 9B combined as shown in FIG. 10, show a detailed block diagram of an embodiment of the control circuitry according to the present invention. The circuitry will now be described in the context of its normal mode of operation, interrupt mode of operation for jam and out of paper supply situation and a mode of operation when the machine is tampered with to cheat differentiated billing scheme.

A. Normal Operation

For the normal operation, the control circuitry includes a functional logic network used for incrementing a counting means 89 differentiated count indicating means 90 in response to successive scan pulses. The logic network includes the scan switch 33, a time delay circuit TD1 in the timing signal generating means 82 and an AND gate 110. For initiating the machine, the counting means and the differentiated count indicating means an initializing chain is provided. The chain comprises the print button 51, and AND gate 113, and an initializing logic circuit 114 and an AND gate 115 connected in a chain as shown. The output of the initializing logic circuit 114 is also connected to initiate a set/reset logic 117, an OR gate 118, flip-flops 119 and 120 in initiating certain functions as follows. The set/reset logic is connected to a matching element memory logic 123 that energizes and actuates a number of machine elements in the copy apparatus. The machine element memory logic is actuated when the set/reset logic 117 is set by the initializing signal from the initializing chain in response to the print signal from the print button 51 via the chain elements 113, 114 and 117. The machine elements connected to the machine element memory logic may include a number of operative elements involved in the machine 124. For example, it may include the developer, exposure lamp, a main drive motor for driving various moving parts such as the selenium drum, scanner drive means, paper feeder, etc., high voltage power supply, AC power supply, etc. The machine element memory logic 123 may be of any suitable design such as a bank of flip-flops that includes a memory designed to switch on and apply power to the various elements in a programmed sequence as required as the machine cycle proceeds. In initiating the operation of AC load elements such as the main motor, the machine element memory logic 123 is used to control a triac switch 124 in the path of AC current from the AC source to the main motor using a light emitting diode and photo-darlington shown (See FIG. 7B).

Under the normal operating condition, that is, where sufficient supply of paper is in the paper tray and is in a proper position to be fed into the copying apparatus and where, otherwise, the machine is in a trouble free state, the following operations take place. The operator places a document on the platen 130 (FIG. 1) above the scanner 13. She sets the copy dials 47 and 48 (FIG. 1) to the number of the copies she wishes to make. She then presses the print button 51 and in response the initializing logic and various other logic networks of the control circuitry puts the machine into operation until the number of copies she has set automatically have been outputted to the paper output tray 27 (FIG. 2), as follows.

Upon pressing the print button, a print command signal is applied to the initializing logic 114 via the initialize AND gate 113. The 114, in turn, applies the initializing pulse to the set/reset logic 117, OR gate 118 and
the flip-flop 120, the counting means 89 via the AND gate 113 and sets in motion a chain of actions. The set/reset logic sends a signal to the machine element memory logic 123 to initiate a chain of operations involved in the copying process.

The initializing pulse applied to a DC machine power logic 133 via the OR gate 118 enables the former to provide DC supplies 125 to the various circuit elements of the control circuitry via a photocoupler 126 of the type shown in FIG. 7C. The initializing pulse applied to the AND gate 115 resets the counting means 89 to an initial starting state. This indicates that the copies about to be made are for a new copy run. The counting means 89 may be made of a suitable temporary memory such as a chain of flip-flops configured in a binary up counter in a conventional manner.

After the print button is pressed, at time t, (FIG. 8C) and after a duration of warm up time $\Delta_t$, a scan pulse $S1$ is generated by the actuation of the scan switch 33 as the scanning means 13 begins to drive away from its rest position, the scan switch 33 is deactivated thereby removing the scan pulse. As started above in connection with the copy count pulse generating means in connection with FIG. 8, after a period of time delay, $\Delta_t$, the time delay circuit TD1 generates the first copy count pulse $C1$, after a predetermined number of pulses from the 60 Hz. power supply are counted. In the foregoing manner, the scan switch 33 generates a train of pulses $S1, S2, S3, \ldots$ as the scanner 13 closes and opens the switch 33 in succession. In response, the time delay circuit TD1 generates a train of pulses $C1, C2, C3, \ldots$.

The output pulse train $C1, C2, C3, \ldots$ of the time delay circuit is then applied to the copy counting means 89 via the AND gate 110. (The gate 110 applies the incoming pulses from the time delay circuit TD1 so long as they are not inhibited). The counting means 89 receives the pulses of the copy count pulses $C1, C2, C3, \ldots$ from TD1 and increments its individual flip-flops. The states of the individual flip-flops are applied to programmable connector and logic 136 causes billing meters $57, 58$, and $59$ to increment in a certain manner in conjunction with pulses from a time delay circuit TD7, as described in the copending application. No. mentioned above. The copy count indication contained in the form of the states of the various flip-flops of the counter 89 are applied to the comparator 135 and to selected ones of billing meters via the programmable connector and associated logic 136. The programmable connector and associated logic 136 is of such a design that it drives the billing meter $57$ to indicate total cumulative counts of the copies being made in response to the pulses from a time delay circuit TD7. The logic 136 is also designed to respond to the counts from the counting means 89 and increment the billing meters 58 and 59 according to a differentiated billing plan, as illustrated in the copending application Ser. No. 344,321 filed Mar. 21, 1973 and assigned to the same assignee.

As described in the copending application, the billing meter 57 is used to indicate a cumulative total count of the copies being made. The second counter 58 to indicate cumulative total counts of copies being made up to a break point, for example, 6, and the third counter 59 to indicate the copies being made from above the break point to a second break point in the successive runs.

After the number of copies to which the dials are set are made, the machine shuts down as follows. The comparator 135 compares the counts of the pulses from the counting means with the count information provided by the copy dial setting. When the pulses from the counting means 89 equal the count setting, the comparator outputs a machine cycle out signal. This cycle out signal is applied to a machine cycle out logic means comprising a machine cycle out flip-flop circuit 120 via the OR gate 138. The flip-flop circuit 120 in turn applies the signal to reset the set/reset logic 117 via a path 139. The flip-flop circuit 120 also applies its output to an inhibit lead b of the AND gate 110. In response, the AND gate 110 prevents the counting means 89 from receiving any count pulses from TD1. When reset, the set/reset logic 117 applies a reset signal to the machine element memory logic 123. In turn, the logic 123 starts to deenergize various load elements such as the main motor high voltage power supply, AC power supply, etc. The set/reset logic 117 also applies a pulse to the timing signal generating means via an OR gate 172 and resets the flip-flops a-h. (FIG. 8A) In turn, the flip-flops begin to count 60 Hz. pulses to start a machine cycle time out operation. The deenergization of the main motor applies a logical 1 to one of the two inputs to an AND gate 171 via a path 162. This AND gate 171 is used to prevent machine cycle out when the machine is placed in its interrupt mode in response to out-of-paper condition as will be explained later.

After a predetermined lapse of time after the deenergization of the motor, a time delay NAND gate 106 of the time delay circuit TD8 (FIG. 8A) sends out a machine cycle out pulse to an OR gate 137. The OR gate 137 in turn resets the DC supply logic 133 and causes the latter to remove DC voltages from the control circuitry and thereby turn off the machine completely. The removal of the DC supply resets the counting means 89 and the programmable connector and logic 136 so that they are, in effect, cleared for the next copy run and returned to the higher billing mode.

B. Interrupt Operation

The control circuitry of the present invention includes functional logic networks that will interrupt the normal mode of the operation described above and cycle the machine through interrupt procedures so that the operator can remove trouble conditions. The networks include means for enabling the operator to restart only if the jam or out of paper supply condition that caused the interruption is corrected and means for holding the billing meters in a static condition during the interruption and enabling them to resume their function of indicating differential counts of the copies being made as if no interruption has occurred. The network also includes means for cycling out the machine if it is tampered with for the purpose of cheating the differential billing arrangement. These interrupt features and cycle out features will now be described.

Jam Mode

Jam mode situation arises when jam detecting means 141 senses the paper jam or the paper fails to detach from the surface of the drum.

The jam condition signal detected is applied to a flip flop 119 to put it in a set condition. The flip flop 119 in turn applies its output to the set/reset logic 117, an input of the OR gate 118. One (m) of the leads of an AND gate 143, one of the inputs (q) of a NOR gate 144 and the timing signal generating means 92. The jam sig-
nal sensing flip flop output is also applied to a suitable circuit 146 in the visual indicating means 54 which lights up the visual lamp to indicate to the operator that the jam condition exists.

In response to the detected jam signal, the jam flip flop 119 sets in motion a number of operations by the control circuitry as follows. It enables the machine to continue to apply DC power to the various circuit elements by maintaining the machine power memory logic 133 in its set state via the OR gate 118. In turn, the logic 133 maintains DC power to certain elements such as the counting means 89 and the differentiated count indicating means 90. This enables the means 89 and 90 to retain their status, retain count information being processed therethrough to the billing counters 57, 58 and 59. More specifically, referring to FIG. 8A, the setting of jam flip flop 119 prevents the NAND gate 106 of the time delay circuit TD8 from applying its cycle out signal. The cycle out pulse would have been generated and applied to the DC supply logic and remove DC supply from the control circuitry and shut down the machine and clear or reset, the counting means 89 and the programmable connector and logic 136 and thereby revert them to a higher billing mode.

In the foregoing manner, in the jam mode, the control circuitry of the present invention prevents the machine from losing the status of the count in progress during the copy run during the interrupting caused by the jam condition and enables the machine resume and complete copy run while maintaining the integrity of the copy counts according to the differentiated counting scheme.

The output of the jam flip flop 119 is also applied to the inhibit gate 147 wherein gate 147 is used to apply a signal to the machine DC power memory logic 133 and remove DC power from the machine when the machine is opened while the machine is not in a jam mode. The output of the flip flop 119 also interacts with the NOR gate 144 for normal machine initialization and AND gate 143 used in the initialization circuit during the jam mode as will be apparent from below. The flip flop 119 also applies its output to cause the timing signal generating means 82 to clamp its count pulse generating means g and h (FIG. 8A) to prevent TD1 through TD8 outputs from occurring. As indicated above, the prevention of the occurrence of TD8 prevents completion of the machine cycle out and, more specifically prevents setting of machine power flip flop 119 and thereby the resultant machine power shutdown.

After the foregoing sequence of events, the machine stops in a suspended or energized state and will not proceed any further. At this point, the counting means is in the energized state and has accounted for the copies made up to and including an extra one that is not completed because of the manner in which the count pulses C1, C2, etc. are generated in response to the scan pulses S1, S2, etc. as explained below. The machine will not restart, until the operator opens the interlock, removes the jam, shuts the interlock and presses the print button again thereby resulting in AND gate 143 providing an initializing signal.

Referring to the FIGS. 9A and 9B, certain parts of the logic elements, used for the foregoing functions respond to the opening and closing of the interlock switch 42, reset to restart the machine after the interruption caused by the jam. The control circuitry includes an interlock sensing means 151. When the interlock switch 42 opens, the interlock sensing means 151 senses this and applies a signal to the AND gate 143 directly and via a jam recovery latch circuit 152.

The machine interlock sensing circuit output is also applied to a flip flop 153. The output of the interlock flip flop 153 is applied to an inhibit lead of the AND gate 115. 115 in turn prevents reinitialization of the counting means 89 after the jam condition is eliminated and the print button is actuated which would otherwise erase the count memory in progress therein and cause an incorrect number of copies to be made at erroneous billing rates.

Various elements involved in the operation of the interlock operate as follows. As described above, in the normal mode of operation, the scanner sends out scan pulses S1, S2, S3, etc. and this causes the time delay circuit TD1 in the timing signal generating means 82 to provide the count pulse C1, C2, C3, etc. as shown in FIG. 8. When the paper jam or the detach failure occurs, a jam signal is generated and this is sensed by the jam signal sensing circuit 141. Referring to FIG. 8B, suppose this happens during the third scanning cycle operation. The third scan pulse S3 is already generated since the scan switch 33 is actuated already at the beginning of the scan cycle. The third scan pulse S3 generated by the scan switch 33 has already set in motion the necessary operations which cause the time delay circuit TD1 to output the third pulse count pulse C3 as shown in FIG. 8C. Since the third scan pulse 3 is already generated since the scan switch 33 is actuated already at the beginning of the scan cycle, the third pulse count pulse by the means 89. The third count C3 is, however, erroneous because the third copy was either jammed or failed to be detached from the drum surface or the scanning means has been rendered inoperative during the third cycle copy resulting in the failure of the machine to provide a completed third copy.

In response to the jam signal, the flip flop 119 causes the set/reset logic 117 to immediately initiate the machine element memory logic 123 to turn off the motor and other operative machine elements. The flip flop also puts the DC power supply logic 133 via the OR gate 118 at a hold state thereby maintaining the DC supply to the control circuitry. This puts the counting means 89 and the timing signal generating means 82, etc. in a static non-clocking state. This happens before the fourth scan starts. So the fourth and succeeding count pulses do not occur. At this point, the counting means 89, the comparator 135 and the billing meters 57, 58, and 59, of the billing means 90 are held in a static, non-clocking state. As stated before, the maintaining of DC power to the logic elements, while the machine is opened to, for example, remove a jammed copy is made possible by the fact that the output of the jam flip flop 119 is applied via the OR gate 118 to the machine power logic 133. The machine power logic 133 is of a design that will, when set by the jam signal via the OR gate 118 enable a DC power logic 133 to continue to provide the DC to the counting means, etc. during the interruption. At this point in time, the operator is alerted of the jam condition by visual indicating lamp 146 lighted in response to the setting of the jam flip-flop 119. The prevention of the normal machine cycle out during the variable time period involved with removal of a jammed copy is provided by the OR gate 103 (FIG. 8A) applying a reset signal to flip flops g and
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To remove the jam, the operator opens the machine by opening the interlock. This is sensed by the machine interlock sensing means 151. In turn, 151 applies a signal that sets the interlock flip flop 153 and sets jam recovery flip flop 152. The interlock flip flop 153 in turn applies its output to an inhibit lead 10 of the AND gate 115 and 110. These inhibited AND gates serve to prevent any incoming count pulses from the time delay circuit TD1 of the timing signal generating means 82 from being applied to increment the counting means 89 when the interlock 48 opens.

During the interruption due to the jam, the machine is prevented from being restarted by the jam initialization logic which includes jam recovery flip flop 152 and the jam AND gate 143, the OR gate 144 interposed between the jam flip flop 119 and the initialization AND gate 143, the OR gate 144 interposed between the jam flip flop 119 and the initialization AND gate 113 and other elements that are connected as shown. The function of these logic elements may be readily understood in connection with FIG. 11.

Referring to FIGS. 9 and 11, in the initialization logic chain, the initializing logic circuit 114 is designed to send out a pulse in response to the presence of a logic 1 in the output of the AND gate 113 for normal jam free condition or the initialization AND gate 143 under jam condition. Under the normal condition, the jam AND gate 143 does not provide logical 1 output because not all of the input signal states are at logical 1.

The normal initialization AND gate 113 controls the actuation of the initializing logic 114. This is shown in FIG. 11 under the first column, designated NORMAL PRINT OPERATION. Under the normal condition, the jam AND gate 143 is not capable of providing an output to control the initializing logic 114 because, in the absence of the jam condition, the input lead m to the jam AND gate 143 is logical 0. More specifically, under normal conditions where no jam condition is encountered, the actuation of the initializing logic 114 is under the control of the NOR gate 144 and the AND gate 113. When either jam condition or out-of-supply conditions exist (as explained later), the NOR gate 144 applies a logical 0 to the AND gate 113 and thereby prevents gate 113 from passing the initializing command from the print button 51. When neither condition exists, the NOR gate 144 applies a logical 1 to the initializing AND gate 113. This being the case, the AND gate 113 is in effect enabled to pass the print command signal coming from the print button 51 under the normal condition. When the print button 51 is pressed, the pulse is then applied through the gate 113 and then to the initializing logic 114. The initializing logic 114 applies the initializing signal to enable the AND gate 115, the set/reset logic 117, the OR gate 118, jam flip flop 119 and the machine latch or flip flop 120 for causing various machine elements to start and operate as described before.

Under the jam condition, the normal initializing AND gate 113 is disabled by the jam condition NOR gate 144 as follows. As long as the jam signal exists at the output of the jam flip flop 119 (or out-of-supply signal, also as explained later), the jam condition provides a logical 1 input to the NOR gate 144. In turn, the NOR gate 144 output goes to logical 0 and prevents the normal initializing AND gate 113 from passing print command coming from the input print button. While this condition exists the initialization will take place in the alternative path from the print button circuit 51 via the jam AND gate 143.

The only way the jam AND gate 143 will provide a logical 1 is when all of its inputs m, n, o, p go to the logical 1. Referring to FIG. 11, this happens only when the machine is opened, the jam is removed and then the machine is closed and then the print button is pressed.

Thus, more specifically, under the jam condition, the initializing logic chain and more particularly the AND gate 143 operate as follows. When the jam condition signal is detected the jam flip flop 119 applies a logical 1 to the m lead of the 143 AND gate. But, the input from the jam recovery flip flop circuit 152 applied to the jam AND gate at its input lead n stays 0. So at this point the jam AND gate 143 cannot output logical 1 to initiate the machine regardless of whether or not the input to its input lead p coming from the print button 51 does to logical 1 or 0, i.e., that is, the operator presses the print button or not. This is shown in the two columns one for print button unpressed and the other for pressed situation, under jam conditions, designated JAM CONDITION in FIG. 11.

Now the operator opens the machine interlock 48. In response, the jam recovery flip flop circuit 152 applies a logical 1 to the input lead n of the jam AND gate 143 and sets the jam recovery flip flop to logical 1. This will not however enable the 143 AND gate to provide the output to the logical 1 because at this point the machine interlocks sensing circuit 151 is at logical 0 and this is applied to the input lead n of the AND gate 143. Upon closing of the interlocks, the AND gate will provide logical 1 to initializing circuit 114 since the three conditions, the jam being removed (interlocks opened), the interlocks being closed and the print button 51 being pressed have been satisfied. The foregoing logical operations involving the interlock and the jam recovery flip flop 152 are shown under the columns designated INTERLOCK OPEN and INTERLOCK CLOSED and PB (but, print button not pressed) in FIG. 11. At this point when the operator presses the print button 51, he will in effect apply the fourth and the remaining logical 1 required by the AND gate 143 to its input lead p. When she presses the button, the input p goes to logical 1 and hence all four inputs m, n, o, and p go to logical 1 as shown under the last column INTERLOCK CLOSED and PB(BUTTON PRESSED) in FIG. 11. In response, the gate 143 sends out an initializing pulse to the various elements of the control circuitry and thereby restarts the machine. Following the pulse, the normal initialize signal applied from AND gate 113 is generated also due to the print button still being actuated when jam flip flop is reset. In turn, the machine completes the interrupted copy run and the counting means 89 and the differentiated count indicating means 90 resume and complete their intended function of counting and recording the copy counts according to the differentiated billing plan as if no interruption has occurred.

Count Balancing Operation

It will be recalled that the control logic circuitry of the present invention is designed to balance the count
registered by the counting means and the number of copies the integrity of the billing outputted as well as maintain the scheme. Referring back to the operation of the control circuitry under the jam condition, it may be recalled that the counting means registered one more count than the number of copies outputted because of the time relationship, associated with when a count pulse is generated and the said in time that a jam is sensed. So the circuitry according to the present invention utilizes certain of the logic elements to prevent the counting means 89 from allowing the first count pulse (e.g., FIG. 8C, C4 in the above example) coming from the timing signal generating means 82 from reaching the counting means 89. This is achieved in the following manner.

The operator removes the trouble conditions, that is, she opens the machine, corrects the jam condition and closes the machine and then presses the print button 51. In turn, the initializing AND gate 143 actuates the initializing logic 114 to apply the start signal as explained above. It may be recalled that when the machine was opened interlock flip flop 153 was set. The flip flop 153, in turn, provided an inhibit signal to the AND gates 115 and 110. As a result, the gate 110 is prevented from passing the count pulses from the time delay circuit TD1 to the counting means 89. This inhibit signal is removed after the jam conditions are removed, the machine closed, the print button pressed, and after a suitable amount of time delay. The time delay is introduced by the time delay signal from a suitable delay circuit TD3 in the timing signal generating means. TD3 provides a reset signal to interlock flip flop 153 after a predetermined number of 60 Hz. pulses, in turn, provides an output which permits logical 1 signal to be generated by gates 115 and 110. The delay time period of TD3 is adjusted so that it occurs after the time the first copy count pulse would occur following the resetting of jam flip flop 119. Thus, in operation, when the operator presses the print button after the jam condition is removed and the interlock is closed, it will immediately initialize the other circuit elements, including the scanner so that the scan starts to complete the remaining cycle and retrace back to the starting point at the homing switch 33 and close the scan switch and thus generate the first scan pulse S4 (FIG. 8B). The time delay introduced by TD3 is such that the inhibit signal from the output of the interlock flip flop 153 applied to the AND gates 115 and 119 is not lifted until after the time that the fourth pulse, C4, would occur. As a result, as seen in FIG. 8C, the fourth pulse C4 shown in a dotted line coming along as generated by the time delay circuit TD1 in response to the fourth scan pulse S4 from the scanning switch of prevented from being passed through the gate 110 and then onto the counting means 89.

It may be recalled that the control circuitry according to the present invention prevents loss of the DC power to the counting means 89 and the billing means 90 during the interruption. This is assured during jam mode of operation by the fact that the signal from the jam flip flop 119 applies a reset signal to the OR gate 118 and machine power flip flop 133 as long as the jam is not cleared. The signal which would cause an immediate machine power shutdown if the interlocks are opened and no jam condition exists is prevented from being propagated through the gate 147 to the machine power logic 133. As indicated above, the machine cycle out and shutdown signal that would be generated by the time delay circuit TD8 and applied to the logic 133 via the OR gate 137 to remove DC from the control circuitry is prohibited from being generated by the jam signal applied via lead 104 to the flip flop g and h (FIG. 8A).

If there is no jam condition and the machine is opened, gate 147 provides a machine power shutdown signal to the OR gate 137 and then to machine power flip flop 133. The machine power logic 133 in turn, turns off the DC power 125 which, in effect, erases the memory in the counting means 89 and the programmable connector and logic 136. The machine power logic 133 shuts off completely the main motor in addition to other machine loads via the photodetecting means as the one disclosed in the copending application Ser. No. 538,808 and briefly described above in connection with FIG. 7B. As a result when the machine is restarted the counting means 89 and the logic 136 will begin to increment the billing meters 57, 58 and 59 at a higher billing rate as a new copy run.

The control circuitry includes a logic circuit 161 that provides an initializing or resetting signal to flip flop 153 only when the print button is actuated after machine power is de-energized as a result of a normal machine cycle out or when the machine is opened when no jam exists. The circuit 161 is also used to reset a flip flop 162 used in the out of paper supply mode. Circuit 161 differs from circuit 114 in that it provides a reset signal to certain memory elements such as flip flops 151 and 162 which cannot be initialized after a jam condition has been removed, but must be delayed from being initialized to, for example, balance copy count with copies outputted.

Out of Paper Supply Mode

In accordance with another aspect of the present invention, the control circuitry includes a chain of logic network for interrupting the machine operation in response to the out of paper condition and enabling restart of the machine to complete the copy run when the paper is replenished and the print button is pressed again. The control circuitry also includes a chain of logic network for detecting tampering with the paper supply and terminating the copy run and returning the differentiated count indicating means 90 it its higher billing rate mode.

The logic networks for the out-of-paper supply and tamper modes comprise AND gates 164 and 165, an out of paper recovery flip flop 162, time delay circuits TD4, TD5 and TD6 and the out of paper sensing switch 167 of suitable design connected operatively as shown. The time delay circuit TD4 applies an interrogation pulse for detecting the out-of-paper supply condition to the AND gate 164. An interrogation pulse occurs during every scan cycle with each pulse appearing almost at the end of each scan cycle as shown in FIG. 12B. Each of the pulses interrogates as to whether an out of paper supply condition has occurred or not as follows: The interrogation pulse pulse is applied to one of the two inputs of the AND gate 164. The second input to the AND gate 164 comes from the out-of-paper sensing switch 167. A suitable means, such as a microswitch is
provided in the paper input tray to detect the absence of the paper. When the out-of-paper condition is detected by the switch, it provides an output signal which is applied to the AND gate 164. The out-of-paper supply condition is indicated visually by a lamp 175 positioned in visual indicating area 54 (FIG. 1).

A logical 1 at the output of gate 164 sets the output of paper recovery flip flop 162. When set, 162 changes its output from logical 0 to logical 1. This change sets off a number of chain actions including the out-of-paper supply mode of operation which interrupts the machine as explained below so that the paper can be replenished. In the case of the out of paper supply situation, no steps are necessary to balance the counts made by the counting means 89 with the copies outputted as was the case in the jam mode of operation because they are already balanced. This is because the timing relationship copy count pulses (FIG. 12B) with respect to the out of paper supply signal (FIG. 12D) and the interregulation pulses (FIG. 12C) for detecting the absence of the paper such that the copy counted and copy outputted is the same.

As shown in FIGS. 12B and 12C, each of the count pulses C1, C2, C3 . . . coming from TD1 occur slightly before each of the interrogation pulses P1, P2, P2 . . . coming from TD4. The operation of the paper feed mechanism and the out-of-paper supply detecting switch 171 are so related that the output of paper condition signal (FIG. 12D) is registered prior to the interrogation pulse toward the end of each cycle time interval.

In operation, suppose an out of paper is sensed at the time t after the third scan cycle. The next interrogation pulse P3 immediately following the out of paper sense signal causes the AND gate 164 to output a signal (logical 1) because of the coincidence of the two inputs. In response, the out of paper recovery flip flop 162 applies an inhibit signal to the inhibit lead b of the count enabling AND gate 115 preventing loss of DC power. This inhibit remains there until a reset signal is applied via a time delay circuit TD5 to the flip-flop 162 after the paper supply is replenished and the machine is restarted. As a result, the initial pulse coming through the gate 114 and applied to the AND gate 115 is prohibited from resetting the counting means 89. This prevents the programmable connector and logic 136 from being initialized and returned to the higher billing mode. More specifically, the out of paper logic permits resumption of operation of 89 and 136 from the copy count and billing mode respectively existing during the time that the last copy sheet from the input tray was being pressed. The out of paper operation is as follows: During the machine interruption caused by an out of paper supply condition the count integrity is maintained, i.e., the memory in the counting means 89 and the programmable logic 136 is not lost during the interregulation. In response to the logical signal from the flip flop 162, the flip flop 120 sets. This causes the set/reset logic 117 to turn off the operative elements such as the motor via memory logic 123 in a sequential manner which provides an output which is applied to an input a of the AND gate 171 via a path 162. This input in combination with an input from the flip flop 162 applied to the second input b of the AND gate 171 causes the AND gate 17 to provide an output of logical 1. This logical 1 is applied via the OR gate 172 to the machine timing counter (FIG. 8A) and thereby clamps all the flip flops in the reset state preventing generation of any machine timing signals until the input paper supply tray is replenished and the print button is actuated. This logical 1 stays there until the flip flop 162 is reset later. As a result the TD8 is prevented from providing a pulse that will cause the DC power logic 133 to remove DC power during the variable time period during which the input paper tray is replenished.

In effect, the output of the out-of-paper flip flop 162 when set by the output of the AND gate 164 starts off the machine cycle out procedure. But the cycle out does not complete and the machine is switched into an interrupt mode in that the two signals come from deenergization of the main motor and the other from the output of the flip flop 162 applied via the AND gate 171 prevents the generation of the time delay circuit TD8 that would de-energize the DC supply logic 133 via the OR gate 118. As a result, as in the case of jam mode, the counting means 89 and the programmable connector and logic 136 are prevented from reverting to the initial copy count state and higher billing mode.

While the out of paper supply sense circuit 167 continues to sense the absence of the paper, the OR gate 144 in the initializing path will apply a logical 0 to the initializing AND gate 113. This prevents the operator from initializing the operation of the apparatus by actuating the print button until the paper is replenished. After the paper tray 68 (FIG. 1) is lowered and is replenished with paper, and the paper tray is put back in its feed position, the out of paper sense circuit 167 returns the out of paper supply signal to a logical 0 at the input to OR gate 144.

At this point, the NOR gate 144 no longer inhibits. So when the operator presses the print button 51, it applies a pulse to the logical 114 via the AND gate 113. The logic 114 in turn applies a signal to the set/reset logic 117, the OR gate 118 and the machine cycle output latch 120 and resets them for restarting the copying operation. The main motor is re-energized in response to the initialize signal applied to the machine element memory 123 via the set/reset logic 117. After an initial delay period that occurs at the start of each copy run to allow the motor to reach process speed, etc., the scanning means 33 starts to scan and sends succeeding scan pulses S4, S5, S6 . . . as in the normal mode operation each time 33 is actuated. In turn, the delay circuit TD1 provides succeeding count pulses C4, C5 . . . that are then applied to the counting means 89 via the gate 110 as described before.

In accordance with another aspect of the present invention, the control circuitry includes a delay circuit TD5 which resets the out of paper flip flop 162 to provide logical 0 output. This logical 0 is applied to logic gate 115 thereby removing the inhibit signal applied thereto via the inhibit lead b. This permits setting of machine flip flop 133 after completion of the copy run via OR gate 138 and the resultant de-energization of machine powers.

Tamper Mode

In accordance with another aspect of the present invention, the control circuitry includes means for detecting an attempt by the operator to tamper with the paper supply tray and thereby cheat the differentiated
count indicating means 90 and gain a lower billing rate. One way the operator would attempt to cheat is by recognizing that the control circuitry of the present apparatus includes out of paper supply detection means previously described; that is by lowering the paper tray to actuate the out of paper sensing switch 167 and thereby entering an out of paper supply interrupt mode and obtain a lowering billing rate. More specifically, he may attempt to obtain this result as follows. First the operator sets the dial at a high number (say 20) for a copy run so that it will not stop until 20 copies are made. The operator would then press the print button and wait until the machine runs off 8 copies so that the lower rate counter 58 has already been disabled from counting and lower rate counter 59 started to count. The operator then stops the machine by lowering the paper tray and causing the out of paper supply sensing means 171 to sense an out of paper supply condition and place the machine in the out of paper supply interrupt mode for the situation. The operator would then place another original on the plate, move up the tray back into the position, press the button and then complete the copy run. As far as the machine is concerned, these operations are taken as a single copy run with an interruption due to an out of paper supply condition. Thus, all of the remaining copies to be made through the 20th copies, are processed at the lower billing rate.

In accordance with an aspect of the present invention, the control circuitry includes means for recognizing the false out of paper supply condition and means for discriminating the false out of paper supply condition from the true one. Referring to FIGS. 9A, 9B and 13A-G, the means for detecting the tampering includes the AND gate 165 and the time delay circuit TD6. Circuit TD6 provides an interrogation pulse every scan cycle with the pulse width extending from the end of the scan pulse up to the point where the normally occurring out of paper supply condition would normally be sensed (FIG. 13B, t1).

The width or “window” of the tamper detect signal from the TD6 is wide enough to occupy a very substantial part of the scan cycle as shown in FIG. 13C. When the AND gate 165 detects a coincidence of the two inputs, that is, the tamper interrogation pulse and an out of paper supply signal from 167 artificially induced by the operator (FIG. 13F) that will happen at any time during the TD6 pulse width time, the AND gate 165 output will provide a logical 1 via the OR gate 138 to cycle out the machine via latch circuit 120. In response, the latch 120 resets the set/Reset 117 and 117 in response turns off the operating elements by actuating the machine element memory logic 123. Also the set/reset logic 117 applies a pulse to the OR gate 172. In response to the pulse from the OR gate 172, TD8 generates after a predetermined time delay, a reset pulse to the DC power supply logic 133 via the OR gate 137 to remove DC power from the counting means 89 and logic 136 and de-energize machine power differentiated counting means 90. In turn the means 90 is reset to an initial state or higher billing mode.

In short, the discrimination between the legitimate out of paper supply and illegitimate out of paper supply signals are provided by utilizing two paper switch interrogation pulse of different widths occurring at different times with respect to the generation of a scan pulse.

In accordance with another aspect of the invention, preferably, the “window” or pulse width FIGS. the interrogation pulse provided by the time delay circuit TD6 for detecting tamper is made much wider than that of the normal out of paper supply interrogation pulse (compare FIGS. 13C to 13E) and they are timed not to overlap. As a result, the mathematical probability that the operator can lower the tray within the narrow time slot associated with a legitimate out of paper sense is practically reduced to zero. Accordingly, the probability of human operator circumventing the tamper detecting means is zero as a practical matter. In the foregoing manner, the operator is prevented from receiving lower billing rate by attempting to induce artificially out of paper supply condition.

For the condition where the last sheet of paper inputted into the machine is also the last desired copy, the digital comparison logic 89 compares the dial setting and copy counter 89 at a point prior to generation of the abbreviated cycle out or start of interrupt mode of operation due to an out of paper condition. In this case, a complete and normal machine cycle out occurs with the out of paper indicator remaining energized until machine power is deenergized via the machine power supply flip flop 133.

Hereinafore, a control circuitry is described in conjunction with a specific illustrative embodiment of the principles of the present invention. Various other modifications and changes may be made to the embodiment of the present invention as described hereinafore without departing from the spirit and scope of the present invention.

What is claimed is:
1. A copier/duplicator apparatus wherein differentiated copy counting and indicating means are provided which includes a first meter for indicating copy counts of the copy run up to a predetermined number and a second meter for indicating copy counts of the copy run above said predetermined number and wherein means are provided to detect out-of-supply condition actually occurring during a copy run and interrupt the operation of the apparatus and counting and indicating means and put them into an interrupt mode, whereby the supply can be replenished and then copying counting and indicating operation can be resumed to complete the copy run, and the improvement which comprises:

means for detecting the out-of-supply condition artificially induced and generating an out-of-supply signal,

means for determining from the nature of the out-of-supply signal whether it is for the actual condition or for an artificially induced condition and generating a first signal indicative of the actual condition and a second signal indicative of the artificial condition,

means responsive to the first signal for putting the apparatus and the counting and indicating means into the interrupt mode, and

means responsive to the second signal for terminating the copy run, whereby an attempt to tamper with the differentiated counting means by introducing artificially induced out-of-supply condition is circumvented.

2. A copier/duplicator apparatus according to claim 1, including

means for detecting jam condition and providing an interrupt signal,

means responsive to said interrupt signal and putting
apparatus and counting and indicating means into the interrupt mode, means for detecting removal of the jam condition that produced the interruption and enabling said apparatus and said counting and indicating means to complete the copy run.

3. The apparatus according to claim 2 including scanning means operating in successive cycles at said regular time interval, means responsive to the operation of said scanning means for generating a train of count pulses, said counting and indicating means counting said train of count pulses and indicating the count of the pulses as the counts of the copies being made by said apparatus, said scanning and count pulse generating means stopping in response to said jam signal, said pulse generating means providing one more pulse than the number of copies actually made by said apparatus, and means for inhibiting the application of the first pulse of the train of count pulses after the apparatus resumes its copy run operation, whereby the copy count indicated by said indicating means correspond to the actual number of copies made by the apparatus.

4. The apparatus according to claim 1, including means for detecting the failure of a transfer sheet from detaching from the image surface of the apparatus and generating said interrupt signal.

5. The apparatus according to claim 2, including means for detecting out of supply condition of the transfer sheets and providing said interrupt signal.

6. The apparatus according to claim 3, including safety interlock for the apparatus, means responsive to the opening of said interlock for removing power supply for the apparatus for safety and removing jammed transfer sheet, said means for resuming the copy run includes a coincidence gate which responds to a command signal to resume the copying operation only after said interlock is opened, jam removed, and then said interlock is closed.

7. The apparatus according to claim 6, including means for de-energizing said counting and indicating means when said interlock is opened in the absence of the interrupt signal.

8. The apparatus according to claim 1, including means for setting said apparatus to make a given number of copies in a copy run, said determining means includes a first coincidence gate, a second coincidence gate, means for applying the out of article supply signal to said first and second coincidence gates, means for generating and applying a first train of pulses to said first coincidence gate wherein said first pulse train is synchronized to occur in succession at the rate at which the articles are fed and wherein the pulses of the first pulse train are timed so that when the out-of-supply condition actually occurs and is detected, one of the pulses coincide at least in part with the out-of-supply signal occurring in response to the actual out-of-supply condition, and means for generating and applying a second train of pulses to said second coincidence gate wherein said second pulse train is synchronized to the rate at which the articles are fed but time displaced with respect to said first pulse train so that said second pulse train do not overlap with said first pulse train and wherein the pulses of the second pulse train are timed so that when the artificially induced out-of-supply condition occurs and is detected, one of the pulses of the second pulse train coincidence at least in part with the out-of-supply signal induced artificially, whereby said first coincidence gate detects the out of supply signal indicative of the actual condition and said second coincidence gate detects artificially induced condition.

9. The apparatus according to claim 8, including means responsive to the output of said first coincidence gate for interrupting the operation of the machine so that the operation can be restarted after the articles are replenished, means responsive to the output of said second coincidence gate for stopping the operation of the machine.

10. The apparatus according to claim 9, said second pulse train generating means is adopted to generate pulses having pulse width which is substantially wider than that of the first pulse train for enhancing the discrimination capability of said coincidence gates between the actual and artificially induced out-of-supply condition signals.

11. The apparatus according to claim 10, including a tray N for holding a supply of transfer sheets, said tray being positioned at a first location from which the sheets are fed automatically, and wherein said tray can be moved to a second position to be filled with the supply, said sensing means being positioned to detect the paper being fed and is adapted to generate the out-of-supply signal when the last sheet of the supply is run out, and said sensing means also detecting the moving of said paper tray from said first position to said second position while the copy run of the copier/duplicator is in progress and generating the artificially induced out-of-supply signal.