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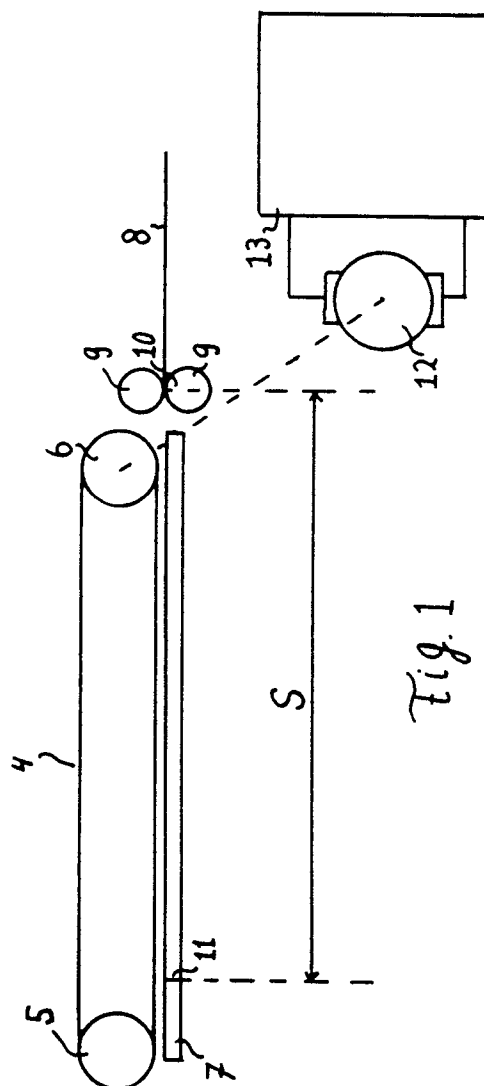
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54 **Sheet positioning device.**

57 Sheet positioning device comprising conveying means (4,5,6,9) for moving a sheet (8) over a pre-determined distance from a starting position, in order to bring the sheet (8) in a required end position, in which the conveying speed of the sheet (8) during the movement is controlled in accordance with a determined required speed course.

Upon determining a speed course having a very gradually changing speed, slip between the sheet (8) and the conveying means (4,5,6,9) can be prevented and, accordingly, wear of the conveying means (4,5,6,9) is also reduced to a minimum.

By determining the relationship between the required conveying speed course and the actual sheet movement which is the result of the control in accordance with the required conveying speed course and by adapting the required conveying speed course by adjusting the length of a part of the speed course which has the highest value, in dependence on the determined relationship a sheet (8) can be brought from a starting position to an end position during a very short interval of time with a high positioning accuracy.



Sheet positioning device

This invention relates to a sheet positioning device for moving a sheet over a predetermined distance from a starting position in order to bring the sheet in a required end position, comprising a conveyor system for moving the sheet, a control system which controls a variable of the conveyor system in accordance with a reference signal, and a reference source for generating the reference signal, the reference signal representing the required course of the variable during the movement of the sheet.

A device of this kind is known from European patent application 0064591, in the form of a document positioning device for a copying machine.

In the known device, a reference signal is generated which represents the required course of the movement as a function of the time. A measurement signal is also generated which represents the actual movement course as a function of the time. A differential signal is derived from the measurement signal and the reference signal and is a measure of the difference between the required movement and the actual movement. Energization of the conveyor system drive motor is controlled in dependence on the difference between the required movement and the measured movement. With such movement control, disturbances can cause considerable fluctuations in speed. Particularly in the case of systems which are required to bring a sheet from the starting position to the end position within a short period of time, these fluctuations may become so considerable that slip may come about between the conveyor system and the sheet. The speed fluctuations also result in extra wear of the conveyor system.

The object of this invention is to provide a device of the kind referred to in the preamble without the above disadvantages. This object is attained in that in a device of the kind referred to in the preamble, the reference signal generated by the reference source represents the required course of the conveying speed during the movement, in accordance with which course the required speed gradually increases to a maximum and then gradually decreases, and in which the sheet movement established by the required course corresponds to the predetermined distance, and in that the control system controls the conveying speed in accordance with the reference signal generated.

In the device according to the invention, the speed is controlled so that the speed will differ only a little from the gradually changing required speed. Slip between the conveyor system and the sheet will accordingly substantially not occur. As a result conveyor system wear is also reduced to a minimum.

An attractive variant of the device according to the invention, which is provided with a measuring system for determining the movement and which is characterized in that the measuring system is provided with means which from the determined sheet movement derive the relationship existing between the required conveying speed and the actual sheet movement which is the result of the control in accordance with the required conveying speed course, and in that the reference source is provided with means which in dependence on the derived relationship bring the movement determined by the required speed course into conformity with the predetermined distance by adjusting the required speed course, has the advantage that the positioning accuracy is independent of the relationship between the required conveying speed and the associated actual sheet movement. This is an advantage particularly in the case of devices manufactured in batch or mass-production methods. With such production methods, considerable differences occur between the devices themselves in respect of the relationship between the required distance and the associated sheet movement, due to differences within the component tolerances.

The invention and further advantages thereof will be discussed in detail hereinafter with reference to the drawings wherein:

Fig. 1 represents a device according to the invention,

Fig. 2 represents the required conveying speed course during the movement, and

Fig. 3 represents the block diagram of the control system.

Fig. 1 represents a device according to the invention, which device forms part of an automatic document feeder and positioning device (e.g. an RDF) for a copying machine. With a device of this kind, a document 8 in sheet form requiring to be copied can be brought from a starting position into a predetermined exposure position on the exposure platen 7 of the copying machine. The position of the leading edge of a document 8 in the exposure position on the exposure platen is indicated by reference 11. The position of the leading edge of a document 8 brought in starting position is denoted by reference 10.

In order to convey a document 8, the sheet positioning device is provided with rollers 9 and a conveyor belt 4, which is entrained about a guide roller 5 and a drive roller 6 and which belt 4 is situated just above the exposure platen 7. The spindle of drive roller 6 is coupled to the spindle of a servomotor 12 forming part of a feed-back control system 13 for controlling the circumferential speed of belt 4. The spindles of rollers 9 are mechanically coupled via transmission mechanisms (not shown) to roller 6, the transmission ratios being selected that the circumferential speeds of the belt 4 and the rollers 9 are equal.

A document 8 to be copied is brought into the starting position by conveying means (not shown), in which position the conveying means press the leading edge of the document into the nip between the rollers 9 in the position indicated by reference 10. Drive roller 6 and rollers 9 are then driven by control system 13 so that document 8 is conveyed by rollers 9 and belt 4 in the direction of the required exposure position. During conveying, the belt speed and the speed of rollers 9 are controlled in accordance with a required course of the speed V_g (see Fig. 2). The distance covered by the document during conveying is equal to the sheet speed time integral. For accurate positioning the required speed course must be so selected that the time integral of the actual speed is equal to the distance S between position 10 and position 11.

As soon as document 8 has stopped in the exposure position, the sheet is exposed by the copying machine exposure system and is then discharged from the exposure platen 7 by means of belt 4.

Fig. 3 represents the block diagram of the control system 13. Control system 13 is of a conventional type comprising: a reference source 18 for generating a reference voltage V_{ref} varying in time, the value of which represents the required speed during document conveying between the starting position and the exposure position, a servomotor 12 for driving drive roller 6 and rollers 9, an angular velocity meter 14 coupled to the spindle of motor 12 and generating a measurement voltage V_m , the value of which represents the value of the circumferential speed of belt 4 and rollers 9, a differential amplifier 15 for determining the difference E between the required speed and the measured speed, and a controller/amplifier 24 which controls the energization of motor 12 in dependence on the difference determined by differential amplifier 15, in such a manner that the measured speed follows the required speed.

Angular velocity meter 14 is of a type comprising a pulse disc known *per se* for generating pulses P at a frequency proportional to the angular velocity of the motor and generating the measurement voltage V_m by means of frequency-voltage converters known *per se*. The pulses P are also fed to an input of reference source 18.

Reference source 18 generates a reference voltage V_{ref} , which represents the required speed course during the movement, which speed course is denoted by speed curve A in Fig. 2. Speed curve A is made up of a starting curve 20, a middle curve 21, a decay curve 22 and a tail curve 23. Starting curve 20 indicates the required speed V_g as a function of the time t during the starting interval t_1 . During interval t_1 the required speed V_g increases in accordance with the equation:

$$V_g = \frac{V_t}{2} \left(1 - \cos \left(\frac{\pi t}{T_1} \right) \right)$$

At time T_1 the required speed has reached the value V_t . At that time interval t_1 is concluded and the middle interval t_2 starts. During middle interval t_2 the required speed stays equal to V_t . At time T_2 the middle interval t_2 is concluded and the decay

interval t_3 starts. During decay interval t_3 the required speed V_g decreases in accordance with the equation:

$$V_g = \frac{V_t}{2} \left(1 - \cos \frac{\pi (t - T_2 + T_1)}{T_1} \right)$$

The tail interval t_4 starts at time T_3 . At this time the required speed has still just not reached the value 0.

Reference source 18 comprises a computer system 17 provided with a program for generating the reference voltage V_{ref} . This program is called up when a document 8 lying ready in the starting position has to be moved to the exposure position.

This program uses tables which are stored in the memory and the contents of which determine the required speed course during the starting and decay intervals. These tables store in the form of binary codes the values of the reference voltage V_{ref} which values correspond to the required speeds at a number of consecutive equidistant times within the starting and decay intervals. By counting pulses P , the program also registers sheet movement during conveying of the sheet from the starting position to the exposure position. After the program has been called up, the binary code associated with each time of the equidistant times during starting interval t_1 is drawn from the tables by computer system 17 and stored in a register 19. A digital/analog converter 16 connected to register 19 converts this binary code into a reference voltage V_{ref} . During starting interval t_1 the number of pulses P_a generated during this interval is also counted. This number P_a indicates at time T_1 the distance covered by the document 8 during the starting interval. At the beginning of interval t_2 computer system 17 determines the distance to be covered during interval t_2 in accordance with the following equation:

$$P_{top} = P_{tot} - P_a - P_u - P_{rest}$$

In this equation, P_{tot} represents the distance S expressed in pulses P . P_{rest} represents the expected distance to be covered during the tail interval t_4 . P_u represents the distance to be covered during the decay interval t_3 . In the embodiment described here, the starting curve is identical in shape to the decay curve, so that P_u is equal to P_a . The equation for P_{top} then becomes:

$$P_{top} = P_{tot} - 2P_a - P_{rest}$$

During interval t_2 , computer system 17 counts the number of pulses P generated from time T_1 on. As long as the number of pulses counted is not equal to P_{top} , computer system 17 does not change the contents of register 19, so that the contents of register 19 remain equal to the binary code associated with the time T_1 during the entire interval t_2 . The required speed accordingly remains equal to V_t during the entire interval t_2 . As soon as the number of pulses counted during interval t_2 and P_{top} become equal, interval t_2 is concluded and the reference voltage V_{ref} associated with decay interval t_3 is generated in a manner comparable to the way in which the reference signal is generated during the starting interval. During decay interval t_3 the required speed V_g decreases to a value V_{rest} just above value 0. During interval t_4 the total number of pulses generated from the starting time

To on is compared with the number P_{tot} . As soon as the total number of pulses generated from To on becomes equal to P_{tot} motor 12 is stopped. This time is denoted by T_4 .

In the above-described generation of the reference voltage V_{ref} , adjustment of the length of the middle interval t_2 causes the leading edge to reach the required position 11 only at the tail interval t_4 , irrespective of the relationship between the required speed course and the associated actual sheet movement. During interval t_4 the speed is very low so that conveyor belt 4 is abruptly stopped at the time when the distance covered by the sheet corresponds to the required distance S to be covered. A sheet is accordingly positioned very accurately by means of the positioning device according to the invention.

The device according to the invention is particularly suitable for positioning devices which are required to bring a sheet from the starting position to an end position during a very short interval of time. In such devices, slip can occur relatively quickly between the document and the conveyor means due to considerable fluctuations in the speed. By the use of a speed control which very gradually controls the speed in accordance with an approximately cosine curve the speed fluctuations are reduced to a minimum. In addition, the wear of the moving parts of the conveyor system is reduced to a minimum as a result of these very gradual speed changes.

In the embodiment described here the required speed course is a cosine-curve during the starting interval and decay interval. It is apparent, however, that other forms having also a gradual course are very suitable, e.g. a trapezoidal curve.

In the positioning device described here, adjustment of the length of the middle interval t_2 adjusts the required speed course in order to render positioning accuracy independent of the existing relationship between the required speed and the associated actual sheet movement. It will be evident that the adjustment of the required speed course can be effected in many other ways, e.g. by adjusting the shape of the decay curve or by increasing/reducing the required speed by a determined factor.

Claims

1. A sheet positioning device for moving a sheet over a predetermined distance from a starting position in order to bring the sheet in a required end position, comprising

-a conveyor system (4, 5, 6, 9) for moving the sheet,

-a control system (12, 13) which controls a variable of the conveyor system in accordance with a reference signal, and

-a reference source (18) for generating the reference signal, the reference signal representing the required course of the variable during the movement of the sheet,

characterised

-in that the reference signal generated by the reference source (18) represents the required course - (A) of the conveying speed during the movement, in accordance with which course the required speed gradually increases to a maximum and then gradually decreases, and in which the sheet movement established by the required course corresponds to the predetermined distance, and

-in that the control system (12, 13) controls the conveying speed in accordance with the reference signal generated.

2. A device according to claim 1, provided with a measuring system (14, 17) for determining the sheet movement, characterised

-in that the measuring system (14, 17) is provided

with means (17) which from the determined sheet movement derive the relationship existing between the required conveying speed and the actual sheet movement which is the result of the control in accordance with the required speed course, and

-in that the reference source (18) is provided with means (17) which in dependence on the derived relationship bring the movement determined by the required speed course into conformity with the predetermined distance by adjusting the required speed course.

3. A device according to claim 2, characterised

-in that the required speed course comprises a fixed starting interval (t1), a variable middle interval (t2) and a fixed decay interval (t3), during which starting interval (t1) the required speed increases as a function of the time to a maximum value, during which middle interval (t2) the required speed remains equal to the maximum value during a variable time interval, and during which decay interval (t3) the required speed decreases from a maximum value as a function of the time, and

-in that the adjustment means (17) adjust the speed course by adjustment of the length of the middle interval (t2).

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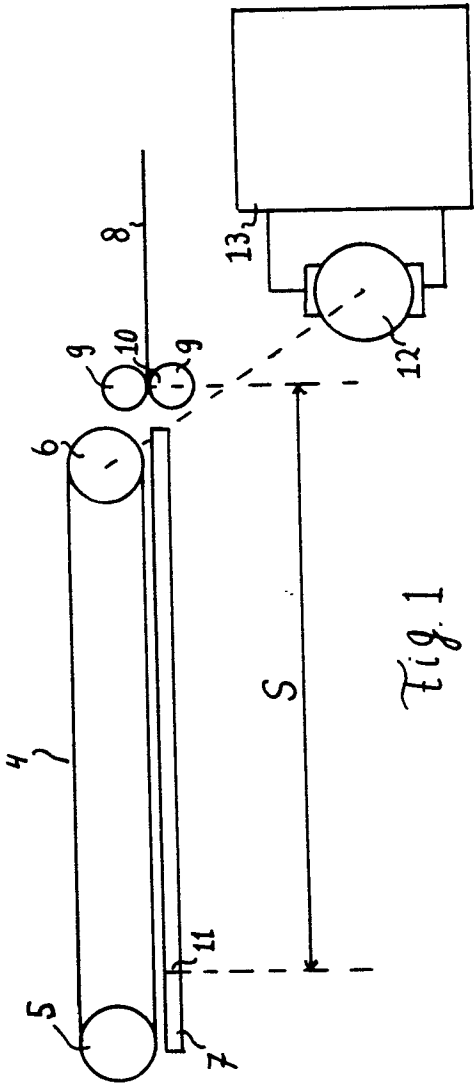


Fig. 1

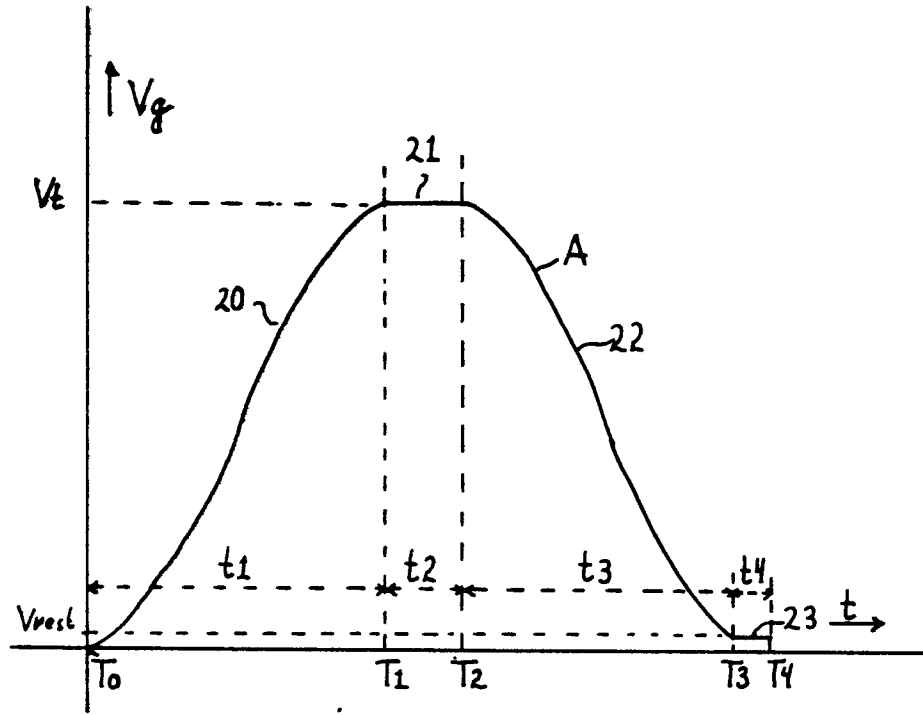


Fig. 2

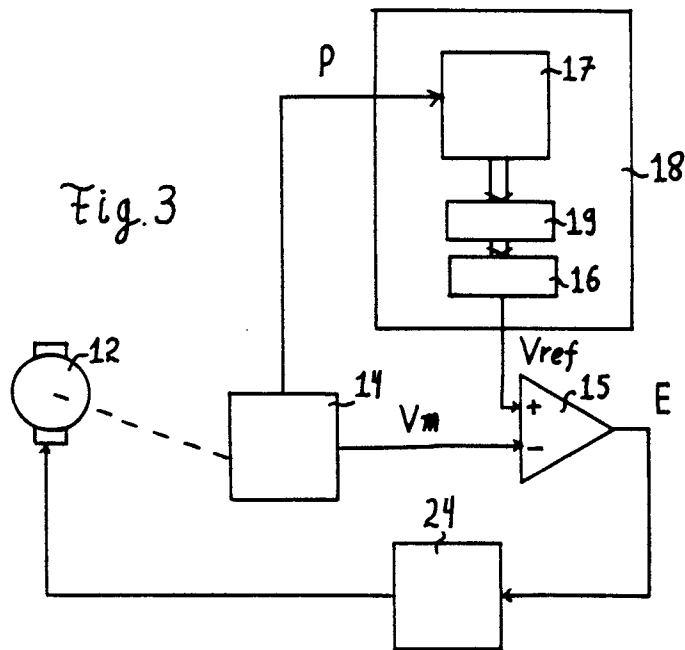


Fig. 3



DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
Y	EP-A-0 077 454 (INTERNATIONAL BUSINESS MACHINES CORPORATION) * Page 9, lines 25-31; figures 3A, 4 *	1-3	G 03 G 15/00 B 65 H 9/00
D, Y	--- EP-A-0 064 591 (INTERNATIONAL BUSINESS MACHINES CORPORATION) * Page 4, line 18 - page 6, line 16; figures 1-4 *	1-3	
A	--- FR-A-1 323 460 (VEB LEIPZIGER BUCHBINDEREIMASCHINENWERKE) * Page 3, column 2, lines 3-41; figure 6 *	1-3	
A	--- US-A-4 023 489 (BEERY) * Abstract; figures 2, 3, 4 *	1-3	
A	--- US-A-3 913 478 (TERZUOLO et al.) * Column 3, lines 10-16; figure 14 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 4) G 03 G 15 G 03 B 27 B 65 H 9
A	--- US-A-3 888 579 (RODEK et al.) * Abstract *	1	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 04-11-1986	Examiner CIGOJ P.M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	