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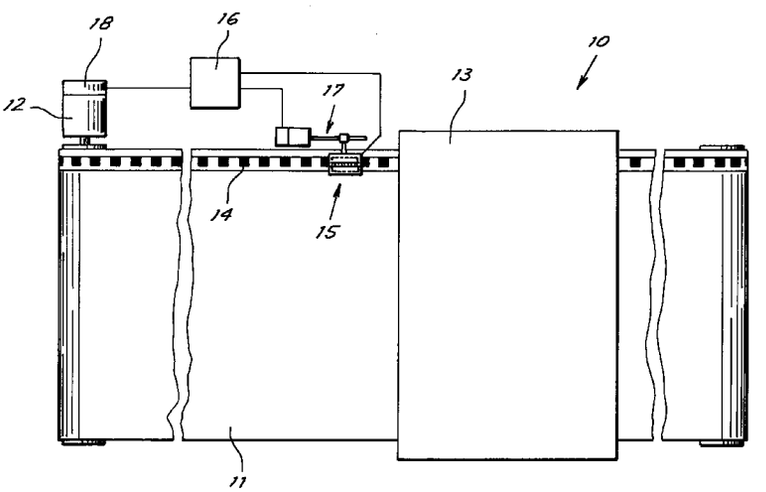
(54) Rotary-belt printing machine comprising a positioning device with linear optical sensor

(57) Rotary-belt printing machine comprising a powered rotary belt (11) to bring segments thereof opposite printing stations (13). A control device (16) for accurate positioning of the belt (11) receives signals from an optical sensor (15) arranged near a lateral edge of the belt to detect the sequential passage under it of marks (14) arranged along the belt edge. The control device 16 processes the signals of the sensor (15) as feedback for correct and accurate positioning of the belt (11). The sensor is a linear sensor (15) with detection line arranged parallel to the lateral edge of the belt (11) to detect the position of marks (14) in its field of vision and permit accurate stopping of the belt in a position corresponding to a mark positioned in a particular position in said field of vision.



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Description

The present invention relates to a rotary-belt printing machine.

Along one edge of the rotary belt of these machines is usually applied for the entire length of the belt a strip on which black marks are silk-printed at regular intervals. When the belt is running a photoelectric cell of the on-off type detects passage of the edges of the marks to supply an accurate indication of the position of the belt with respect to the printing stations along it so that the belt may position itself accurately under the various printing units.

The positioning accuracy which it is desired to secure is very high and on the order of hundredths of a millimeter.

For this reason during initialization of the machine the photoelectric cell detects in sequence the relative positions of all the marks so as to have correction parameters for the printing errors and application of marks on the belt. When the machine has to position the belt in a particular position, it identifies the mark nearest the required dimension and moves the photoelectric cell (arranged for this purpose on a powered slide with centesimal precision for traversing along the belt edge) into a position such that reaching the desired belt position corresponds to having the photoelectric cell detection point opposite the edge of the mark. The machine then performs a rapid 'rough' movement so as to take the belt to a few millimeters or fractions thereof from the required position by using as a position sensor an incremental encoder making up part of the belt movement system. Then the belt is slowly moved until the transition consisting of the edge of the mark moves past the photoelectric cell detection point. At the instant of the transition detection there is generated a signal which zeroes the position counter of a secondary encoder controlled by a wheel kept in contact with the belt surface. In this manner the position indicated by this second encoder corresponds to the deviation from the desired position. The secondary encoder supplies the position error to the control system which drives the belt positioning motor so that the control system can reduce the deviation by successive approximations under the required tolerance.

These known machines have the disadvantage of great complexity both as to production and management with likeliness of failure due to the many moving precision parts.

In addition, positioning errors due to e.g. running on the belt of the second encoder operating wheel are not averted.

The general purpose of the present invention is to obviate the above mentioned shortcomings by supplying a rotary-belt printing machine in which there is a highly accurate positioning device which however has a simpler structure less subject to failure and errors.

In view of the above mentioned purpose it is sought to provide in accordance with the present invention a rotary-belt printing machine comprising a powered rotary belt for bringing segments thereof opposite printing stations with there being along one lateral edge of the belt a plurality of position marks, a control device for accurate positioning of the belt receiving signals from an optical sensor arranged near the lateral edge and detecting sequential passage under it of the above mentioned marks with the control device processing the sensor signals as feedback for accurate and correct positioning of the belt and characterized in that the sensor is a linear sensor with detection line arranged parallel to the lateral edge of the belt to detect the position of marks in its field of vision.

To clarify the explanation of the innovative principles of the present invention and its advantages compared with the prior art there is described below with the aid of the annexed drawing a possible embodiment thereof by way of non-limiting example applying said principles.

With reference to the figure there is shown a diagrammatic top view of a printing machine indicated generally by reference number 10 and having a rotary belt 11 moved by a motor 12 to pass under successive printing stations 13 (only one being shown for simplicity). The various parts for practical production of such a machine are well known to those skilled in the art as are well known the structure and operation of the printing stations. The latter are accordingly not further shown or discussed.

In accordance with the known art, along one edge of the belt is applied a strip 14 bearing at intervals position stamps or marks having edges transversal to the belt with high contrast compared with the background, e.g. the marks can be black on a white background.

In accordance with the principles of the present invention along the edge of the belt is arranged a linear optical sensor advantageously of the known charge-coupled device (CCD) type made up of a row of sensitive elements arranged in accordance with the axis parallel to the strip to allow row detection. The sensor is generally indicated by reference number 15 in the figure and has adequate optics to be able to have a linear field of vision greater than the distance between marks so as to ensure that at least one white-black or black-white transition is always inside the field of vision of the sensor. In other words the extension of the field of vision of the sensor longitudinally with respect to the belt is not less than the distance between two leading edges of successive marks.

The number of sensitive elements making up the linear sensor must be such as to ensure with the optics selected the desired positioning resolution, e.g centesimal. The typical sensor resolution can be increased electronically by means of ordinary interpolation techniques to achieve the desired resolution.

The sensor wheel 15 is connected to a control device or electronic processor 16 (virtually of the prior art) which manages positioning of the belt by means of the motor 12 and an associated position encoder 18.

In use when the machine has to position the belt in a particular position a first quick and rough shift of the belt is ordered while controlling the belt position by means of the encoder 18 until the mark nearest the desired position enters the field of vision of the linear sensor.

Then the belt is moved slowly while using as position feedback the position signal produced by the linear sensor which detects the movement of the edge of the mark in its own field of vision. When the sensor detects that the edge of the mark has been taken by successive approximations into the position of the sensor field of vision corresponding to the desired belt position the desired position is achieved.

It is clear that the preset purposes are achieved by providing a machine with a positioning device having a simple and robust structure with moving parts reduced to the minimum.

Even with the device of the present invention it is necessary to perform prior determination of a mark calibration table, that is to say a table containing the distances between the marks detected with the same accuracy as the desired belt positioning accuracy. To this end, in the calibration phase (e.g. when the belt is stretched or replaced) the belt is made to run to bring all the marks sequentially into the field of vision of the linear optical sensor which in this manner measures the relative distance between marks so that the control device 16 can calculate the relative distance between marks and in short their position with respect to a predetermined origin. The result of these calculations is memorized by the control device and used to learn accurately the position of each mark with respect to the desired belt stopping position.

Advantageously the linear sensor 15 is mounted on a powered slide 17 for moving the sensor longitudinally with respect to the belt. The movement is performed upon command of the control device 16 with the same resolution as the desired resolution for belt positioning and with an amplitude permitting for example bringing the sensor to scan at least three consecutive marks. During calibration this permits accurate detection of the relative mark position and allows making the sensor run to bring into its field of vision the edges of consecutive marks with the desired positioning accuracy regardless of the accuracy of belt movement by the motor 12.

Naturally the above description of an embodiment applying the innovative principles of the present invention is given by way of non-limiting example of said principles within the scope of the exclusive right claimed here.

For example the control device 16 can be provided in a distributed manner, that is to say that there could be inserted in an electronic element (e.g. with microprocessor) the management functions of the signal coming from the linear sensor and, in a separate main machine-management processor, the belt movement functions.

The electronic element acquires and examines the image detected by the linear sensor as discussed above and sets the transition points corresponding to the edges of marks in the field of vision while if necessary performing electronic interpolation for resolution increase. The main processor interrogates the device at preset frequency, e.g. through interconnected serial lines, to receive the transition information detected during the last acquisition and set the position error and check belt movement.

Claims

1. Rotary-belt printing machine comprising a powered rotary belt (11) for bringing segments thereof opposite printing stations (13) along a lateral edge of the belt with there being present a plurality of position marks (14) and a control device (16) which accurately positions the belt (11) and receives signals from an optical sensor (15) arranged near said lateral edge and detecting the sequential passage under it of said marks (14) with the control device (16) processing the signals of the sensor (15) as feedback for correct and accurate positioning of the belt (11) and characterized in that the sensor is a linear sensor (15) with detection line arranged parallel to the lateral edge of the belt (11) to detect the position of marks (14) in its field of vision.

2. Machine in accordance with claim 1 and characterized in that the linear sensor (15) has a field of vision not smaller than the distance between the leading edges of two successive marks.

3. Machine in accordance with claim 1 and characterized in that for belt positioning in a desired position opposite the sensor (15) in a first approach phase the control device (16) sends to said desired position signals for movement of the belt at a first speed until it has brought into the field of vision of the sensor (15) the mark nearest the desired position and in a second phase signals for belt movement at a second speed which is less than the first until by successive approximations it has brought the mark present in the field of vision into a position corresponding to having the belt in said desired position.

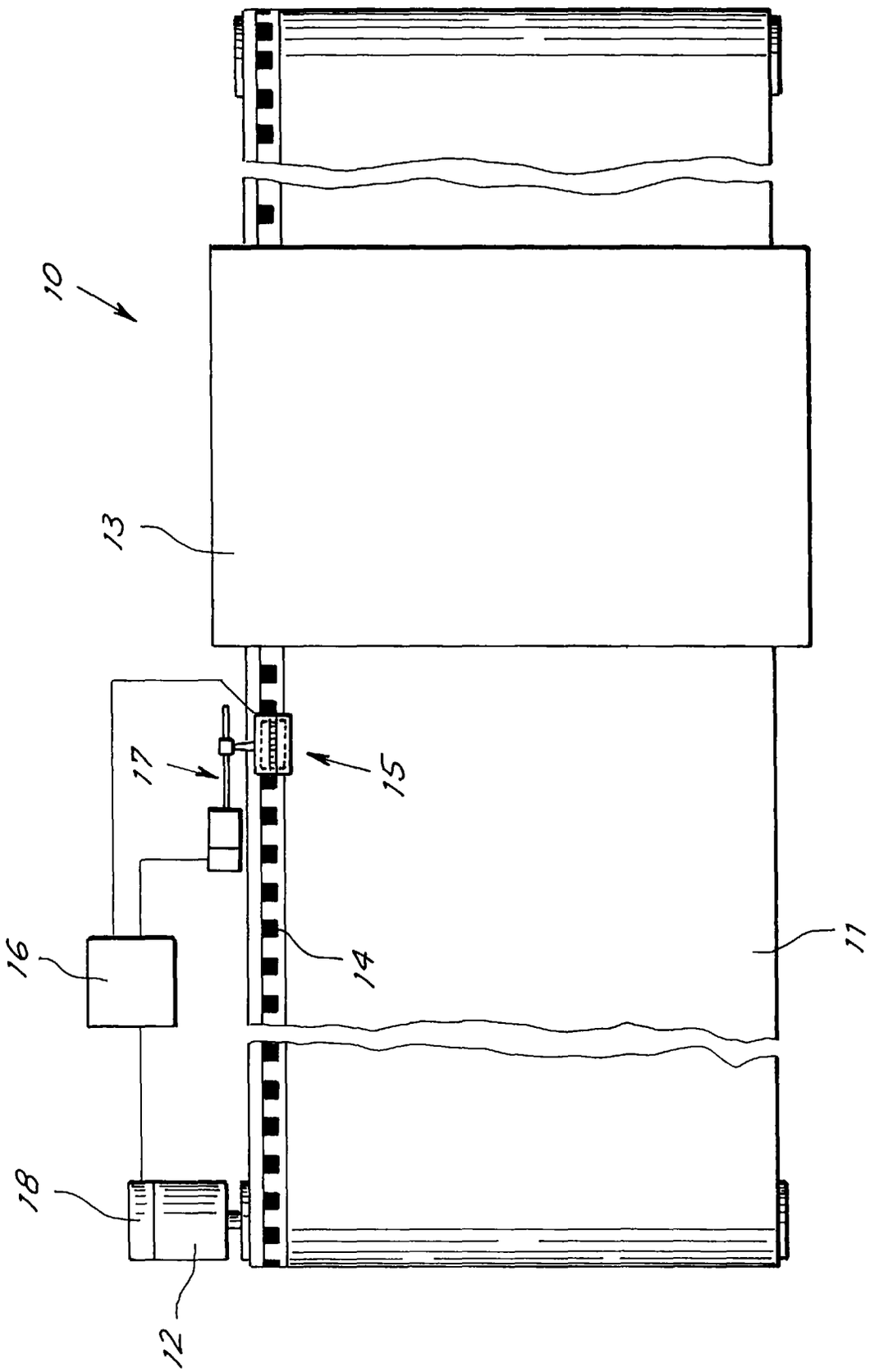
4. Machine in accordance with claim 3 and characterized in that it comprises an encoder (18) for detection of the approximate position of the belt (11) with the control device (16) receiving in a first phase belt position signals from said encoder (18).

5. Machine in accordance with claim 1 and characterized in that the sensor (15) is mounted on a powered slide (17) to be accurately movable in a direction longitudinal with the lateral edge of the belt (11).

6. Machine in accordance with claim 5 and characterized in that that during calibration the control device

(16) sends control signal for movement of the slide to move the sensor in a direction longitudinal with the lateral edge of the belt (11) and detect and memorize the exact relative positions of the marks.

7. Machine in accordance with claim 6 and characterized in that the linear sensor is a CCD linear sensor.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EUROPEAN SEARCH REPORT

Application Number
EP 96 20 3586

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.6)
A	EP 0 242 846 A (MS MACCHINE & SISTEMI SRL) 28 October 1987 * abstract *	1	B41F15/08 B41F13/12 B41F17/00 B41F33/00
A	EP 0 309 023 A (SALVADE S A S OFF MEC) 29 March 1989 * abstract; figure 2 *	1,5	
A	DE 40 24 357 A (E M MUELLER KG) 6 February 1992 * abstract *	1	
A	EP 0 522 640 A (STORK BRABANT BV) 13 January 1993 * abstract; figure 1 *	1,4	
A	US 5 329 466 A (MONNEY PATRICK) 12 July 1994 * column 2, line 37 - line 51 *	1,7	
A	DE 40 23 329 A (POLYGRAPH CONTACTA GMBH) 6 February 1992 * abstract; example 4 *	1,7	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B41F B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	11 April 1997	Zellhuber, W

CATEGORY OF CITED DOCUMENTS

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