Electrophotographic information printer.

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WO-A-80/02464
GB-A-1 570 870

"STEP MOTORS AND CONTROL SYSTEMS"
edited by B.C. Kuo SRL Publishing Company,
Champaign, Illinois USA

The file contains technical information
submitted after the application was filed and
not included in this specification

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Description

The invention relates to an electrophotographic reproduction printer comprising a xerographic reproduction system including a sheet supply device with sheet feeding means for feeding individual sheets to a sheet advancing path, a photoconductor and image transfer device arranged at the sheet advancing path for transferring a toner image developed on a movable photoconductor to a sheet arriving at the sheet advancing path and means for conveying the sheet after the image transfer to a fixation device.

Information printers for use in connection with data and word processing systems may essentially be divided into two main categories. In one category, the transformation of electronic character information into printed information on a paper sheet is performed by means of writing devices operating with mechanical impact in connection with carbon ribbons in the same way as is known from manually operated typewriters. Printers of this category comprising, inter alia, matrix printers and daisy-wheel printers have a relatively low speed and have appeared in practice to be rather sensitive in mechanical respects and, in addition, in respect of reproduction performance they are limited to a definite number of characters.

The other main category operates without mechanical impact and comprises mainly so-called jet-ink printers, a machine operating with an electrophotographic transfer of information in connection with the xerographic reproduction technology known from usual copying machines. In particular, machines of the latter kind comprise laser printers, in which an electrostatically latent image is formed on a photoconductor by means of a controlled laser beam. Due to the very high printing speed and the fact that in respect of information reproduction they are not limited to a definite number of e.g. alpha-numerical characters defined e.g. by the characters on a daisy-wheel, these machines are finding increasing use.

The electrostatically latent image is developed by means of toner powder and is transferred to a paper sheet and affixed thereto under use of the well-known xerographic technology.

Since the starting point for such information printers has been the technology known from usual xerographic copying machines, these machines are designed, in practice, in the same way as conventional copying machines with a number of processing stations comprising:

- a photoconductor station with an electrostatically chargeable, movable photoconductor;
- an imaging station in optical information transfer relation to the photoconductor station;
- a developer station with a toner development system and a toner cleaning station arranged in operative relation to the photoconductor station;
- an image transfer station arranged in operative relation to the photoconductor station for transferring a toner image on the photoconductor to a sheet-shaped printing material;
- a fixation station for permanently affixing a toner image to the printing material; and
- advancing stations arranged between a sheet feed supply and the image transfer station and between the latter and the fixation station, respectively.

As a driving means, use is made in such machines of a single motor for several mechanically movable, usually rotatable members, such as a photoconductor drum, sheet advancing rollers, and toner transport mechanisms, complicated transmission means being often used between the driving means and the individual rotating members or between the latter mutually.

As in the case of conventional copying machines, this machine design makes maintenance heavily complicated and often results in interruptions of operation of long duration, since irregularities in the mechanical functions usually require a difficult and time-consuming repair involving replacement and/or adjustment of components which are frequently difficult to access.

Whereas these disadvantages may usually be tolerated in connection with conventional reproduction equipment, they will often be considered unacceptable in connection with data and word processing systems and in this field attempts are made to circumvent them by use of spare equipment with the cost penalties resulting therefrom.

GB—A—1570870 discloses a conventional copier, where paper supply bins are lowered and lifted by reversible elevator motors. There is a centralised electronic process feedback control system, described as the copier logic control system. The sheet supply devices with their respective sheet feeding means are structured as one individual replaceable module.

WO—A—8002464 discloses a printer for continuous sheets of the kind used in computer systems with a pulley driven by a motor via a belt. Also so-called fan fold paper is shown.

GB—A—1446531 discloses a reproducing apparatus with a unit module which comprises several processing stations. The drive arrangement comprises a conventional motor in connection with a belt drive.

GB—A—2041830 discloses a similar arrangement, in which the module comprises several distinct operating functions with a common drive motor for the photoconductor, the sheet feeder and the transfer roller.

A publication "Step Motors and Control Systems" edited by B. C. Kuo and published by SRL Publishing Company, Champaign, Illinois, USA, discloses a number of uses of step motors, including in photocopying machines and in serial and line printers, and more particularly as a motor drive for the paper-feed mechanism of a word processor or printer, and to control the print wheel of a word processor or terminal printer.

Due to the high printing speed of non-impact information printers of the xerographic type, the sheet supply device which picks up sheets individually from a sheet supply and advances them into a sheet advancing path leading to the image
transfer station must be able to perform its functions quickly and reliably in an exactly timed relationship to the rotation of the xerographic device so that a sheet advanced from the sheet supply will arrive at the image transfer station in synchronism with the powder image formed on the xerographic device.

Conventional driving means and transmission devices as mentioned above will normally impose restrictions on the structural design of the sheet supply device and its location in the machine frame with respect to the single drive motor and the image transfer station.

It is the object of the invention to provide a new design of an information printer of the kind mentioned above breaking with the conventional technical structure of electrophotographic machine through a very simple structural design resulting in a higher level of precision in the control of the mechanical movement operations, a considerably simpler maintenance and an increased flexibility with respect to machine structure and function.

According to the invention an electrophotographic information printer of the kind mentioned in the preamble and wherein said sheet supply device with sheet feeding means is structured as one individual replaceable module, is characterised in that said photoconductor and image transfer device is structured as another individual replaceable module, and each module comprises an individual drive means in the form of an electronic step motor which is mechanically coupled to at least one rotatable member within said module and the operation of which within an operational sequence of the information printer is directly controlled by selectively supplying drive pulses of a predetermined pulse number and pulse frequency from a pulse supplying device controlled by a program-controlled control unit.

As a result of this design of the sheet supply, the photoconductor unit and said further sheet advancing device as separate, individually replaceable modules, which may be inserted into supporting means in a frame structure of a machine housing in such a way that they may be individually removed from and inserted into the machine casing without interfering with the remaining modules, repair of a mechanical malfunction may take place by a simple and quick replacement operation.

As a result of the use of an electronic step motor as a driving means in each of these modules, use is not made of mechanical transmissions between the modules mutually or from the modules to a common motor, which also makes a major contribution to making the information printer more easy to service by improving the accessibility to all parts of the machine.

Operation of each step motor in a processing station is initiated by control from a common control unit which preferably comprises a microprocessor programmed to initiate the mechanical movement functions in said modules as well as other operations in a working cycle, such as charging and discharging of the photoconductor by means of corona wires at the right moments in a sequence of operations. By this control, the step motor will be individually supplied with pulse sequences which, without any need for feedback or position-sensing, causes it to rotate with prescribed speed or a prescribed angular turn. As a result thereof, an essentially more accurate control is obtained than is possible for conventional driving means in xerographic machines, since the operation of the driving means is linked and directly governed by the main control unit. Thereby, an essentially improved accuracy with respect to the operational cooperation between the sheet feeding means, the photoconductor and the further sheet advance means is obtained.

In an information printer in which the invention is embodied, the further advantage is obtained that operational parameters for the movement and other operational functions of the station may be changed individually by simple reprogramming of the control unit. Thereby, it is made possible for a given machine to make changes in the individual stations formed as modules concurrently with the development of technology without any need for changes in other parts of the machine.

Preferably the movable photoconductor, which may be a rotary drum, is driven by the respective motor through a belt drive.

In the following, the invention will be explained in further detail with reference to the accompanying drawings, in which

Fig. 1 is a perspective view of an information printer in which the invention is embodied;

Fig. 2 illustrates the connection of a number of module units to a coupling unit;

Fig. 3 is a block diagram illustrating the control of a step motor in an individual processing station;

Figs. 4 and 5 are function and pulse diagrams for explaining the control of the step motor; and

Fig. 6 shows the design of sheet cassette modules.

In the embodiment shown in Fig. 1, the machine casing of the information printer, the side walls of which are removed, comprises a box-like frame structure having vertical and horizontal frame members 1 and 2, to which supporting means, not illustrated, are secured in the form e.g. of sliding rails for the arrangement of the processing station designed as separate individually replaceable modules.

An imaging module 3, to which electronic information signal codes are supplied, is constituted in this embodiment by an electronically controlled line-scanning electro-optical device having a scanning direction, as shown by a light exit slit 4.

Such an electro-optical device may be constituted e.g. by a cathode ray tube having a high brilliance whereby the advantage is obtained that the imaging unit unlike other scanning imaging devices does not comprise mechanically moved scanning members.
module in the embodiment shown, whereby an optimum flexibility in respect of the machine design is obtained.

Fig. 2 also shows the photoconductor 8, which, as stated above, may be a rotary drum, is driven by the step motor 26 through a belt drive, and the driven member of the second sheet advancing module is driven by the step motor 25 through a respective belt drive.

For each module, the only external connection consists of a plug 27, 28 and 29, respectively, for direct insertion into terminal connections 30, 31 and 32 of a coupling unit 33, which may have the same design as the circuit card. The terminal connections 30, 31 and 32 are connected, on one hand, to a power supply unit 34 for supplying operational voltages to the modules and, on the other hand, to a common program-controlled control unit 35. The plugs may be fixed with respect to the individual modules as shown, or they may be connected therewith through relatively short wire conductors, for instance a multi-conductor flat cable.

The units 34 and 35 are arranged together with an interface module 36 on the side of the plate-shaped coupling unit 33 opposite the modules 9, 21 and 23.

The interface module 36 serves in a known manner as a matching device between the imaging module 3 and an electronic data or word processing system in accordance with the standard protocol applicable therefor.

Fig. 3 shows schematically the features of the design of a single processing station, for instance the above mentioned sheet feeding unit having the pair of rollers 19, 20, which are essential to this embodiment of the invention.

The driven roller 19 is connected through a toothed belt transmission 37 with the output shaft of an electronic step motor 38 which is supplied with drive pulses from a motor drive unit 39. In a module design, the motor drive unit 39 may be arranged in the module itself, possibly in direct integration with the step motor 38. The motor drive unit 39 is connected by means of a plug and socket connection 40 to the program-controlled control unit 35 which, as indicated by outputs 41, may be common to step motors in a number of different processing stations.

In a manner known per se, the step motor 38 is provided with a number, for instance four, pulse operated windings which may be actuated from the motor drive unit 39 so as to cause the step motor to perform a certain angular turn, for instance 1.8° or 3.6°, in one or the other direction of revolution dependent on the switching configuration of the drive windings, not illustrated, at each supplied drive pulse. Thus, the number of revolutions or the angular turn performed in a given operational phase for the step motor will be determined by the number of pulses, whereas their separation or the pulse frequency will determine the velocity and acceleration in the rotation of the step motor and the pulse power, i.e. the product of pulse height and width, will determine
the torque.

Thus, by controlling the supply of drive pulses from the motor drive unit 39 to the step motor 38, an arbitrary desired movement function of the step motor 38 and, thereby, of the member driven by it, in this case the roller 19, may be realized in practice.

In Figs. 4 and 5, an example thereof is illustrated purely schematically. Fig. 4 showing a movement diagram, for instance for the roller 19, for velocity $v$ as a function of time $t$. In this example, the course of movement illustrated by a curve 42 comprises an acceleration phase 42a succeeded by a rotational phase 42b of constant velocity. Such a course of movement may be realized by means of a pulse train of the form shown very schematically in Fig. 5, in which the separation of the pulses 43 in a first portion corresponding to the acceleration phase 42a is gradually reduced corresponding to a gradually increased pulse frequency, after which the pulse separation is kept constant in the succeeding part of the pulse train corresponding to the rotation phase 42b.

The generation of drive pulses in the motor drive unit 39 is actuated and controlled from the control unit 35 which may comprise a micro processor provided in a manner known per se with an internal clock unit and a program memory, for instance of the EPROM type. In the program memory of the micro processor, programmes or subroutines for the actual movement function to be performed of each of the step motors controlled by the control unit in the operational phase associated therewith within the entire operational sequence are stored in addition to the main program for the entire sequence of operations to be performed by the processing stations controlled by the control unit.

Each of these subroutines comprises complete information about the pulse train to be generated in the motor drive unit 39 for the performance of the desired movement function. The motor drive unit 39 comprises a pulse generator for generating drive pulses of the pulse power necessary to obtain a desired torque, and a logic circuit which, under control by the information supplied from the control unit establishes the switching configuration for the windings of the step motor corresponding to the rotation in the desired direction of revolution, on one hand, and supplies the drive pulses to the step motor in a pulse train comprising the prescribed number of pulses with the prescribed mutual separation thereof, on the other hand.

For a given machine configuration, the desired movement function for a given step motor in a certain operation phase within an operational sequence, as well as the drive pulse train from the motor drive unit 39 associated therewith and the control information contained in the associated subroutine in the micro processor will remain unchanged, so that each subroutine is burned in fixed form into the program memory.

However, the design of the program memory as an EPROM type memory opens a simple and advantageous possibility of reprogramming of any stored movement function with the possibility resulting therefrom for individual change of the operational parameters for a single processing station without interfering with the functions of the remaining processing stations.

As a particular embodiment of a processing station, the advancing module 47 designed as a sheet feeding unit is shown in Fig. 6.

In the design illustrated, the sheet advancing rollers 19 and 20 and a guide wall 43 cooperating therewith are positioned below a sheet outlet opening 44 in the upper wall of a cassette 45 outside a sheet supply 46 positioned therein.

For cooperation with one or more underlying cassettes 47, only one of which is shown in Fig. 6, an opening 48 is, furthermore, provided in the bottom wall of the cassette 45 to receive sheets from the cassette 47.

In principle, the cassette 47 is designed in the same way as the cassette 45 in respect of the positions of a sheet collecting roller 49 and sheet advancing rollers 50 and 51. However, in this case the guide wall 52 cooperating with the latter rollers has a more rectilinear form for advancement of sheets from the cassette 47 to the intermediate clearance between rollers 19 and 20 in the cassette 45, the guide wall 43 of which is curved to define a sheet advancing path leading to the image transfer module 16.

Different driven, for instance rotating members with individual directions of revolution in a given sheet processing unit or module may be operated in different operational phases during an operational sequence by means of a single step motor. In particular, such a design of the drive arrangement may be advantageous in processing stations like the illustrated sheet feeding unit having relatively closely positioned members to be operated in different phases. If several driven members are to be operated in the same phase or step in an operational sequence, or if the connection with a common step motor will require a relatively complicated transmission, it will often be more advantageous to use a step motor individually for each of the driven members.

Although the advantages of the invention will appear to the widest possible extent in case of an apparatus composed entirely of modules like the described information printer, the advantages with respect to a more accurate control will in particular, also be obtainable if a smaller number of sheet processing units are designed in accordance with the invention including in particular the sheet supply with associated sheet feeding means, the photoconductor and the sheet advancing device conveying sheets onto the fixation device when they are being stripped off from the photoconductor at the image transfer station.

The sheet feeding device of the information printer that is described above with reference to the accompanying drawings is the subject of our European patent application number
Claims

1. An electrophotographic information printer, comprising a xerographic reproduction system including at least one sheet supply device (17) with sheet feeding means (18, 19) for feeding individual sheets to a sheet advancing path, a photoconductor (8) and image transfer device (16) arranged at said sheet advancing path for transferring a toner image developed on a movable photoconductor (8) to a sheet arriving at said sheet advancing path and means for conveying the sheet after said image transfer to a fixation device (23), said sheet supply device (17) with sheet feeding means (18, 19) being structured as one individual replaceable module, characterised in that said photoconductor (8) and image transfer device (16) are structured as another individual replaceable module, and each module comprises an individual drive means in the form of an electronic step motor (24, 25, 26, 38) which is mechanically coupled to at least one rotatable member (8, 19) within that module and the operation of which within an operational sequence of the information printer is directly controlled by selectively supplying drive pulses of a predetermined pulse number and pulse frequency from a pulse supplying device (39) controlled by a programmed control unit (35).

2. An information printer as claimed in claim 1, characterised in that control information for a prescribed movement function for each step motor (24, 25, 26, 38) is stored in the form of program routines in a program memory in the form of an EPROM-device in the control unit (35).

3. An information printer as claimed in claim 1 or claim 2, wherein the movable photoconductor (8) is driven by the respective step motor (26) through a belt drive.

4. An information printer as claimed in claim 3, wherein the movable photoconductor (8) is a rotary drum.

Patentansprüche

1. Elektrophotographischer Informationsdrucker mit einem xerographischen Reproduktionsystem mit zumindest einer Blattzufuhrvorrichtung (17) mit Mitteln (18, 19) zum Vorschieben einzelner Blätter zu einer Blattbearbeitungsbahn, einem Photoleitern (8) und einer bei der Blattbearbeitungsbahn vorgesehenen Bilddarstellungsvorrichtung (16) zur Übertragung eines auf einem beweglichen Photoleiter (8) erzeugten Tonerpulverbildes zu einer Blattzufuhrvorrichtung (17) mit den Blattvorschubmitteln (18, 19) als ein eigenes, auswechselbares Modul ausgebildet ist, dadurch gekennzeichnet, dass der Photoleiter (8) und die Bilddarstellungsvorrichtung als eine andersartige, eigenes auswechselbares Modul gestaltet sind und jedes Modul ein eigenes Antriebsmit- tel in Form eines elektronischen Schrittmotors (24, 25, 26, 38) besitzt, der mindestens an ein angetriebenes Element (8, 19) innerhalb dieses Moduls mechanisch gekoppelt ist, und dass die Arbeitsweise des Informationsdruckers innerhalb einer Arbeitsfolge durch selektive Zuführung von Steuerimpulsen einer vorausbestimmten Impulszahl und Impulsfrequenz von einer Impulszufuhrvorrichtung (39) einer programmgesteuerten Steuereinheit (35) gesteuert wird.

2. Informationsdrucker nach Anspruch 1, dadurch gekennzeichnet, dass Steuerinformationen für eine vorgeschriebene Bewegungsfunktion eines jeden Schrittmotors (24, 25, 26, 38) in Form von Programmroutinen in einem als eine EPROM-Einheit ausgebildeten Programmspeicher in der Steuereinheit (35) gespeichert sind.

3. Informationsdrucker nach Anspruch 1 oder 2, worin der bewegliche Photoleiter (8) von dem betreffenden Schrittmotor (26) durch einen Riemenscheibenantrieb betätigt wird.

4. Informationsdrucker nach Anspruch 3, worin der bewegliche Photoleiter (8) eine Dreh trommel ist.

Revendications

1. Imprimante électrophotographique d’information, comprenant un système de reproduction xérogaphique comportant au moins un dispositif d’alimentation en feuilles (17) avec des moyens d’avancement de feuilles (18, 19) pour l’avancement individuel de feuilles vers une piste d’avancement de feuilles, un photocoducteur (8) avec un dispositif de transfert d‘image (16) disposé près de ladite piste d’avancement de feuilles pour le transfert d’une image latente de poudre, développée sur un photocoducteur en mouvement (8), sur une feuille provenant de ladite piste d’avancement de feuilles, et des moyens pour transporter la feuille, après ledit transfert d‘image, à un dispositif de fixation (23), ledit dispositif d’alimentation en feuilles (17) avec les moyens d’avancement de feuilles (18, 19) étant construit comme un module individuel remplaçable, caractérisé en ce que ledit photocoducteur (8) et ledit dispositif de transfert d‘image (16) sont construits comme un deuxième module individuel remplaçable, et en ce que chaque module comprend un moyen individuel d’entraînement sous forme d’un moteur pas-à-pas électronique (24, 25, 26, 38) qui est mécaniquement relié à au moins un élément rotatif (8, 19) dans ce module et dont le fonctionnement, dans une séquence opératoire de l’imprimante d’information, est commandé directement par alimentation sélective d’impulsions de commande dont le nombre et la fréquence sont prédéterminés et qui proviennent d’un générateur d’impulsions (39) commandé par une unité de commande programmée (35).

2. Imprimante d’information selon la revendication 1, caractérisée en ce que l’information de commande pour une fonction prescrite de mouvement pour chaque moteur pas-à-pas (24, 25, 26,
38) est stockée sous forme de routines de programmes dans une mémoire morte programmable électriquement (EPROM) dans l'unité de commande (35).

3. Imprimante d'information selon la revendication 1 ou 2, dans laquelle le photoconducteur en mouvement (8) est entraîné par le moteur pas-à-pas respectif (26) par l'intermédiaire d'un entraînement à courroie.

4. Imprimante d'information selon la revendication 3, dans laquelle le photoconducteur (8) est un tambour rotatif.