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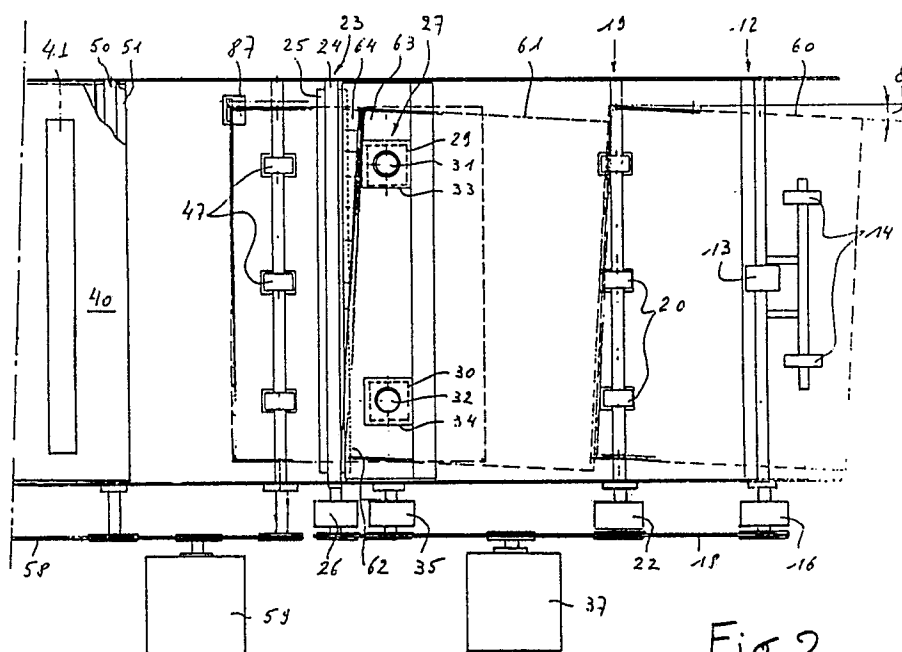
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71 Applicant: **AGFA-GEVAERT naamloze vennootschap**
Septestraat 27
B-2510 Mortsel(BE)

72 Inventor: **Boeve, Gerard Jozef**
Timmerdonckstraat 45,
B-2520 Edegem(BE)
Inventor: **Trouillard, Frank Charlotte**
Boekenberglei 181, bus 4,
B-2100 Deurne(BE)

54 **Electrophotographic printer with longitudinal image alignment.**

57 An electrophotographic printer with an electronic line-imager (41) for line-wise exposing an image on an electrostatically charged drum (40), wherein sensor means (87) is provided for sensing the longitudinal position of a moving sheet (61) as such sheet approaches to the drum, and control means for controlling the start of the operation of the line-imager in response to the output signal of the sensor means.



ELECTROPHOTOGRAPHIC PRINTER WITH LONGITUDINAL IMAGE ALIGNMENT

The present invention relates to an electrophotographic printer with a line-imager, which is provided with means for obtaining a correct longitudinal position of the electrophotographic image onto a sheet of paper onto which the image is transferred from a photoconductor drum.

The correct position of a sheet that is forwarded to an imaging station in an electrophotographic printer is important since usually the locus where the image is produced in such station is fixed so that it will depend on the actual position of a sheet at such locus whether or not the image will take a correct position on the sheet. Possible causes for an uncorrect position of an image on the sheet are : a longitudinal, a transversal and an angular misalignment of the sheet. The present invention deals with the longitudinal position of a sheet fed to an imaging station.

In conventional mechanical printing apparatus, paper sheets are picked up from a stack of sheets by mechanisms comprising sucker cups and guide arms that ensure a reproducible position of a sheet at the imaging station where an image is printed by an inked printing drum on the sheet.

In known electrophotographic copying apparatus, paper sheets are usually withdrawn by friction fingers or rollers from a stack of sheets and fed by a first roller pair towards a second roller pair that is at standstill as the sheet arrives. The distance between both roller pairs is smaller than the length of the sheet so that the sheet will buckle as its leading edge abuts in the nip of the second roller pair. The sheet buckling causes a biasing force that urges the leading edge of the sheet in firm contact with the nip of the second roller pair. This contact ensures an alignment of the leading edge of the sheet with the roller pair, also when the sheet had a skewed position as it approached towards said roller pair, and in this way it angularly aligns the sheet.

The control of the rollers for conveying a sheet in such known copying apparatus is as follows.

At the moment a copy is to be made, the mechanism for taking a sheet from the stack of sheets, and the first roller pair are started to advance a sheet up to the sheet-aligning roller pair that is at standstill. The time of operation is fixed and is sufficiently long for giving the sheet the opportunity to become stopped by the sheet aligning roller pair.

A short, fixed lapse of time later, the exposure of the image on the semi-conductor drum is started, and after a further lapse of time an electromagnetic clutch that controls the rotation of the sheet aligning rollers is energised whereby the advancing

of the sheet is resumed. The second time control is such that the drum has made about half a revolution so that the top of the exposed, and developed, image on the periphery of the drum coincides with the heading of the sheet as the sheet arrives in contact with the drum for transfer of the toner image.

The following factors influence the accuracy of the longitudinal (i.e. vertical) position of the image transferred onto the sheet.

The response time of the electromagnetic clutch, which varies in accordance with variations of the applied voltage, of the temperature (resistance of clutch coil), and of the coefficient of friction (dust, stain).

The distance over which the leading edge of the sheet is engaged in the nip of the sheet aligning roller pair, which depends on the thickness of the sheet, the pressure with which the sheet was urged into the nip of the rollers, and the resilience of the roller covering.

Finally, the slip of the sheet between the sheet aligning roller pair.

All these factors cause tolerances in the sheet position from 1.5 to 2.5 mm.

In known electrophotographic printers, such as laser or LED printers, the sheet feeding mechanisms are largely based on techniques used in electrophotographic copiers, and thus it will be understood that the precision of image positioning on the sheet is often not on the level of the quality of the image production itself.

It is the object of the present invention to provide an electrophotographic printer with means for an improved longitudinal positioning of the image on the sheet. The invention is particularly concerned with so-called E.P.P. apparatus, i.e. electronic printing and publishing apparatus.

According to the present invention, an electrophotographic printer, comprising a rotatable semiconductor drum, driving means for rotating the drum, means for electrostatically charging the drum, a line-imager for line-wise exposing an image on the rotating, electrostatically charged drum, a developer station for toner-developing the electrostatic image on the drum, sheet feeding means for taking a sheet from a stack of sheets, for angularly aligning such sheet on its path towards the drum and for advancing the angularly oriented sheet in contact with the drum, means for causing transfer of the toner image from the drum onto the paper sheet as the sheet makes progressively contact with the drum, and means for fixing the transferred toner image on the paper sheet, is characterized thereby that said printer comprises de-

tection means for detecting the arrival of the leading edge of an angularly aligned sheet at a detection point located between said aligning means and the point of image transfer, the distance between said detection point and the point of image transfer from the drum to the sheet, measured along the sheet path, being at least equal to the distance between the point of the line-wise exposure of the drum and the point of image transfer, measured along the periphery of the drum, and control means for starting the line-wise exposure of the drum at the earliest as the leading edge of the sheet has reached said detection means.

The term "printer" as used in the present specification does not only envisage LED or laser printers that produce an image starting from information from a work station, but it covers also so-called laser copiers which have advanced editing features as compared with conventional copiers.

The term "line-imager" stands for an elongate exposure head that comprises a multiplicity of individually energizable sources of radiation, disposed on one line, or on several parallel lines in staggered relationship in view of a higher image resolution, but said term applies also to a laser beam that is swept over the semi-conductor drum and that is dotwise modulated to produce in this way discrete image points along one line.

According to a suitable embodiment of the invention, the detection means for detecting the arrival of the leading edge of the sheet is a sensor that is arranged to measure also the position of one lateral edge of a sheet in view of the control of the correct lateral position of the electrophotographic image on the sheet. A printer wherein the latter control is performed is disclosed in our co-pending application entitled "Photographic printer with lateral image alignment", filed on even date herewith.

The electrophotographic printer according to the invention may further comprise time delay means for delaying the starting of the line-wise exposure of the drum for a given period after the leading edge of the sheet has reached the detection means. In this way the extent of the blank heading portion on the sheet does not depend on the geometry of the printer, but is adjustable.

The electrophotographic printer according to the invention may also comprise two paper drive arrangements, namely a first, lower grade paper drive that extends from the supply stack of sheets to the mechanism for the angular sheet aligning means, and a second, high grade paper drive that extends from a roller pair behind the angular sheet aligning means to the fixing station for the sheet. In this way, a cheaper paper drive is achieved than in case one high grade paper drive would stand for the complete apparatus.

The invention will be described hereinafter by

way of example with reference to the accompanying drawings in which :

Fig. 1a is the right-hand part of a diagrammatic longitudinal sectional view of one embodiment of an electrophotographic printer according to the invention, whereas

Fig. 1b is the left-hand part of this view,

Fig. 2 is a partial diagrammatic plan view of the printer of Figs. 1a and 1b,

Fig. 3 is a diagrammatic isometric view of the exposure station of the printer, and

Fig. 4 illustrates the electronic block circuit for the control of the exposure station.

Referring to Figs. 1a, 1b and 2, there is illustrated one embodiment of a LED printer for the production of images on plain paper sheets. Fig. 1a shows the right-hand part of the view of the printer, and Fig. 1b shows the left-hand part of this view. Both parts should in fact be linking to each other at the lines 3-3'. A portion of the left-hand part of the printer has been omitted in the plan view of Fig. 2.

The printer comprises basically a paper feeding section and an imaging section, as indicated by the arrows 10 and 11 respectively. Both sections have separate drive means, the paper feeding section being provided with a conventional paper drive, whereas the imaging section has a high-grade paper drive as will further be explained.

The paper feeding section 10 comprises the following elements.

A dispenser mechanism 12 with driven rollers 13, 14 and a non-driven pressure roller 15, for taking sheets one by one from a stack of sheets 17. The stack of sheets is provided with means known in the art for keeping the top of the stack within the reach of the rollers 14. The roller 13 takes a stationary position and the rollers 14 are bodily pivotable about the axis of the roller 13 and are rotationally coupled with the roller 13 via a belt drive, not illustrated. The roller 13 is driven via an electromagnetic clutch 16 and a corresponding chain wheel by an endless chain 18.

Further, a first roller pair 19 with upper and lower roller sections 20, 21. The shaft of the roller sections 21 is driven by the chain 18, via a clutch 22. The roller sections are covered with a resilient material, such as rubber, and the upper sections are driven by contact with the lower ones.

Still further, a second roller pair 23 with an upper and a lower roller 24, resp. 25. The roller 25 is driven via a magnetic clutch 26 and a corresponding chain wheel by the chain 18. The bearings of the roller 24 are vertically displaceable, and are spring-biased (not illustrated) towards the roller 25 so that both rollers contact each other in the absence of a sheet.

Finally, the apparatus comprises additional drive means 27 constituted by a shaft 28 with two

laterally spaced roller sections 29 and 30, and co-operating balls 31, 32 that are journaled in stationary housings 33, 34 having a vertical cylindrical bore that permits free vertical displacements of the balls. The diameter of the bore exceeds the diameter of the balls by a few tenths of a millimeter. The roller sections 29 and 30 have a resilient covering, and the shaft 28 is driven by the chain 18 via an electromagnetic clutch 35.

The distances L_1 between the driving means 27 and the first roller pair 19, and L_2 between the roller pair 23 and the driving means 27, are smaller than the length L of the sheet to be fed, whereas the distance L_3 between the second roller pair 23 and the first roller pair 19 may be smaller or greater than the length of such sheet.

A plate 36 serves to support a sheet during its travel through the paper feeding section 10, and a plate 66 determines near the end of the plate 36 a straight narrow passage for the sheet.

The different rollers, resp. roller sections of the paper feeding section constitute a first paper drive and they are driven by a motor 37 that is rotationally coupled with the chain 18, and that rotates uninterruptedly during the operation of the apparatus. The different electromagnetic clutches are energized in timed relationship to obtain the desired paper feeding sequence. The energizing of the different clutches may occur under microprocessor control.

The imaging section 11 of the printer comprises the following elements.

A rotatable photoconductor drum 40. An exposure station 41 for line-wise exposing the drum in accordance with the image that must be exposed. In the present embodiment, the exposure station 41 comprises a LED-bar with a plurality of LED-arrays mounted in closely adjacent relationship, whereby two staggered rows of LED's are formed that each comprise also their related electronic driving, buffer, shifting and resetting circuitry.

A developing station 42 for applying a developing toner to the rotating drum.

A toner transfer station 43 with a corona wire for causing the transfer of the developed toner image from the drum onto a sheet of paper that is fed in contact therewith, and a paper release station 44 with a corona wire for causing the sheet of paper to release from the drum surface onto which it might adhere.

A cleaning station 45 for cleaning the drum from which the developed image has been removed.

And finally, a charging station 46 for uniformly electrostatically charging the drum prior to the next image-wise exposure.

The drive means of the image section constitutes a second paper drive and comprises the

following elements.

A pair of input roller sections 47, 48, for taking over the sheet transport from the feeding section 10, and a pair of rollers 50, 51, for directing the sheet in contact with the drum 40.

Further, vacuum-belt means 53 for carrying the sheet with the fresh toner image away from the drum, and finally a fixing station 54 with a lower roller 55 and an upper roller 56 which is internally heated by an IR-heater. The fixed sheet is received in a tray 57. The driving of the different rotatable members of the imaging section occurs by a timing belt 58 driven by an electric motor 59. The drum 40 is directly coupled with the belt 58, and rotates continuously during the operation of the apparatus.

The motor 59 may be a servo-controlled D.C. motor, an A.C. motor with inbuilt high-precision reduction gear, etc. The tension control and the loop control of the timing belt, the quality of the bearings of the rollers and the precision of their mounting in the frame, and also the rigidity and the precision of the frames have received special attention so that a sheet drive is obtained with a more uniform sheet speed and a better sheet path control than the first sheet drive of section 10. The cross-over from rollers 24, 25 towards rollers 47, 48 ensures an efficient separation between both drives so that occasional imperfections in the sheet drive caused in the section 10, are not transmitted towards the section 11.

Further particularities of the described sheet transport system may be found in our co-pending application filed on even date herewith and entitled : "An electrophotographic printer with angular sheet alignment".

The exposure station 41 is illustrated diagrammatically in Fig. 3. The station comprises an exposure head 68 with optical transfer means 69. The exposure head comprises an elongate channel section bar 70 wherein a plurality of exposure modules 71 are mounted next to each other. Each module comprises a plurality of LED emitters arranged in two parallel rows 72, 73 that run parallel with the axis of the drum. The optical transfer means 69 is an elongate element wherein a plurality of self-focussing fibers are provided.

A diagrammatic view of the control circuits for the exposure head is shown in Fig. 4. The control circuits of both rows (72, 73) of emitters are identical to each other, and therefore only the circuits for the row 72 are illustrated in the drawing.

Numerical 75 is a shift register with an input terminal 76 and an output terminal 77. Switches 78 are load switches that are simultaneously controllable by a line 79, 80 is a latch register, and 81 are individual drivers for each LED 74. The outputs of the drivers are connected to the corresponding LED's. All the described elements are integrated in

a monolithic silicon chip, and each module comprises suchlike chip and a corresponding array 83 of LED's. The output 77 of the shift register 75 is connected to the input of the shift register of the next module, etc., whereas the line 79 should be considered as controlling all the load switches of the control chip of all the modules.

The circuits for the control of the information flow to the recording head comprise a recording signal or character signal generator 85, and a controller 86 with selector means for applying the recording signal alternatively to the row of even and of odd LED's, memory circuits, a clock frequency generator, setting and re-setting circuits, synchronization circuits, etc. All these circuits are known in the art and a description thereof is not required for the understanding of the operation of the apparatus.

The controller 86 is commanded by a detector 87 in such a way that a signal from the detector starts the line-wise exposure of an image onto the rotating photoconductor drum.

In accordance with the invention, the distance a , see Fig. 1b, between the detector 87 and the point 88 of image transfer from the drum to the sheet, measured along the sheet path, is at least equal to the distance b between the point 89 of the line-wise exposure on the drum and the point 88 of image transfer, measured along the peripheral surface of the drum.

The detector 87 co-operates with a radiation source 90 to detect the position of the leading edge of a sheet after the sheet has been angularly aligned and been taken over by the second sheet drive from the first sheet drive. In one suitable form, the radiator 90 may produce a spotlike bundle of light that becomes intercepted by the leading edge of an oncoming sheet. The detector 87 may be in the form a single photosensor that is responsive to the radiation of the source 90.

However, the source of radiation and the detector may also be in the form of elongate members that are arranged so as to operate with a line of radiation, considered in the plane of the sheet, rather than with a pointlike radiation bundle.

Thus, the detector may be in the form of an elongate photosensitive member, e.g. a photosensitive CCD (charge-coupled device) chip with a plurality of line-wise arranged individual photosensors that run parallel with the plane of the sheet and in a direction that is normal to the transport direction of the sheet, and that partially cover one lateral margin of the sheet. The radiation source 90 may be an elongate radiator with an appropriate optic for producing a line of radiation.

In the mentioned way, the lateral position of a sheet may be measured in addition to the measuring of the position of the leading edge of the sheet.

We refer for the latter point to the co-pending application : "Electrophotographic printer with lateral image alignment" already mentioned hereinbefore.

5 The operation of the described electrophotographic printer is as follows for a sheet the length of which is smaller than L_3 .

10 The apparatus being warmed up and the driving motors running, the clutches 16, 22 and 35 are energised in response to a signal from the imaging station that a print is to be made.

15 The rollers 13 and 14 take the upper sheet from the stack 17 of sheets and feed it towards the first roller pair 19. The removed sheet has taken a skewed position, for a reason that is unimportant in the present description, and this position is indicated by the rectangle 60 in broken lines and the skew angle Δ in Fig. 2.

20 The sheet becomes engaged by the roller pair 19 and this roller pair takes over the sheet drive as the trailing edge of the sheet left the roller pair 12. During the further transport of the sheet the skew position of the latter may remain unaltered or may increase, depending on the precision of the different elements that have an influence on the sheet transport.

25 The length L of the sheet is greater than the distance L_1 , so that the leading end of the sheet becomes engaged by the sheet drive 27 before the trailing end of the sheet becomes disengaged from the roller pair 19.

30 The transport of the sheet continues until the leading sheet corner abuts in the nip between the rollers 24, 25 of the roller pair 23. This situation is illustrated in Fig. 2, where the rectangle 61 drawn in broken lines shows the skewed sheet, and 62 is the leading sheet corner that makes the first contact with the roller pair 23. At the moment the described contact occurs, the contact between the trailing sheet end and the roller pair 19 may have been broken but in the meantime, the sheet drive has been taken over by the drive means 27 since the bias of the balls 31, 32 on the sheet is sufficiently great to produce a sufficient friction between the sheet and the roller sections 29, 30 for said roller sections to take over the sheet drive after the sheet drive by the roller pair 19 was stopped.

35 However, the bias of the balls 31, 32 is also sufficiently small to permit the roller sections 29, 30 to slip on the sheet surface as the sheet is unable to advance any further. This situation occurs as the sheet abutted against the stopped roller pair 23. While the sheet corner 62 is unable to further advance, the remainder of the leading edge of the sheet remains remote from the roller pair 23 over a distance that increases from zero (at the corner 62) to a maximum at the opposite trailing

sheet corner 63. This separation has been illustrated by the wedgelike opening 64 in Fig. 2. The sheet drive continues at the side of the corner 63, so that the sheet will start to rotate in its own plane about the corner 62 until finally the leading edge of the sheet abuts in precise parallel relationship against the rollers 24, 25. At this moment, a correct angular sheet position has been obtained since the rollers 24, 25 are accurately aligned in parallel with the semi-conductor drum 40.

The roller sections 29, 30 continue to rotate, and a 100 %'s slip occurs between said roller sections and the arrested sheet. During said continued driving force, and also during the adjustment of the angular sheet position, the leading sheet portion that is involved in the driving forces is kept well straight by a sheet guidance formed by the closely spaced guide plates 36 and 66.

A short while after the sheet abutted against the roller pair 23, the clutch 26 is energized whereby the sheet drive is resumed. The now rotating rollers 24, 25 pull the sheet from the sheet feeding section 10 and introduce it into the imaging section 11 where the rollers 47, 48 and 50, 51 take over the sheet drive.

During the temporarily arrestment of the sheet driving in the sheet feeding station, the leading edge of the sheet is kept arrested for a brief period whereafter the sheet driving is resumed. The re-starting of the sheet drive may cause inaccuracies, the causes for which are mentioned in the introduction of the specification.

Said inaccuracies are unimportant in the printer according to the present invention, since now it is the moving sheet that controls the starting of the imagewise exposure of the semi-conductor drum.

The measurement of the sheet position is done by the detector 87 that controls the controller 86 to start the linewise exposure of the drum 40 by the exposure head 41. As the first exposed image line reaches the point 88 of image transfer, the leading margin of the sheet has just reached such point. The starting of the operation of the exposure head 41 may be delayed over a number of milliseconds, in order to establish a blank heading space on the sheet. Such delay may be adjustable.

The measuring of the longitudinal sheet position provides in the present embodiment of the printer also an indication of the lateral position of the sheet, and this signal may be used to control the lateral position of the image on the sheet.

The sheet bearing the transferred toner image is received on a vacuum conveyer belt 53, and then fed through a station 54 where the image is heat-fixed. Finally the sheet is received in a collector tray 57.

The following data illustrate the described printer.

Sheets : A4 (L = 210 x 297 mm) and A3 (L = 297 x 420 mm) format.

L₁ : 190 mm

L₂ : 235 mm

5 L₃ : 45 mm.

Angular sheet deviations, measured after the pair of rollers 24, 25 : always less than 3 arc minutes.

Distance a : at least 125 mm

10 Distance b : 125 mm

Deviations of the longitudinal position of the image on the sheet : smaller than 0.5 mm.

Sensor 87 : CCD chip with 1728 photosensors over a length of 13.8 mm.

15 Radiator 90 : tungsten-halogen lamp.

The invention is not limited to the described embodiment of an electrophotographic printer.

The printer may as well operate with a laser exposure station, instead of LED means.

20 The sensor means for measuring the longitudinal and the lateral position of a sheet may also comprise a linear LED array that is mounted at one side of the sheet path in a direction normal to the transport direction of the sheet, means for repeatedly energizing the distinct LED's of said array in sequence, and detection means at the opposite side of the sheet path with one sensor, e.g. an amorphous silicon detector, and with a light collector for collecting the radiation of the distinct LED's onto said sensor. In the operation of the circuit, the LED's are energized from one side of the sheet path to the opposite side, and the sensor will receive light until the radiation becomes intercepted by the lateral sheet edge. The last LED that was effective to still radiate the sensor is representative for the lateral position of the sheet.

Claims

40 1. An electrophotographic printer, comprising a rotatable semi-conductor drum (40), drive means (58, 59) for rotating the drum, means (46) for electrostatically charging the drum, a line imager (41) for line-wise exposing an image on the rotating electrostatically charged drum, a developer station (42) for toner-developing the electrostatic image on the drum, sheet feeding means (13, 14, 29, 30, 31, 32, 50, 51) for withdrawing a sheet from a stack (17) of sheets, for angularly aligning such sheet on its path towards the drum and for advancing the angularly oriented sheet in contact with the drum, means (43) for causing transfer of the toner image from the drum onto the paper sheet as the sheet makes progressively contact with the drum, and means (54) for fixing the transferred toner image on the paper sheet, characterized in that said printer comprises detection means (87) for detecting

the arrival of the leading edge of an angularly aligned sheet at a detection point located between said aligning means and the point of image transfer, the distance a between said detection point and the point (88) of image transfer from the drum to the sheet, measured along the sheet path, being at least equal to the distance b between the point (89) of the line-wise exposure on the drum and the point (88) of image transfer, measured along the periphery of the drum, and control means (86) for starting the line-wise exposure of the drum at the earliest as the leading edge of the sheet has reached said detection means.

2. An electrophotographic printer according to claim 1, which comprises time delay means for delaying the starting of the line-wise exposure of the drum for a given period after the leading edge of the sheet has reached the detection means.

3. An electrophotographic printer according to claim 1, wherein said detection means is formed by a photo-sensitive device.

4. An electrophotographic printer according to claim 3, wherein said device is a CCD.

5. An electrophotographic printer according to claim 4, wherein said device is an amorphous silicon contact sensor.

6. An electrophotographic printer according to claim 1, wherein said exposure means is formed by a longitudinal array of LED's.

7. An electrophotographic printer according to claim 1, wherein said detection means is arranged for measuring also the lateral position of a sheet fed to the drum surface.

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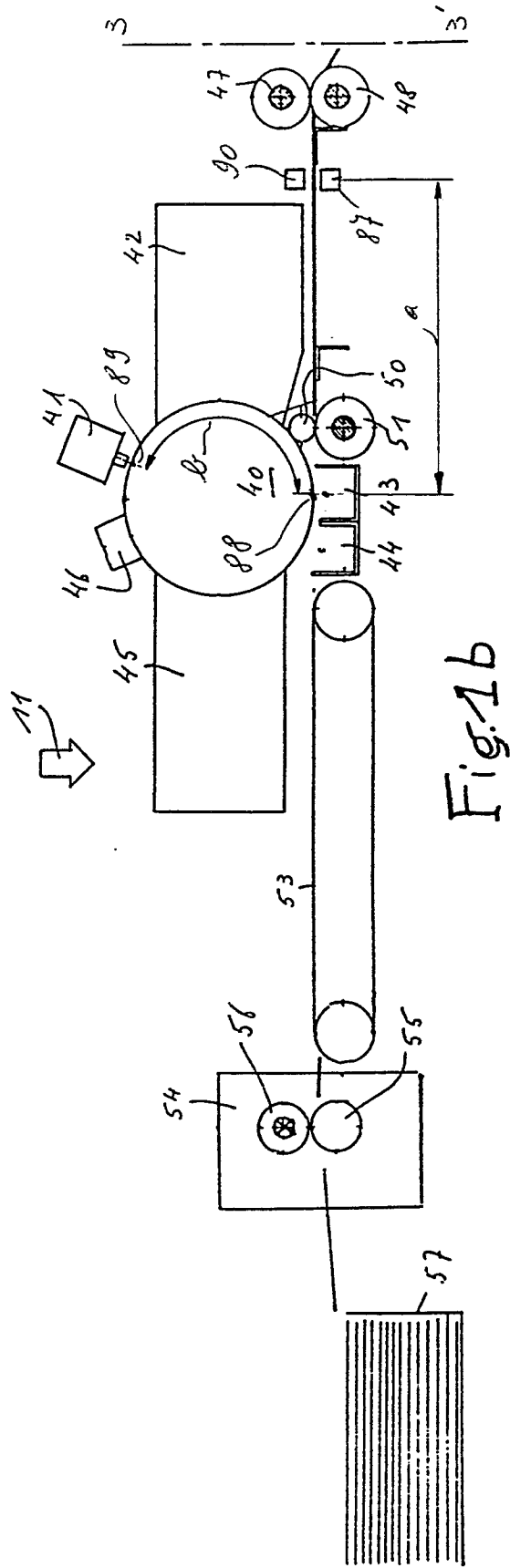
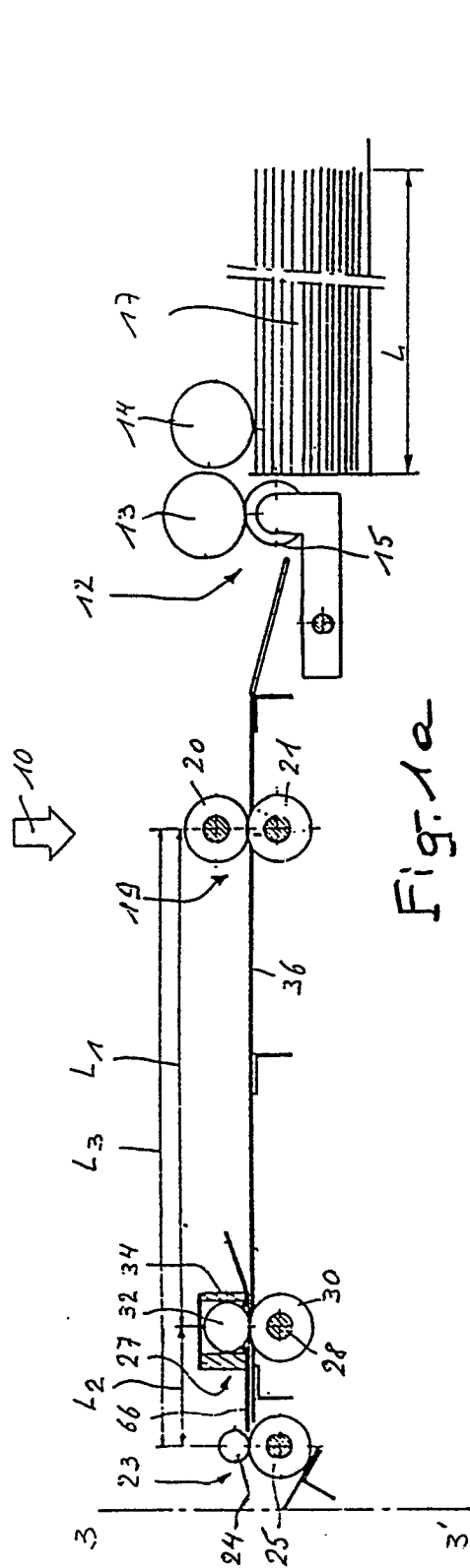
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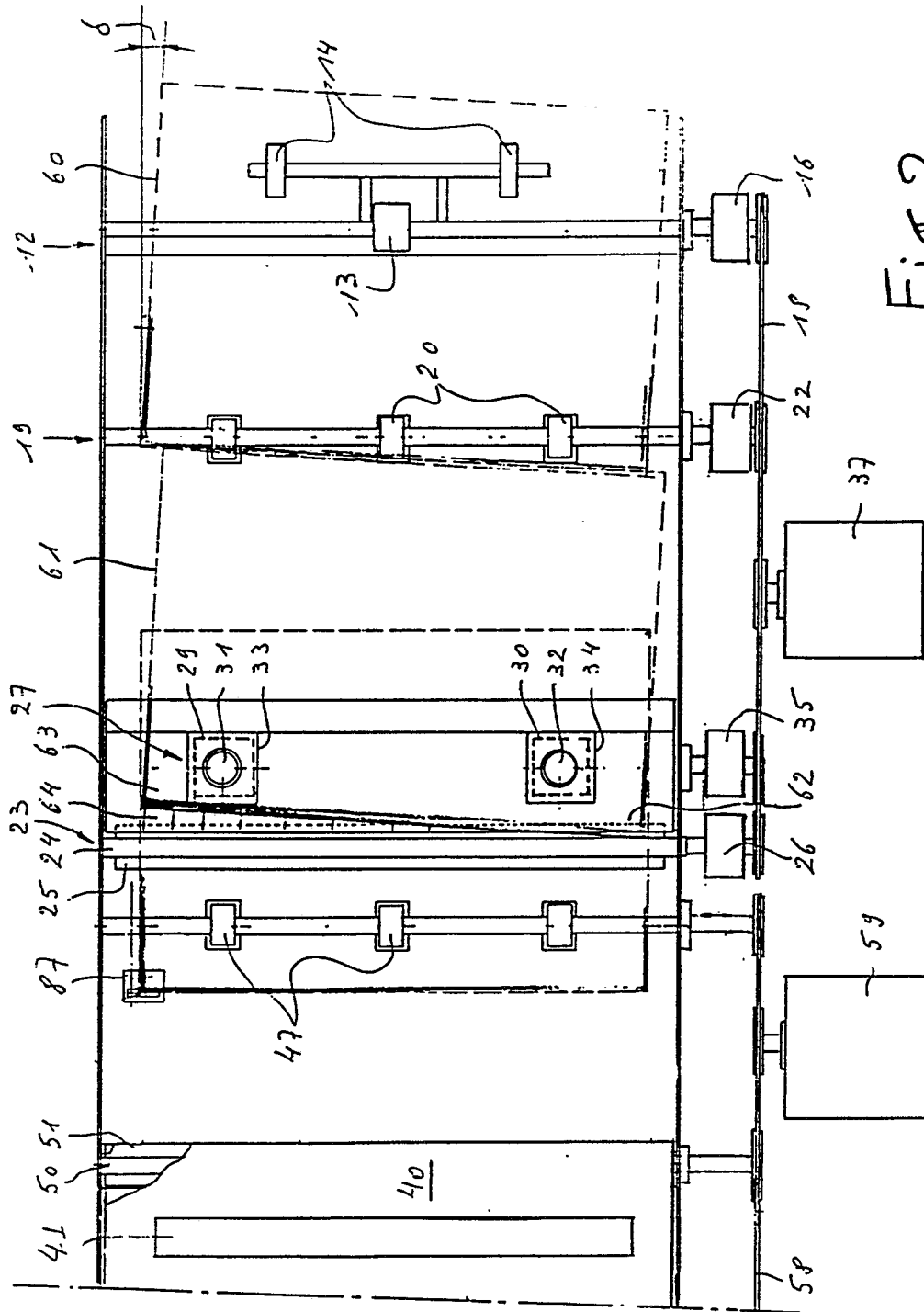


Fig. 2

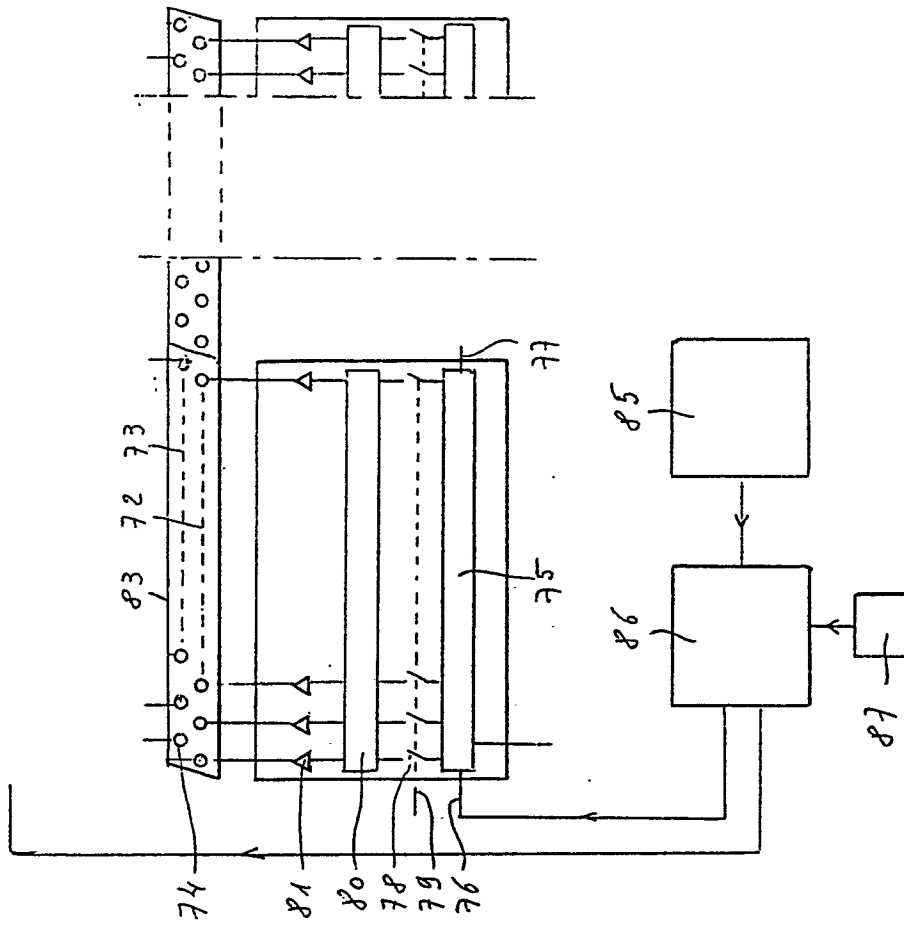


Fig. 4

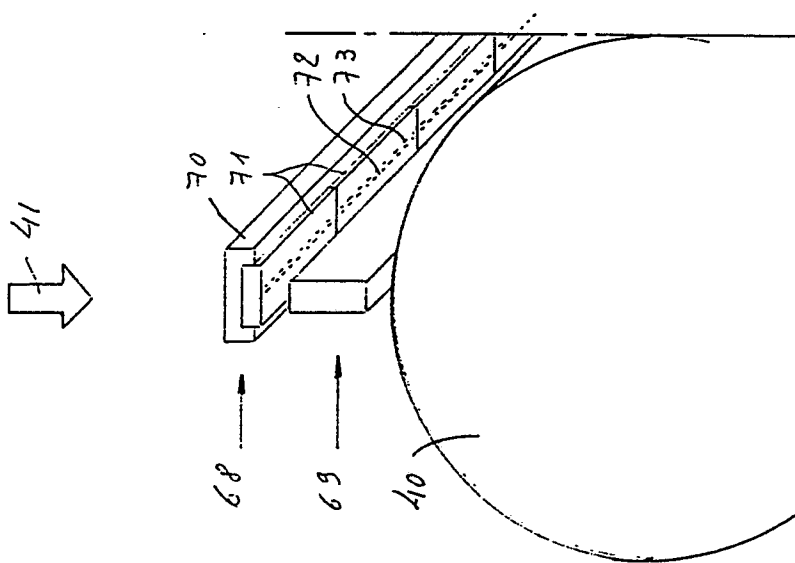


Fig. 3



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	PATENT ABSTRACTS OF JAPAN, vol. 7, no. 152 (P-208)[1297], 5th July 1983; & JP - A - 58 63974 (HITACHI KOKI) 16-04-1983 ---	1	G 03 G 15/00 G 03 G 15/30		
Y	PATENT ABSTRACTS OF JAPAN, vol. 6, no. 13 (P-99)[891], 26th January 1982; & JP - A - 56 137 365 (RICOH) 27-10-1981 ---	1			
Y	PATENT ABSTRACTS OF JAPAN, vol. 6, no. 133 (P-129)[1011], 20th July 1982; & JP - A - 57 58164 (RICOH) 07-04-1982 ---	1			
Y	DE-A-2 657 426 (CANON) * figures 1-8 * ---	1			
Y	PATENT ABSTRACTS OF JAPAN, vol. 8, no. 92 (P-271)[1529], 27th April 1984; & JP - A - 59 7966 (RICOH) 17-01-1984 ---	1			
Y	US-A-4 519 700 (BARKER et al.) * complete document * -----	1	TECHNICAL FIELDS SEARCHED (Int. Cl.4) G 03 G 15/00		
The present search report has been drawn up for all claims					
Place of search BERLIN		Date of completion of the search 29-02-1988	Examiner HOPPE H		
<table><tr><td>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</td><td>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</td></tr></table>				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
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				