Automatic control of reproduction and sorting of reproduced copies is accomplished in a printing or duplicating machine, a reprography machine, of the type which utilizes masters or originals from which copies are made and which has a hopper, magazine, bunker or chamber for masters, with provision for feeding them in succession to a cylinder associated with inking, duplicating and cleaning mechanisms. Masters are employed which are formed with indicia or coded markings along one or two edges which provide signals for causing a desired number of copies of each successive master to be produced and for sorting the produced copies in a desired manner, for example according to the number of copies to be sent to each of a plurality of different destinations. A scanner is provided for examining the code marks to produce signals, and circuits responsive thereto serve to actuate parts of the duplicating machine. A digital memory device is utilized to store information supplied by the code of one master while reproduction from a previous master is going on.

15 Claims, 19 Drawing Figures
REPROGRAPHY MACHINE CONTROLLED BY INFORMATION ON MASTER

This is a division of application Ser. No. 5,035, filed Jan. 22, 1970, now U.S. Pat. No. 3,650,204.

PRELIMINARY DESCRIPTION

An object of the invention is to make it unnecessary in rephotography for the operator to stop the machine after the number of copies desired for any master has been run and to reset the machine for the number of copies desired for the next master. It is thus an object of the invention to obviate the need for manually set counters and to provide counting mechanism which is wholly responsive to the encoded master.

Another object of the invention is to provide for automatic distribution of the copies with any desired number of copies distributed to each of the plurality of different destinations.

Other and further objects, advantages and features will become apparent as the description proceeds.

In carrying out the invention in accordance with a preferred form thereof in conjunction with a printing or duplicating machine such as a "Multiphith 2750" manufactured by Addressograph Multigraph Corporation, masters are employed similar to those ordinarily used with such machines except for the fact that the master is formed with a code along at least one edge, preferably two adjacent edges which contain instructions as to the number of copies to be made from each master and the manner in which the copies are to be distributed. A computer apparatus is provided responsive to the code for carrying out the instructions.

A scanner is provided with a carriage so constructed that the scanner will move along either the side or the end of the master and receive the coded instructions. In one embodiment of the invention, the master is provided also with a set of clock marks along the instruction code marks for synchronizing the computer. In another embodiment of the invention, the clock signals are produced in response to rotation of the shaft of the carriage for the scanner.

A memory or storage device is provided for storing the instructions received from one master in order that the instructions provided from the previous master may be carried out by the machine while a new set of instructions is being obtained by the scanning of the next master. A subtracting counter is provided for response to the storage information which saturates when the desired number of copies has been produced and stops a paper feeder. When the invention is employed with a type of duplicator such as Multiphith 2750 there is a magazine for masters.

Bistable circuits are employed for the clock and paper counters.

In the embodiment of the invention illustrated, the encoding on the masters is in the form of black marks which may be read by a scanner or reader provided with a lamp and photosensitive detectors. The invention is not limited thereto, however, and does not exclude the use of other types of encoding and sensing means such as magnetic markings and magnetic responsive scanner equipment, or punched holes with scanning equipment responsive thereto or any other indicia which provides control data and which can be read. By reading is meant not merely traversing the indicia with a scanner, or moving the master with its indicia with respect to a reading head or scanner, but also utilizing a bank of pick-up devices such as photoelectric cells to view separate parts of the indicia simultaneously for reading information in parallel as arrayed on the master. The invention relates to any type of machine which makes copies of some original, a process generally referred to as "rephotography." Although specially prepared masters may be employed in rephotography the invention is not limited thereto. The invention encompasses a procedure whereby the item inserted into the machine for copying is not such a printing master but is merely an original document carrying the appropriate control data, referred to herein as "indicia."

This document, upon being fed into the machine has its control data read, and then proceeds to have some sort of copies made from it either by direct repetitive photography, or by first making a special master by some sort of photographic process and then printing copies from the special master. The term "master" as employed herein when used in its broadest sense, is intended to include such an original document with indicia marked thereon carrying control data as well as specially prepared duplicating masters.

A better understanding of the invention will be afforded by the following detailed description considered in conjunction with the accompanying in which:

FIG. 1 is a side elevation, partly broken away, of a printing apparatus in which scanning apparatus and computer circuits of FIGS. 4-7, 9-12, and 14-16 are employed in conjunction with coded masters;

FIG. 2 is a face view of a portion of a master employed in carrying out the invention;

FIG. 3 is a face view of a portion of a coded master similar to that shown in FIG. 2, but in which clock marks as well as control data information are provided,

FIG. 4 is a perspective view, partly broken away, of the scanner carriage and mounting thereon arranged for scanning marks on the side of the master in the hopper;

FIG. 5 is a perspective view, partly broken away, corresponding somewhat to FIG. 4, and showing the scanning head turned for scanning marks on the end of the master, and also illustrating how the scanning carriage and its mounting are related to the master hopper and its supporting structure;

FIG. 6 is a block diagram of the system employed for automatic control of a duplicator function such as the copy paper feed;

FIG. 6a is a diagrammatic view showing an alternate clocking means for identifying data fields on the master face.

FIG. 7 is a logic diagram of two subtracting binary paper counters employed in carrying out the invention;

FIG. 8 is a circuit diagram of the type of bistable circuit illustrative of the clock counter but due to space limitations, showing 4 binary stages instead of 6;

FIG. 8a is a logic diagram indicating the functions performed by the counter circuit of FIG. 8;

FIG. 9 is a logic diagram of the binary scanning apparatus and clocking device in which the clocking impulses are produced by rotation of the scanner carriage shaft utilizing magnetic pulses produced by magnetic or magnetizable material mounted on the shaft.
FIG. 10 is a logic diagram corresponding somewhat to FIG. 9, but showing an embodiment of the invention in which there are clock marks on the master and a clock mark scanner is employed;

FIG. 11 is a circuit diagram of the apparatus employed for controlling the scanning;

FIG. 12 is a circuit diagram of the data pickup scanning device and amplifier;

FIG. 13 is a circuit diagram of the feeder control relay and amplifier driver;

FIG. 14 is a circuit diagram of the clock pulse amplifier responsive to rotation of the scanner drive shaft;

FIG. 15 is a circuit diagram of the clock inhibitor employed in the computer apparatus;

FIG. 16 is a logic diagram of the binary storage device for use in conjunction with the apparatus, and

FIG. 17 is a schematic perspective diagram of one form of apparatus for imaging and encoding the masters.

Like reference characters are utilized throughout the drawing to designate like parts.

DETAILED DESCRIPTION

A typical automatic printer or duplicator in connection with which the invention may be employed is illustrated in FIG. 1 which comprises certain conventional elements not constituting a part of the present invention, namely structure 11 carrying a magazine or hopper 12 for master plates, adapted to rest in a stack 13, means 14 for feeding paper or other sheets upon which printed matter is to be duplicated, if desired an auxiliary paper feeder 15, a mechanism not shown in FIG. 1 for delivering the masters successively to a master cylinder 16, means not visible in FIG. 1 for ejecting each master after the requisite number of copies of that master has been impressed on sheets to be printed, and a collector or sheet distributor 17 having a plurality of bins or pockets 18 into which printed paper copies may be segregated. There are also a blanket cylinder 16a and an impression cylinder 16b, the paper being fed between the latter two cylinders. Such machines have also heretofore been provided with mechanical counters which may be set by the operator to cause a predetermined number of impressions to be made from the master and distributed to the distributor 17 in successive pockets. Such machines operate automatically, according to predetermined cycle which include the steps of feeding a master, treating and inking the master, feeding copy paper, stopping the copy paper feed on count down, ejecting the master, and cleaning a blanket which transfers the impression to the paper. The foregoing as thus far described in connection with FIG. 1 is conventional and does not constitute a part of the present invention.

In accordance with the present invention, however, among other features in an illustrative embodiment specially prepared masters are employed. These specially prepared masters differ from those heretofore employed in that they contain not only the writing, drawing and so forth which are to be reproduced on the paper copies but also indicia cooperating with the computer equipment provided in accordance with the invention to control the operation of the duplicator FIG. 1, including the number of copies made from each master and the manner in which the copies are sorted in the sorting bins or pockets of FIG. 1.

As illustrated in FIG. 2, there is a master 19, the central portion of which is left blank and this is where the usual message to be duplicated is written or drawn. However, in accordance with the invention, the master 19 is provided with one or two rows of boxes or spaces 20 and 21 in which indicia in the form of coded markings are placed for effecting the operation of the circuits to control the duplicator. As illustrated, there is one row of spaces 20 along the end and another row 21 along the side so that either end or side scanning may be employed. For example, there may be spaces 22, 23, and 24 which may be employed for various control markings such as markings to indicate last of the set, if desired. Then there may be a set of seven spaces 25, to permit applying a seven bit binary code for controlling a first counter and a similar set of spaces 26 for applying a code to control a second counter. There are electronic counters provided in accordance with the invention, replacing the mechanical counters heretofore employed, and making it possible for each master to determine the number of copies of that master which will be made independently of the number of copies made of any other master in the hopper. In addition to spaces for the foregoing markings, spaces such as 27 are provided in the row 21 or 20 for digital code markings, for instance 5-bit markings for controlling distribution to successive pockets, for example, the first 2 of the pockets 18 of the distributor 17 of FIG. 1. The spaces 27 are followed by additional spaces 28 which may be used for other control purposes, for example a general program selection control for selecting any one of several distribution programs already prepared on punched tape and each associated with its own tape read head.

For use with conventional duplicators the masters are specially prepared sheets. However, in equipment for automatically copying or duplicating original copy such as clippings or pages from publications the coding which is selectable for operation by entering an appropriate binary designation in the spaces 22 to 28, may be marked directly on each original copy or on paste-on sheets, and the original material then serves as the master. It may be fed into the copies or duplicator by appropriate mechanism or first automatically photographed to form a second master to be received by the master cylinder 16 of a duplicator.

A scanner 29 is provided including an element which travels along the rows 20 or 21 and reads the information markings for supplying their data to storage and control circuits. However, in the arrangement shown, in order to enable the storage and control circuits to assign to the coded information the correct interpretation, clock impulses are also required. These may be provided by clock marks on the master 19 as illustrated in FIG. 3 or the scanner itself may be arranged to produce clock signals.

A form of scanner which may be employed is illustrated in FIGS. 4 and 5 having a supporting housing 31 which may be secured to one or both of the sidewalks or master sheet guides 32 of the master hopper 13 in either of two alternative positions by suitable conventional mounting means, not shown. The position for side reading of the master encoded information is illustrated in FIG. 4 and the position for end reading is illustrated in FIG. 5. It will be understood that the surrounding structure shown in FIG. 5 would be present in the FIG. 4 arrangement also, but has been deleted to
avoids redundancy. Within the housing 31 is a screw 33 driven by a motor concealed in an enclosure 34 for traversing a reading head 35, which contains a lamp for illuminating the edge of the master and photoelectric responsive reading elements in the form of scanner illustrated in FIGS. 4 and 5. If the form of the master illustrated in FIG. 3 is employed, the photoresponsive reading head is a dual head adapted for reading markings on each of two rows 36 and 37, one the information row, the other the clock counting row.

If the type of master is employed which is illustrated in FIG. 2, the scanner shaft 33 is provided with means for producing clock counter impulses at the same rate as the rate of rotations of the shaft 33. Such synchronized pulse producers are conventional and do not constitute a part of the present invention and need therefore not be illustrated herein. Examples of shaft-rotation-responsive pulse generators for producing electrical impulses in response to movement of a magnet or magnetizable member carried by a shaft are found in U.S. Pat. No. 3,301,053 to Walch et al. and Pat. No. 3,287,969 to Hardy.

The block diagram of FIG. 6 illustrates the general arrangement of the apparatus responsive to coded information on the master with the clock signals, and the storage and control circuits for responding to the information to control the number of copies made of each master and to control the distribution or sorting of the copies. Where the clock marks are provided on the master as in FIG. 3, the scanner reading head 35 includes dual pick-ups 38 and 39 provided with amplifiers 41 and 42 respectively. For the sake of illustration it has been assumed that the clockings 39 are of the photoelectric type in which the current increases and decreases according to whether the scanner "sees" the blank space or a black mark in each information area of the master as the head traverses the master. The invention is not limited to the use of photoelectric responsive scanners, however, and does not exclude the use of electrical impulse producing magnetic pick-ups in case magnetic marks are employed on the master or electrical feelers or other pick-ups in case punched holes are used on the master.

In use a master is of the type illustrated in FIG. 2 and the clock signals are produced by rotation of the scanner shaft, the signals are fed to an amplifier 42', which takes the place of amplifier 42, from an electrical pick-up such as the coil 43, responsive to rotation of a magnet 44 carried by the scanner shaft 33 as illustrated in FIG. 6a.

A suitable counter 45 serving as a clock counter is connected to the output of the clock pulse amplifier 42 or 42'. For synchronizing and indicating the significance of the output signals from the data scanner pick-up 38, an AND gate circuit 46 is provided to which the outputs of the clock counter 45 and the data scanner amplifier 41 are supplied. In order that the data output of one master may be processed while the preceding master is being reproduced a data storage device or memory 47 is provided which receives the output of the AND gate circuit 46.

First and second feeder controls 48 and 49 are provided for the conventional paper feeders 14 and 15 in the duplicator 51. In the form of circuitry illustrated by way of example, subtracting counters 52 and 53 are provided for actuating the feeder controls 48 and 49 when the desired number of copies stored in the mem-

ory 47 has been produced. The subtracting counters 52 and 53 are responsive to the output of AND gate circuits 54 and 55 respectively, each having input from the storage 47 through lines 56 and 57, respectively, and an input from a counter-accept line 58.

The storage also has an output line 59 to a distributor. Provision is made for erasing the information in the storage 47 when this information has been utilized for actuating the counters 52 and 53. As illustrated in FIG. 6 schematically, it takes the form of a line 62 from the counter accept line 58 through a delay device 65 to a line 66 to storage erase circuits. The subtracting counter arrangement is indicated in greater detail in the logic diagram of FIG. 7. The logic diagram for the scanning and clocking device is shown in FIG. 9 or 10.

FIG. 8 illustrates the type of circuit which may be employed for the clock counter, the storage, and the subtracting counters for the feeders and the distributor pockets. As shown, there is a plurality of electronic valves 67 which may be of the solid state transistor type in cascaded, cross-coupled pairs to form successive bistable circuits, each bistable circuit or pair of transistors being capable of being shifted from one bistable state to the other by output from the previous stage or pair of transistors. Suitable cross-coupling elements including resistors 68, capacitors 69 and diodes 71 are employed. The transistors 67 are shown as PNp by way of example. Power is supplied through a negative terminal 1, which may by way of example be \(-15\) volts. An over bias terminal 2 is provided. Input counting signals are supplied at a terminal 3 to either side of the first stage, and output signals of successive digital orders are taken at terminals 4, 6, 8, and 10. There is a grounded or zero-volt terminal 5 and positive bias is supplied at a terminal 7, for example at 9 volts. A terminal 9 is provided for reset signals to restore all stages in parallel to zero position. The functioning of the circuit of FIG. 8 as counting device is illustrated in a logic diagram of FIG. 8a. In the interests of space economy, the circuit of FIGS. 8 and 8a is shown as having a 4 bit capacity. It will be understood, however, that it may be extended to embrace as many bits as required for the particular application.

FIG. 7 is a logic diagram illustrating the arrangement of elements in the subtracting paper counters, such as the counters 52 and 53, which are shown as being of the binary type, and which are used in place of the mechanical or electrical counters usually found on such duplicators. In the arrangement illustrated, the first counter 52 is a 7 bit binary counter and the counter 53 is a 6 bit binary counter, each having both a serial input and a parallel input. In serial input lines 72 and 73, outputs from AND gates 54a and 55a are received, which have inputs from enabling signal lines 74 and 75 which are energized by the relays which cause paper to feed from the feeders, and from a signal generator which acts each time a sheet is fed from the feeder. Output terminals from the storage devices are connected to the respective parallel input lines for the first and second subtracting counters represented schematically by the cable bundles 76 and 77. The outputs from the counters 52 and 53 are supplied through AND gates 78 and 79 to control lines 81 and 82 for controlling the first and second feeders.

FIG. 9 is a logic diagram illustrating the arrangement of the scanning and clocking device when the clock...
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pulses are obtained from the rotation of the scanner shaft 33 by a magnetic pulse generator 43. The clock counter 45 has its input terminal 3 connected to the output of an AND gate 88 one of whose inputs is the output of the amplifier 42 of the clock signal pulse generator 43, the other inputs being the output of a clock inhibitor 83 via an output line 87, and a scanner return inhibit line 84 (See FIG. 11) which likewise supplies an AND gate 90 whose other input is derived from the data scanner amplifier 41 and whose output is the data pulse line 92. The clock counter 45 also has a parallel reset line 85 connected to its parallel reset terminal 9.

The clock inhibitor 83 has a signal input terminal 89 receiving the output of the data scanner amplifier 41, and has a reset terminal 91, the latter supplied from the reset line 85. The output signal terminals of the clock counter 45 are connected through a fragmentarily represented logic circuit 46 to parallel input terminals in the memory stages of the storage 47.

FIG. 10 illustrates a logic diagram corresponding to FIG. 9 except for an arrangement in which clock marks are provided on the master, and the clock mark scanner pick-up 39 is employed. In this case the clock inhibitor 83 is not required since the clock marks on the master are not continued beyond the number required for synchronizing the code marks in the information line of the master.

The arrangement for producing data signals or clock mark signals when the clock marks are placed on the master in the case of a photoelectric type of scanner is illustrated in FIG. 12. There is a lamp (not shown) for projecting a beam of light on the data spaces in the master through a suitable optical lens system (not shown), and a photoelectric response device such as a selenium cell 98 for example, which has relatively low resistance, for example 300 kilohms, when the light is reflected upon it but increases to a relatively high resistance value, for example 20 megohms, when the beam of light reaches the dark mark on the master so that relatively little light is reflected to the photoelectric device 98. The photo responsive device 98 is connected in series with a resistor 99 having a resistance comparable with that of the photoelectric device 98 when it is dark, for example of the order of 10 megohms.

The elements 98 and 99 are connected in series across a power supply having terminals 101 and 102 which may for example be at +9 volts and -15 volts with a grounded or zero-volt terminal 103. Two amplifier stages are provided including solid state devices such as NPN transistors 104 and 105 connected between power supply terminals 102 and 103 and having load resistors 106 and 107 respectively. The transistor 104 has a base 108 connected to a junction terminal 109 of the photoelectric response device 98 and the resistor 99 and the transistor 105 has a base 111 connected to the collector terminal 112 of the transistor 104, which is in turn slightly positively biased through a resistor 113 connected to the positive bias terminal 101. The collector terminal 114 serves as the signal output terminal of the amplifier. When the photoelectric response device 98 is darkened upon scanning a black mark on the master its resistance rises, causing potential of the junction terminal 109 and the transistor base 108 to rise thus cutting off the flow of current in the transistor 104, permitting the potential of the terminal 112 to fall from approximately zero volts to very nearly the potential of the negative terminal 102. This lowers the potential of the base 111 of the transistor 105 causing it to become conducting. Current then flows through the load resistor 107 raising the potential of the signal output terminal 114. In this manner a positive voltage pulse is supplied by the amplifier whenever a code mark is scanned. It will be understood that the scanner and amplifier shown in FIG. 12 represents a circuit usable as the scanner and amplifier 38, 41 of FIGS. 9 and 10 or 39, 42 of FIG. 10.

The feeding of paper in a duplicator 51 such as that illustrated in FIG. 1 is caused by conventional means controlled by a relay. Such a control, specifically the control 48, is represented in FIG. 13 by a relay winding 115 operating contacts which perform conventional functions in such apparatus. However, in accordance with the present invention, circuit devices such as hereinafore described are employed for the control of the feeder relay winding 115 as illustrated in FIG. 13. Each control relay is actuated by the output of one of the subtracting counters through a diode gate and amplifier means.

An amplifier 117, shown as being of the solid state PNP transistor type, is provided which is connected in series with the feeder relay winding 115 and a direct current power supply circuit having positive terminal 118 represented as being grounded or at zero volts and a negative terminal 119 represented as being -15 volts.

The transistor 117 has a base 121 supplied by the output of the stages of the subtracting counter 52 or 53 through diode AND gate 78 (or 79) and normally closed contacts 115a of the feeder relay which are associated with and driven by the winding 115. As shown the base 121 is positively biased by the AND gate 78 so that the transistor 117 and the winding 115 normally do not conduct current. The winding 115 is not energized while the subtracting counter is waiting to be satisfied. When the counter is satisfied, all the diodes of the AND gate 78 go negative and the transistor 117 conducts. This energizes the winding 115 and causes the associated normally closed contacts 115a to open, allowing the base 121 to be held negative by the bias resistor 123 connected to the negative terminal 119. A reset terminal 124 is provided which is connected to the base 121 for resetting the transistor to non-conducting condition when a positive pulse is supplied at the terminal 124.

A suitable amplifier for the counting pulses received from a magnetic induction-type clock pulse generator 43 is illustrated in FIG. 14. It includes a pair of amplifier stages such as PNP transistors 125 and 126 connected across a direct-current power supply source having a zero-volt terminal 127 and a negative voltage terminal 128. The stages are connected as collector follower stages with collector resistors 131 and 132. A signal output terminal 133 is connected to the collector of the transistor 126.

The input circuit of the transistor 125 includes a resistor 136 biasing the transistor 125, and a resistor 137, a capacitor 138 and the pulse generator 43 series connected between the base of a transistor 125 and the negative terminal 128. The generator 43 is shunted by a rectifier or diode 139, poled so that only positive pulses from the generator 43 are supplied to the transistor 125. The circuit of FIG. 14 represents in more detail the pulse generator amplifier combination 43, 42 of FIG. 9.
As illustrated in FIG. 15 the clock inhibitor 83 is a bistable circuit which may comprise a pair of solid state devices such as PNP transistors 141 and 142 connected to a grounded or zero volt power supply terminal 143 and negative power supply terminal 144, for example at $-15$ volts, through collector resistors 145 and 146 and cross coupled through resistors 147 and 148 shunted by capacitors 149 and 150 of high capacity such as one-tenth microfarad. The bases of the transistors 141 and 142 are preferably positively biased through resistors 152 and 153. Signal input is provided through the terminal 89 from the data scanner amplifier 41 to the base of the transistor 141 through a resistance-capacity circuit 154. The external reset line 91 is coupled to the base of the transistor 142 through a resistance-capacity circuit 155.

The arrangement of the storage device 47 is illustrated by the logic diagram of FIG. 16 representing the connections of the binary units employed. Registers or groups of storage stages 156 and 157 are provided for storing the data concerning the number of sheets to be duplicated from each of the two copy sheet hoppers, and are caused to discharge their data into the subtracting counters 52 and 53 via lines 76 and 77 upon reception of a counter accept signal via counter accept line 58. Such a signal triggers the AND gate circuits 54 and 55 (fragmentarily illustrated) at the appropriate time to cause transfer of the stored data. The counter accept line 58 is also connected through a line 62 and through a delay device 65 to a line 66 for supplying a storage erase impulse to the storage after the subtracting counters have emptied.

In order that the desired number of copies will be placed in each of the pockets 18 of the distributor 17, the storage 47 also includes registers 170 and 171 for the first group of pockets. For simplicity in the drawing only two such pocket counters are shown, although there may be a greater number. For distribution in excess of such a predetermined number of pockets, an additional general distribution program register 172 is provided and instruction tapes, which may be punched tapes or magnetic tapes, are provided containing the instructions for any desired additional number of pockets together with suitable tape reader and distributor control thereby. The general distribution program register 172 is arranged to select by code number and activate the reader for whichever one of such tapes is desired. While not illustrated in this view, it will be understood that suitable analogous counter accept circuitry including appropriate AND gate circuits similarly related to the storage stages 170, 171, 172, and similar storage erase provisions, will be provided on the distributor frame and will be suitably timed and triggered on the basis of the chosen pattern of distributor functions. The counter accept signals in either case will be drawn from any suitable machine function occurring at the appropriate time for transfer, such as the signal for ejecting a master from the master cylinder in the case of line 58, and the signal which indicates completion of the previous count or program in the case of the distributor apparatus.

The master 19' illustrated in FIG. 3 for use with the clock marks on the master is shown blank. It will be understood, however, that if desired the masters may be pre-printed with the black marks in every space of the clock track 37 for the number of spaces utilized in the information track 36. The masters may be produced in any desired manner. For example, blanks printed in manner illustrated by FIGS. 2 or 3 may be provided with the rectangles delineating space for signal marks already printed on the blanks. Then whatever message is to be duplicated is typed, written or drawn on the blank. If clock marks have not already been preprinted in the spaces 27 these are marked in with black pencil or black crayon and suitable markings for the digital code representing the desired information in the spaces 22, 23, 24, 25, 26, 27 and 28, referring to FIG. 2, (or their corresponding spaces in FIG. 3) are marked in with black pencil or crayon. Then the filled in sheet forms a completed master and is utilized to produce copies on a duplicator of the type illustrated in FIG. 1.

If desired a projector 173, FIG. 17 may be utilized with suitable lens system 174 for projecting an image from a typed or written sheet 175 on a photosensitive master 19' which is subsequently developed in the usual manner. If it is desired to use an original sheet not preprinted with the spaces for code markings, a separate blank 176 with the code markings may be placed in a separate projector 177 and projected along edges 20' and 21' of the photosensitive master at a location which lies beyond the normal typed or printed page on which the message normally appears.

Instead of printers 173 and 177 there may be provided, if desired, printers of the cathode ray tube type used in photo typesetting described by Klenisch and Simhauser in "The CRT in Photo Typesetting Systems" - IEEE Spectrum, Volume 6, No. 9, pages 75-80, September 1969. As another alternative, the masters may be output of computers in a high speed line printer which prints not only the next material but also the code and clock marks for the rows 36 or the rows 36 and 37 on the margin of each master.

Suitable means are provided for causing the scanner to make an excursion along the edge tracks of the next exposed master at either the side or the end, according to the arrangement selected, whenever the top master is removed from the hopper and placed in printing position with respect to the roll of the duplicator. Then the scanner is arranged to return at the end of the scan so that the master which has been read may in turn be transferred from the hopper to the printing position and the next master code marks may be read, etc. Preferably a reversible drive motor 178 is provided having a separate winding 179 for a forward movement and winding 180 for reverse rotation to produce a return movement as illustrated in FIG. 11. Any desired type of reversible motor may be employed.

The circuit of FIG. 11 can best be understood by considering that circuit means in the duplicator 51 provide, in a known manner, at an intermediate point in the previous printing cycle, whenever it is time to feed a new master into ready position, a maintained alternating voltage on line 183 which may be considered a "master feed signal," and that lines 192 would normally carry the effect of this signal directly to the master feed clutch. As soon as the master being fed in response to this signal will have progressed out of the hopper and into a certain position approaching the cylinder, its presence will be sensed and circuitry on the duplicator will terminate the master feed signal on line 183. The circuit of FIG. 11, however, acts as a delay circuit superimposed upon this normal function, and so controls switching as to prevent forwarding of the mas-
ter feed signal from line 183, when received, until after the scanning of the master about to be fed has been performed.

If alternating current is the supply source, the motor may be of the single-phase, split-phase condenser type having a condenser or capacitor 182 interposed in the connections. The connections are shown only schematically in FIG. 11 since reversible motors are well known to those skilled in the art. The motor 178 is connected in a circuit between line 183 which is energized by the master feed signal and a return or common line 184 which may be neutral or ground line. The forward winding 179 is normally energized when voltage appears on the line 183. There is then a circuit from the line 183 through normally closed contacts 185a of a limit relay, which has a winding 185, the motor winding 179 and the return line 184. There is also a circuit from the line 183 through normally closed contacts 185c of the limit relay 185 and a winding 187 of a scan relay to the return line 184.

In addition there is also a potential connection from the line 183 through normally open contacts 185b of the limit relay 185, contact B of a double throw scan home switch 186 which normally lies on its contact A, but senses the home position of the scanner and shifts to its contact B in response to activation by the scanner head upon arrival thereat. This connection further proceeds via line 190, the normally closed contacts 187a of the scan relay 187, the input or alternating-current terminals of a full-wave rectifier 189 and back to the return line 184, but this circuit is open whenever voltage first appears on line 183 since the relay 185 is not energized and contacts 185b are normally open. The direct-current output terminals 191 of the full-wave rectifier 189 are connected through lines 192 to the winding of a conventional master feed control clutch (not shown).

A normally open scan limit switch 181, in circuit between the line 183 and the limit relay winding 185, is mounted at the end of the forward travel of the scanner, and when activated, energizes winding 185 to open the contacts 185e and 185c and close the contacts 185b to start the return travel of the scanner. At this point, of course, the scan home switch 186 is unaffected by the scanner and therefore lies in normal position on contact A completing the circuit to the return motor winding 180. Since it is off of contact B the circuit to the rectifier and line 192 is still incomplete. There are also relay contacts 185e which are normally open, and which close when the limit relay winding 185 is energized. Since they are in parallel with the scan limit switch 181 they provide a holding circuit for maintaining energization of the return motor winding 180 even after the scanner carriage backs off the limit switch 181.

When the carriage completes its return excursion it strikes the switch 186 and moves it to contact B breaking its circuit and stopping the motor. Since limit relay 185 is still held in by its holding contacts 185e, contacts 185b are closed and 185c are opened, deenergizing scan relay 187 allowing contacts 187a to close. There is now a circuit from line 183 through switch 185b, switch 186 on contact B and switch 187a to the rectifier and line 192, causing the master to feed out of the hopper and into a position where it eliminates the voltage signal on line 183, thus causing relay winding 185 to drop out and restoring the circuit of FIG. 11 to its initial state.

The limit relay winding 185 also has normally open contacts 185a in the inhibit clock counter return line 84 of FIGS. 9 and 10. The scan relay winding 187 has normally open contacts 187b in the parallel reset line 85.

In the apparatus illustrated the scanning is intended to be done with the master in static condition. As illustrated in FIGS. 4 and 5, the scanning head 35 travels toward the lower right hand corner (See FIGS. 2 and 3) of the master in either of the two attitudes of the motor driven lead screw 33. Then the head returns to await another signal to scan.

The track markings containing the information blocks may be printed with a non-reproducing ink of low color contrast so that they will not be seen by the photoelectric responsive devices nor will they be printed. However, if it is desired that the clock and information marks be in the same medium as the printed image, the clock and information tracks can be located in the margin of a master that is larger than the printed copy so that the marks will be beyond the edge of the copy.

As illustrated, in FIG. 2, the information field is made up of eight items of information. The first three and the last two deal with the duplicator proper and the remainder deal with the distributor. Those dealing with the duplicator proper are the index block 22, the “first hopper” block 23 the “last of set” block 24 (which represent any particular two duplicator functions which it is designed to control), the first feeder counter blocks 25, and the second feeder counter blocks 26. The two groups of blocks designated 27 are for distributing to the first two distributor pockets, and the last group of blocks 28 are for the selection of an appropriate general distributor program.

In the alternate embodiment of the invention, represented by the master of FIG. 3, there are two rows of track markings on each margin, one for information marks and one for clock marks, designated 36 and 37 respectively. The clock marks in row 37 must appear one in each block, and they are counted serially in the binary manner by the clock counter illustrated in FIG. 10.

In the FIG. 2 embodiment the counting pulses are generated by rotation of the shaft 33 and are counted serially by the clock counter illustrated in FIG. 9.

The clock counting arrangements in the two forms are largely analogous, however, so that the scanning operation will be described in detail mainly for the FIG. 2 form, from which the corresponding operation for the FIG. 3 form will be readily apparent. In this embodiment there are no clock marks on the master nor is there a clock mark scanner. In an illustrative arrangement, the lead screw 33, the revolutions of which are counted, has ten turns to the inch and makes one revolution for each of the information blocks 24 which are spaced one-tenth inch apart. On the approach to the information field, the clock counter is inhibited from counting by the clock inhibitor 83 shown in FIG. 15. The first information block, the index block 22, requires a mark in every case. When the photoresponsive device sees a mark in this information block 22, the inhibitor state 83 flips over and enables the clock counter to make use of the amplified magnetic pulses delivered to the gate 88 in FIG. 9.
At the end of its travel the lead screw drive motor is reversed and the scanning head is returned to its starting position. During the return travel both the clock counter amplifier 42 and the information pick-up amplifier 41 are inhibited from transmitting count signals to the clock counter 45 and the storage 47.

Reverting momentarily to the embodiment of FIGS. 3 and 10, as the scanning head travels over the field, the clock counter 45 counts all the spaces since each will contain a mark. When the data scanner 38 sees a mark at a particular block a "yes" signal combines with the clock counter output, at that time, and a discrete AND gate which is associated with that particular count value, such as gate 194, 194' or 194", sends a signal into storage (FIGS. 10 and 16). Storage is necessary because the subtracting counters are still in use, being now occupied in performing the function ordered by the previous master. While specific storage stages have not been illustrated for the functions represented by spaces 23 and 24 on the master track, it will be readily understood that similar storage provision for these can be made if required.

After the scan the duplicator completes its cycle and ejects the old master and inserts the new one. The storage in it the information relative to the new master that is being put on the cylinder. Since the subtracting counters are through with counting for the old master, they can now accept the information for the current master out of storage. This is done by a counter accept signal from a set of contacts on a conventional sequence start relay (not shown) in the duplicator 51 through line 58 and discreet AND gate circuits 54 and 55 (FIGS. 6 and 16).

On this transfer, the complement of the desired count is put into the subtracting counters 52 and 53 shown in FIGS. 6 and 7.

Then, when the paper feed begins, they need only to count to saturation and the function takes place. The relay or control 48 that causes paper to feed from the first feeder provides the enabling signal via AND gate 54a to the first counter, and the relay 49 that causes paper to feed from the second feeder provides enabling signal via AND gate 55a to the second counter as illustrated in FIG. 7.

Before either of the counters count to saturation the zero level voltages come through the diode gate 78 of the subtracting counter as illustrated in FIG. 13. This view represents specifically the gate arrangement in connection with counter 52, but, except for the number of bits, it is also representative of the gate associated with the counter 53. All or any one bit of the subtracting counter can keep the transistor 117 backward biased. When all the bits go to minus 15 volts, the transistor 117 is forward biased, pulls in the relay 115, opens the normally closed contact 115a between gate 78 and the base 121 of the transistor 117 and the transistor 117 is thereafter forward biased until the reset signal is applied to the base 121 from the line 124. The relay stops the feed of the associated feeder via one of its normally open contacts 115b (FIG. 13) which, upon closing, provide a feeder stop signal to the conventional circuit (not shown) which governs feeder operation.

**DISTRIBUTOR**

The first group of two pockets 18 of the distributor 17 are counter controlled. The remainder of the distributor pockets, along with the general distributor program, are tape controlled. There is a choice on each master of a predetermined number of tape programs, for example 31. The first two pocket counters in the illustrated apparatus are shown as having each a 31 sheet capacity. The voltages are retained in the memory device for a period of time from when the master is scanned until the end of the duplicator cycle. At that time, the memory data is transferred to suitable subtracting counters in the distributor, similar to the previously described sheet feed counters (or in the case of register 172, to an appropriate tape selection circuit) and then the storage is erased. This is effected by duplicator counter accept and storage erase circuits corresponding to the circuits 58, 65 and 66 for the feeder counters. Thus the memory of FIG. 16 can command the number of sheets to be accepted by each of the first two distributor pockets (registers 170 and 171) and can command which of the thirty-one general program tapes to employ (register 172). The general distributor program tape which is thus selected controls the number of sheets that the remainder of the sorter pockets will accept.

Certain embodiments of the invention and certain methods of operation embraced therein have been shown and particularly described for the purpose of explaining the principle of operation of the invention and showing its application, but it will be obvious to those skilled in the art that many modifications and variations are possible, and it is intended therefore, to cover all such modifications and variations as fall within the scope of the invention. It will be recognized, for example, that although the preferred form shown involves reading the data on a master in the hopper, or before it reaches the master cylinder, this function can just as well be performed with the master on the master cylinder during the printing operation, in which case the indicia on the master can be read directly and applied to the printing operation of the current master without necessarily being held in memory. In a particular example, a peripheral location of the indicia relative to the home position of the master cylinder can be used to indicate the number of copies to be printed, and the signal derived from the sensing of this indicia directly on each revolution can be combined with information derived from a stepping operation occurring at the feed of each sheet. When the signals coincide a further signal would result, stopping the copy paper feed and/or shutting off the printing machine at the number of copies represented by the indicia on the master margin.

What is claimed is:

1. An apparatus for reproducing an image from a master onto a plurality of sheets of material and distributing the sheets of material to receiving locations in accordance with control data on the master, said apparatus comprising reproducing means having a master thereon for reproducing on each of a plurality of sheets of material in turn the image on the master, means defining a plurality of sheet material receiving locations for holding sheets of material having images produced thereon from the master, reader means disposed adjacent a position occupied by the master in the apparatus for sensing control data on the master and generating signals corresponding thereto, and distributor means between said reproducing means and said receiving locations receiving a series of individual sheets from said reproducing means and feeding them each in turn to one of said receiving locations, and control means op-
eratively associated with said reader means and responsive to said signals for controlling the operation of said distributor means in a manner to direct to each receiving location the number of sheets determined by the control data on the master.

2. An apparatus as set forth in claim 1 in which said control means further includes data storage means for holding a plurality of programs each of which contains data indicative of a different numerical pattern of distributing sheets to at least some of said received locations, and in which said reader means includes means for sensing control data on the master indicative of at least one of said plurality of programs, said control means also including means for controlling said distributor means as to direct to at least some of the sheet material receiving locations numbers of sheets which are in accordance with the program indicated by the control data sensed on the master by said reader means.

3. An apparatus as set forth in claim 1 further including storage means adjacent the reproducing means for holding a plurality of masters on each of which is disposed an image and control data, means in operative association with said storage means for transferring each of the plurality of masters in turn from said storage means to said reproducing means, and means supporting said reader means at a location adjacent to said storage means to enable said reader means to sense the control data on each of said masters in turn prior to utilization of the masters to reproduce images on sheet material.

4. An apparatus as set forth in claim 3 further including means operatively associated with said reader means for effecting operation of said reader means to sense control data disposed on the master prior to the reproduction of images from the master onto the sheet material, said control means including data storage means operatively associated with said reader means and said distributor means for receiving therefrom data corresponding to the control data sensed by said reader means on the master prior to reproduction of the images from the master on the sheet material and retaining the same for subsequent control of operation of said distributor means during use of the master for reproduction.

5. An apparatus as set forth in claim 1 wherein the control data on the master to be used by the apparatus is in the form of a linear indicia track, and wherein said reader means includes a single sensing device for sensing the control data on the master and producing signals in response thereto and means for progressing the single sensing device and the master relative to each other in such direction that the sensing device effectively proceeds lengthwise of the indicia track on the master and generates signals serially in response thereto, said control means including means to store the signals received serially from said reading device as electrical control information accessible in parallel.

6. A device as set forth in claim 5 in which the information on the indicia track is arranged in distinct indicia unit positions, in which the signal storage means is a digital device having bistable storage stages corresponding each to an indicia unit position on the master indicia track, in which control means are also provided for directing the serially incoming indicia unit signals each to its corresponding storage stage, and in which the distributor means includes acceptance storage stages corresponding to said bistable storage stages, and which includes means for transferring in parallel the information in each bistable storage stage to the corresponding acceptance storage stage.

7. A device as set forth in claim 6 in which the control means for directing the incoming unit signals comprises a clock counter generating counting signals and an AND gate matrix jointly responsive to the clock counter signals and the input unit signals.

8. A device as set forth in claim 7 in which there is also provided a clock counter coacting with said signal storage means, and a second sensing device mechanically associated with the first sensing device so as to read a clock track on the master parallel to the linear control data indicia track, with individual positions corresponding to the unit positions on the control data track, at the same time as the control data track is being read, said second sensing device generating signals for stepping the clock counter.

9. An apparatus for sequentially reproducing different images onto a plurality of sheets of material from a plurality of masters and distributing the sheets of material to receiving locations in accordance with control data on the masters, said apparatus comprising master storage means for holding a plurality of masters, reproducing means for receiving each of the masters in turn from said master storage means and for reproducing images from each of the masters in turn on a plurality of sheets of material, master feed means operatively associated with said master storage means and said reproducing means for sequentially feeding masters from said master storage means to said reproducing means, reader means disposed adjacent to said master storage means in operative relation to masters stored therein for sensing indicia on each of said masters in turn prior to feeding of the master to said reproducing means and transmitting data corresponding to the master indicia, data storage means for receiving and storing data from said reader means, means for defining a plurality of receiving locations for holding sheets of material, and distributor means operatively associated with said reproducing means to receive sheets sequentially therefrom, connected with said data storage means and responsive to data received therefrom for distributing to each receiving location the number of sheets determined by data in said data storage means.

10. An apparatus as set forth in claim 9 wherein said master storage means is a hopper for holding a stack of masters and said reader means includes means located above said hopper for sensing control data on the top master of the stack of masters prior to feeding of the top master toward said reproducing means by said master feed means.

11. An apparatus as set forth in claim 9 further including control means operatively associated with said reader means, said data storage means, and said distributing means for effecting operation of said reader means to sense control data on one of the plurality of masters during operation of said reproducing means to reproduce on sheets of material an image from another previously read master.

12. An apparatus for reproducing an image from a master onto a plurality of sheets of material and distributing the sheets of material to receiving locations in accordance with control data on the master, said apparatus comprising reproducing means having a master thereon for reproducing on each of a plurality of sheets
of material in turn the image on the master, means for defining a plurality of sheet material receiving locations for holding sheets of material having images produced thereon from the master, data storage means for storing a plurality of different sheet distribution programs each of which includes data corresponding to a different numerical pattern of distributing sheets to at least some of said receiving locations, reader means disposed adjacent said reproducing means for sensing control data on the master indicative of one of said plurality of programs corresponding to a desired pattern of numerical distribution to at least some of said receiving locations of sheets having images thereon reproduced from the master and operatively associated with said data storage means to activate the appropriate program in accordance with the control data on the master, and distributor means between said reproducing means and said receiving locations for distributing to said receiving locations a number of sheets determined by the program corresponding to the control data sensed on the master by said reader means, said distributor means including means for receiving from said reproducing means a series of sheets of material having images thereon reproduced from the master, and control means cooperating with said distributor means and operatively associated with said data storage means for causing the distributor means to direct to said receiving locations numbers of sheets determined by the program corresponding to the control data sensed on the master by said reader means.

13. An apparatus as set forth in claim 12 wherein said reader means, in addition to means for sensing control data on the master indicative of one of said plurality of programs, further includes means for sensing second control data on the master indicative of a number of sheets to be distributed to one of said receiving locations, said further included reader means being operatively associated with the control means for the distributor means, and said control means including means cooperating with said distributor means for directing to said one receiving location a number of sheets which is determined by said second control data sensed on the master by said further included reader means.

14. An apparatus as set forth in claim 12 further including master storage means adjacent said reproducing means for holding a plurality of masters on each of which is disposed an image and control data, transferring means adjacent said master storage means for transferring each of the plurality of masters in turn from said master storage means to said reproducing means, and means supporting said reader means at a location adjacent to said storage means and said reproducing means to enable said reader means to sense the control data on each of said masters in turn prior to utilization of the master to reproduce images on sheet material.

15. An apparatus as set forth in claim 14 wherein said master storage means is a hopper for holding a stack of masters and said reader means includes means for sensing control data on the top master of the stack of masters prior to transfer of the top master toward said reproducing means.