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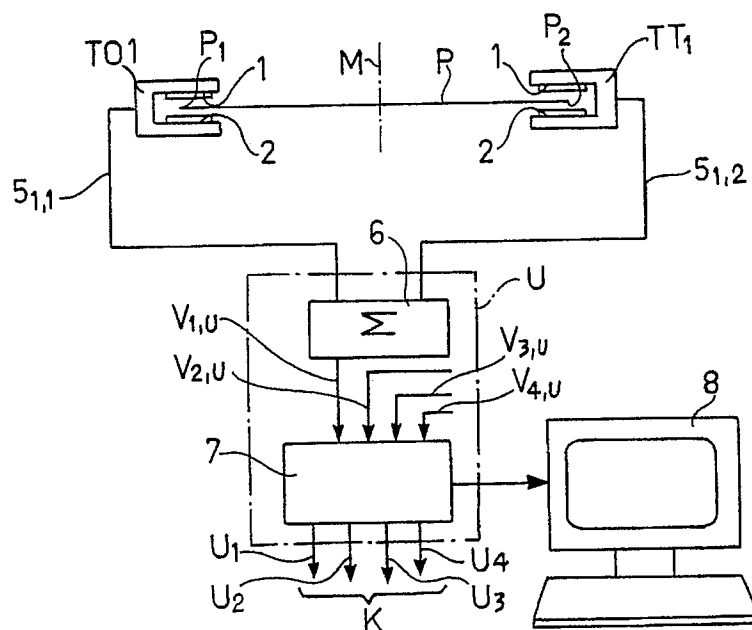
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54 **A method and a system for monitoring changes in the widths of longitudinally moving strips, particularly paper webs during printing.**

57 The position of each longitudinal edge (P_1 , P_2) of the moving strip (P) is monitored as its distance from a datum point. A respective position signal indicative of that distance is thus generated for each edge (P_1 , P_2). The position signals generated for the two edges (P_1 , P_2) are added (6) to give a sum signal which is indicative of changes in the width of

the strip (P) but which does not change with variations in the absolute position of the strip. This signal can be displayed externally (8) and/or used as a feedback signal ($U_1 \dots U_4$) for action on the width of the strip to keep it substantially constant.

FIG. 2



A METHOD AND A SYSTEM FOR MONITORING CHANGES IN THE WIDTHS OF LONGITUDINALLY MOVING STRIPS, PARTICULARLY PAPER WEBS, DURING PRINTING

The present invention relates in general to the problem of monitoring changes in the widths (that is shrinkage or expansion) of longitudinally moving strips.

The invention has been developed with particular view to its possible use in printing presses, for example, rotogravure presses.

Figure 1 shows schematically the structure of such a press which is constituted by a cascade of printing stations each of which prints a paper web P which is moving continuously at high speed (for example 10-15 metres per second) in one of the four basic printing colours (yellow, magenta, cyan and black).

The press illustrated in Figure 1, which comprises four stations in cascade, may be used for four-colour printing on one face of the web. If four-colour printing on two faces is required, it is generally necessary to provide a further four stations in cascade. In other situations, for example for two-colour printing of large runs of graphic products or for printing high-quality artistic reproductions, the number of stations may again be varied: in any case, the present invention can be applied to presses having any number of printing stations.

Essentially, each station includes a printing plate (a rotogravure cylinder) F which is immersed in printing ink in a respective fountain C in order to apply an impression (print) to a web P which passes between the cylinder F and an overlying impression cylinder R.

Immediately after it has received the printed impression, the web P passes into a drying unit T (a tunnel or a hood) which evaporates the aromatic-based solvent and dries the ink on that surface of the paper web P which is intended to receive a further printed impression in the station immediately downstream.

The drying tunnel T contains blowers B which can direct on to the web P air heated to a temperature above the ambient temperature and having a lower relative humidity with which the paper tends to become equilibrated to the extent permitted by the short period of time in which it is in the tunnel (for example, 0.5 seconds). In fact, the duration of this time interval is necessarily limited by the speed of the web P and the length of the tunnel T which, in most presses, cannot be more than 5-8 metres.

Humidifiers D may be provided near the tunnel T.

Naturally, the representation of Figure 1 (which is simplified deliberately in order to show the invention clearly) does not show all the auxiliary

members (doctors for removing excess ink from the surfaces of the printing formes, auxiliary cylinders, etc.) normally included in a printing press. In fact only the transmission rollers W which determine the path of the web P through the different printing stations are shown.

The conditioning of the paper in the tunnel T with regard to its relative humidity generally results in a loss of water from the paper itself and causes a corresponding dimensional variation in the sense of a shrinkage of the web, that is, a change in the distance between its opposite longitudinal edges.

In general one tries to arrange for the relative humidity of the paper at the entrance to the conditioning tunnel T to be fairly stable within quite small tolerances between one batch and another and between one reel and another, etc. In fact paper produced by paper mills has a water content of about 6-7% plus or minus approximately 1% and it is necessary to allow for a certain amount of shrinkage by providing for so-called "stepping" of the various printing plates (cylinders, rotogravure cylinders, etc..) used to reproduce the images directly on the web.

For example, in a rotogravure press which can print in four basic colours on both sides of the same web (that is a rotary press comprising eight stations in cascade), the absolute water loss is about 1-1.5% by weight at the output of the last printing station.

Under these conditions, it has been found experimentally that the shrinkage of the web detected at the output of the last printing element may be of the order of $0.25^{\circ}/\text{oo}-1^{\circ}/\text{oo}$, the smallest values applying to coated paper and the largest values to calendered paper with a weight of 50-60 g/m². This shrinkage is not generally distributed uniformly between the various printing elements: for example, in the case of four-colour printing on two faces of the web, the shrinkage is greater for the four elements which print on the first face.

The degree of shrinkage is such that, in very wide webs (in rotogravure presses produced recently, the web may be more than 3 metres wide), it may give rise to an "off register" condition (an error in the superposition of the various colours on one face) much greater than the maximum tolerated for high-quality printing. For example, in mail-order catalogues, the off-register condition may not exceed limits of 0.05 mm between one colour and the subsequent or preceding colours.

Elementary calculations show that (taking four-colour printing as an example), with a web of the order of 3 metres wide (if the centreline M of the

web P is perfectly aligned and the widths of the images to be reproduced, which are cut into the surfaces of the printing cylinders or plates, are equal) a shrinkage of, for example, $0.5^\circ/_{\infty}$ between the first and fourth printing elements causes the outer edges of the web to become off register between the first and fourth colours by $0.75:3 = 0.25$ mm, that is, by a value much greater than the tolerance described above.

For quality printing, it is thus essential to be able to control the effects of the tunnels T and of the humidifiers D very precisely in order to minimise the shrinkage or expansion (to bring it within the permitted tolerances). Off-register printing in fact produces rejects and consequently increases costs.

In order to achieve effective control, however, it is necessary to be able to detect the degree of shrinkage in real time, preferably around the period in which the printing plate acts, that is directly at the inputs or outputs of the cylinders F.

In the past it has been proposed to achieve this shrinkage measurement by the application of register marks to the web P (in the form of dashes or lines cut in each printing cylinder) and the subsequent monitoring, usually optically, of the displacement of these reference marks as a result of the shrinkage or expansion of the web.

Apart from all other considerations (problems of precision in the application of the reference marks, fluctuations as a result of the displacement of the centreline M of the web, etc...) this solution is unsatisfactory both because of the presence of the reference marks (which, once applied, cannot be removed, cancelled or covered up) on the final printed product and, above all, because of the subjectivity, discontinuity and slowness with which the error is evaluated and the consequent inertia of the corrective operations which causes many copies to be printed "off register" before the appropriate correction is effected.

There is therefore a need to provide a solution which enables the shrinkage or expansion of a longitudinally moving strip (typically a web during printing) to be monitored precisely but which does not give rise to the problems indicated above.

According to the present invention, this need is satisfied by a method and a system having the characteristics recited in the claims which follow.

The invention will now be described, purely by way of non-limiting example, with reference to the appended drawings, in which:

Figure 1, which has largely been described above, shows schematically a printing press which makes use of the invention,

Figure 2 corresponds to a theoretical section taken on the line II-II of Figure 1, showing the essential elements of the solution according to

the invention,

Figure 3 and 4 show possible different embodiments of the invention, and

Figures 5 to 8 show schematically some possible operating situations of a system according to the invention.

In Figure 1, control units for the conditioning tunnels T are indicated K and can vary selectively (by acting on the blowers B and on the humidifiers D, if present) the degree of humidity of the web P passing through the tunnel in question in dependence on respective control signals supplied on respective output lines $U_1 \dots U_4 \dots$ by a master control unit U.

These control signals are generated by the unit U on the basis of the shrinkage values detected, following known criteria and generally in accordance with a feedback control system. The criteria may coincide, inter alia, with those adopted in systems in which the shrinkage is measured by the detection of the displacement of reference marks applied to the web.

The main characteristic of the solution according to the invention lies in the fact that the shrinkage is measured by the monitoring of the relative displacement (that is the variation of the distance apart) of the opposite longitudinal edges P_1 and P_2 of the web P.

This monitoring is effected in each printing station by a pair of opposed monitoring heads TO_i , TT_i ($i = 1, 2, \dots$) located adjacent the printing element (the cylinder F) of that station. In the embodiment illustrated it is assumed, with the exception of the station furthest upstream, that the monitoring heads in question (only the heads TO_i situated on the so-called operator side of the rotary press are visible in the side view of Figure 1) are situated immediately downstream of the printing cylinder F so that they are interposed between the cylinder and the conditioning tunnel T associated therewith.

Different arrangements may, however, also be used, for example, with the monitoring heads situated upstream of the printing cylinder F or, possibly, even at the output of the conditioning tunnels T. In particular, as shown in Figure 1, in the first printing station it may be advantageous to measure the width of the web P upstream of the printing cylinder F (downstream of the unwinder). As will be explained further below, the nominal width with which the shrinkage or expansion values are compared can thus be reset continuously to take account of the fact that the width of the paper in the reels supplied by the paper mills may vary within a range of ± 5 mm.

In any case, the choice of the position of the measurement head involves the need to adapt (according to known principles) the feedback to the

control units K correspondingly. In any case, the principle of measuring the relative positions (that is, the spacing indicative of the width of the web P) of the two opposite edges P_1 and P_2 remains unaltered.

In the two possible embodiments shown in Figures 3 and 4, each measurement head (in the specific case the heads TO_1 and TT_1 of the first printing station) is constituted by a light source (emitter) which illuminates a respective edge of the web P and a sensor (receiver) which receives some of the light according to the position of the web P.

The monitoring heads in question may be formed so as to operate either by transmission (direct light) or by reflection.

In the first case, to which Figures 2 and 3 relate, each head TO_1 , TT_1 has a generally fork-like configuration with two opposite arms which are intended, so to speak, to embrace the corresponding edge P_1 or P_2 of the web P in a generally U-shaped configuration.

A linear light source 1, such as a linear array of light-emitting diodes, is arranged on one of the two arms of the monitoring head, for example the upper arm. The light source 1 extends along a line generally transverse the direction of movement of the web P, that is in the direction in which the two heads TO_i , TT_i are aligned on the two sides of the web P.

A corresponding linear array 2 of photosensitive elements is situated in a homologous position on the other arms of the monitoring head, approximately symmetrically with respect to the web P.

In the solution of Figure 4, a sensor element 3 constituted, for example, by two adjacent linear arrays of light emitting diodes and photosensitive diodes is situated on the upper arm of the monitoring head. On the opposite side (that is beneath the web P), however, there is a flat screen 4 of reflective material which returns the light radiated downwards by the light-emitting elements of the sensor 3 to the sensor 3 itself.

Since paper is a generally opaque material with a low index of reflectivity, in each case, the amount of light striking the receiver elements of the monitoring head depends on the position of the edge of the web: in fact, only those detectors of the array 2 which are "not covered" by the web P are struck (directly or by reflection) by the light output by the source.

In each case, the photosensitive array of the receiver supplies, on an output line, an analog or digital electrical signal which varies in dependence on the amount of light which strikes the receiver and is thus indicative of the position of the corresponding longitudinal edge of the web.

In Figures 1 to 4, the output lines of the heads

TO_i and TT_i are generally indicated by references such as $5_{i,j}$, in which the subscript i indicates the number of the printing station with which the head is associated (1 to 4 in Figure 1) and the subscript j indicates the side on which the monitoring head is situated (1 for the operator side, 2 for the transmission or rear side).

It is possible, however, to use a monitoring system which uses an airstream instead of a light beam. In this case, the receiver element, which supplies the monitoring signal on the corresponding output line $5_{i,j}$, is a pressure-sensitive element, that is, an element which supplies an electrical signal which depends on the force applied to its surface.

Monitoring systems of the type described above are already used in equipment for controlling the overall position of the web in printing machines.

The main characteristic of the solution according to the invention is the fact that, whatever kind of monitoring head is used, the output signal emitted thereby corresponds to the displacement of the corresponding edge P_1 , P_2 of the web from a theoretical datum point (taken as 0 on the monitoring scale), situated on a predetermined side of the web. In the embodiment illustrated, this datum point (which, in the solutions shown in Figures 3 and 4, corresponds to the common starting point of the linear light sources and the photodetector arrays associated therewith) is situated on the outer edge of the web.

As an example, it may be assumed that, both in the solution of Figure 3 and in the solution of Figure 4, the photosensitive elements (2 or 3) are constituted by linear arrays of CCD sensors each comprising, for example, 500 elements.

Still with reference to the pair of monitoring heads TO_1 , TT_1 situated furthest upstream (the argument is exactly the same for the other pairs) it may be supposed that each of the heads outputs a monitoring signal $V_{1,1}$ (head TO_1) or $V_{1,2}$ (head TT_1) constituted by a digital or digitisable signal whose value is indicative of the number of CCD elements left uncovered by the web.

Thus, for example, in the situation to which Figure 5 relates, (the web P centered exactly relative to the monitoring heads TO_1 , TT_1 with its median plane M exactly central) it may be assumed that the signal $V_{1,1}$ emitted by the head TO_1 on the line $5_{1,1}$ and the signal $V_{1,2}$ emitted by the head TT_1 on the line $5_{1,2}$ have identical values $V_{1,1} = V_{1,2} = 250$.

Figure 6, however, relates to a situation in which the web P is displaced from its centered position towards the so-called operator side of the rotary press by a distance such that it covers all of the photosensitive elements of the monitoring head TO_1 . In these conditions, the signal $V_{1,1}$ output by

the head in question is zero. Therefore, $V_{1,1} = 0$.

The displacement of the web P towards the operator side, however, results in all of the photosensitive elements of the head TT_1 situated on the rear or transmission side being uncovered. In these conditions, therefore, $V_{1,2} = 500$.

In any case, both in the situation of Figure 5 and in the situation of Figure 6, $V_{1,1} + V_{1,2} = 500$, regardless of the absolute position of the web P.

This is also true in the situation shown in Figure 7 in which the web P is assumed to be displaced fully towards the transmission side. In this case, $V_{1,1} = 500$ and $V_{1,2} = 0$, that is, a situation exactly symmetrical to that of Figure 6.

Naturally, the aforesaid also applies in the same way for all positions intermediate the central position of Figure 5 and the two extreme positions 6 and 7. This is all true provided that the width or height of the web P - that is the distance between the edges P_1 , P_2 - remains unchanged. In these conditions, in fact, the displacement of the web P in one direction (towards the operator side or towards the transmission side) and the consequent covering of a certain number of photosensitive elements on one side (P_1 or P_2) is compensated for by the fact that a corresponding number of photosensitive elements is uncovered on the opposite side (P_2 or P_1).

This means that the sum of the signals $V_{1,1}$ and $V_{1,2}$ does not change with variations in the absolute position of the web P.

Figure 8, however, shows a situation in which, regardless of the position of the median plane M of the web (which, as has been seen, is an irrelevant factor), the height or width of the web has changed as a result of shrinkage or expansion (for example of the order of one millimetre).

For example, shrinkage causes the web P to cover a smaller number of photosensitive elements (for example, ten photosensitive elements less with reference to the magnitude of shrinkage indicated above).

If the web P expands, however, it will cover a larger number of photosensitive elements.

In general, this may occur on both sides and not necessarily symmetrically.

In any case, the change in the number of photosensitive elements covered causes a corresponding change in the signals ($V_{1,1}$ and $V_{1,2}$) output by the heads TO_i and TT_i - and in their sum.

In fact, if the width of the web P changes, the compensation described above with regard to the signals $V_{1,1}$, $V_{1,2}$, which means that their sum does not change with variations in the position of the web, does not take place.

Thus, supposing that one starts from a situation 1 in which the width of the web P is such that $V_{1,1} + V_{1,2} = 500$, it may be assumed, for example,

that, with an expansion of the magnitude indicated above, a further ten photosensitive elements will be covered, resulting in a situation in which $V_{1,1} + V_{1,2}$ equals 490.

In short, the foregoing means that:

- the sum, $V_{1,i} + V_{2,i} = V_{i,u}$, of the signals generated by the monitoring heads on the opposite sides of the web is a quantity which does not change with variations in the absolute position of the web, and
- any change $\Delta V_{i,u}$ in the sum signal is an indication of a change in the width or height of the web P.

In Figure 2, an adder, indicated 6, receives the signals output by the heads TO_1 , TT_1 and produces their sum in the form of a signal $V_{1,u}$, whose variations $\Delta V_{1,u}$ are indicative of any changes in the width of the web in correspondence with the first printing station of the rotary press.

Corresponding sum signals $V_{2,u}$, $V_{3,u}$, $V_{4,u}$... are produced in a manner identical to that described with reference to the reading heads TO_1 , TT_1 by the pairs of monitoring heads associated with the other printing stations.

The various sum signals $V_{i,u}$ ($i = 1, 2, \dots$) are fed into a main processing unit 7 which, from these signals, which are indicative of the shrinkage of the web in correspondence with the various printing stations, calculates (following known criteria, as has been seen) signals $U_1 \dots U_k$ which provide the feedback to the control unit K for minimising the variations in the transverse dimensions of the web during printing.

As already stated, the devices which enable the web P to be expanded or shrunk according to requirements are the drying tunnel T and the humidifier bars D respectively.

In the drying tunnel T through which the paper passes after printing in each station, the air is projected on to the paper by the blowers B so as to evaporate the excess solvent, which is one of the three components of the ink, and to cause the other two components, which are resinous and coloured-pigment fractions, to set on its surface.

If the ink is not dried completely with air at ambient temperature which is not often the case, or if it is necessary to increase the shrinkage of the web by the removal of more of its water content, the blown air may be heated by means of a steam/air exchanger.

In general, the ink is normally blow-dried effectively with air at ambient temperature.

The temperature of the blown air is adjusted by the control of the quantity of steam flowing through the exchanger. For this purpose, it is well known in the art to use of a Honeywell regulator, model SA 93. Such a regulator can easily be interfaced with the control unit 7 of the system of the invention so

that the temperature of the air can be varied automatically when it is necessary to shrink or expand the web.

If the paper needs to be expanded, for larger expansion values, it may not suffice to bring the air to, or keep it at, ambient temperature. In this case it is necessary to dampen the paper to achieve the desired effect.

The devices used in current high-speed roto-gravure presses are humidifier bars D placed between the printing units.

The models produced by the United States company Armstrong (for example Armstrong Series 80 humidifiers) are well known.

The regulator which regulates the quantity of steam supplied to the surface of the paper by the humidifier bars B can also be interfaced with the control unit of the system of the present invention.

An interface for external dialogue (for example a unit including a video terminal) on which the shrinkage values measured in correspondence with the various printing stations are displayed together with the other parameters indicative of the operating conditions of the rotary press, is generally indicated 8.

This enables an operator to follow the progress of the printing process.

In principle, as an alternative to a completely automated solution such as that described (direct feedback from the processing unit 7 to the control unit K), semi-automatic operation may be considered, the unit 7 being limited to the external display of the measured width changes by means of the interface 8 and the task of acting on the unit K to control the shrinkage appropriately being left to the operator.

It is also possible to provide for selective changing from automatic operation to semi-automatic operation with the intervention of an operator.

This enables semi-automatic control to be used for limited runs on particular batches of paper to be printed for which the ad hoc definition of automatic control strategies - usually by trial and error - would not be justified from the point of view of productivity.

Since the purpose of the system of the invention is to measure the shrinkage or expansion of the web P in a rotary press, the measurements of the width changes $V_{i,u}$ can be processed in the following manner.

The measurement $\Delta V_{1,u}$ (that is the monitoring effected in correspondence with the printing station furthest upstream, preferably downstream of the unwinder and before the printing) is the reference measurement for the subsequent elements. This measurement can be reset continuously so as to take account of the variations in the width of the web within the tolerances typical of a supply from a

paper mill.

A homologous signal $\Delta V_{2,u}$ will be available in correspondence with the station immediately downstream.

The quantity $R_2 = \Delta V_{2,u} \Delta V_{1,u}$ is indicative of the width change (shrinkage) undergone by the web as it passes from the first station to the station immediately downstream, regardless of the base or starting value of the sum signal.

The same criterion for the measurement of the width change can be adapted for all the other stations in cascade with reference either to the station immediately upstream or to the station furthest upstream, used as a common reference for all the stations.

This means that, as well as being independent of the position of the web P, the width-change measurement obtained from an analysis of the width changes and their comparison with those of the element upstream, suitably translated, is also completely independent of the overall width of the web P.

Claims

1. A method of monitoring changes in the width of a longitudinally moving strip (P) having two opposite longitudinal edges (P_1 , P_2), characterised in that it comprises the steps of:

- monitoring (TO_i , TT_i) the position of each longitudinal edge (P_1 , P_2) as its distance from a datum point (0), generating, for each edge (P_1 , P_2), a respective position signal ($V_{i,1}$, $V_{i,2}$) indicative of that distance, and

- adding the position signals to produce a sum signal ($V_{i,u}$) whose variation ($\Delta V_{i,u}$) is indicative of the change in width; the sum signal ($V_{i,u}$) remaining unchanged with variations in the absolute position of the strip (P) relative to the reference points.

2. A method according to Claim 1, applied to a strip moving longitudinally through a plurality of stations (F), characterised in that it comprises the steps of:

- monitoring the position of each longitudinal edge (P_1 , P_2) and generating a respective position signal ($V_{i,1}$, $V_{i,2}$) for each edge (P_1 , P_2) and a respective sum signal ($V_{i,u}$) for each of the stations (F), and

- using the sum signal ($V_{i,u}$) or its variation ($\Delta V_{i,u}$) generated in correspondence with at least one of the stations as a reference signal for detecting deviations from the reference signal of the homologous signal ($V_{j,u}$; $\Delta V_{j,u}$) generated in correspondence with at least one other station (F).

3. A method according to Claim 2, characterised in that, in the stations in cascade downstream of the first station, the signal generated at the work station immediately upstream is used as the reference

signal ($V_{i,u}; \Delta V_{i,u}$).

4. A method according to Claim 2, characterised in that, in the stations in cascade downstream of the first station, the signal ($V_{i,u}; \Delta V_{i,u}$) generated in the furthest upstream of all the stations is used as the reference signal ($V_{i,u}, \Delta V_{i,u}$).

5. A method according to any one of Claims 1 to 4, characterised in that it includes the step of displaying externally (8) the changes in width detected.

6. A method according to any one of Claims 1 to 5, characterised in that it includes the steps of:

- providing means (K, B, T) for acting on the width of the strip (P), the means being operable selectively in dependence on a respective control signal (U_i) and

- generating (7) the control signal (U_i) on the basis of the width changes detected generally in accordance with a feedback control system.

7. A method according to any one of Claims 1 to 6, characterised in that the position of each longitudinal edge (P_1, P_2) is monitored optically.

8. A method according to any one of Claims 1 to 7, characterised in that the position of each longitudinal edge (P_1, P_2) is monitored pneumatically.

9. A system for monitoring changes in the width of a longitudinally moving strip (P) having two opposite longitudinal edges (P_1, P_2), characterised in that it includes:

- monitoring means (TO_i, TT_i) which can monitor the position of each longitudinal edge (P_1, P_2) as its distance from a datum point (O) and which, for each edge (P_1, P_2), can generate a respective position signal ($V_{i,1}, V_{i,2}$) indicative of that distance, and

- adder means (6) which are supplied with the position signals ($V_{i,1}, V_{i,2}$) and which can generate a sum signal ($V_{i,u}$) whose variation ($\Delta V_{i,u}$) is indicative of the change in width; the sum signal ($V_{i,u}$) remaining constant with variations in the absolute position of the strip (P) relative to the datum points.

10. A system according to Claim 9, for monitoring changes in the width of a strip (P) moving longitudinally through a plurality of stations (F), characterised in that it includes respective monitoring means ($TO_1, TT_2; TO_2, TT_2, TO_3, TT_3; TO_4, TT_4$) and adding means (6) for each of the stations (F) and in that processing means (7) are provided for processing the signals ($\Delta V_{1,u}; \Delta V_{2,u}; \Delta V_{3,u}; \Delta V_{4,u}$) indicative of the changes in width generated in correspondence with each of the work stations (F).

11. A system according to Claim 10 or Claim 11, characterised in that the monitoring means (TO_i, TT_i) are optical monitoring means.

12. A system according to Claim 11, characterised in that the optical monitoring means operate by transmission (1, 2) with the interposition of the respective longitudinal edge (P_1, P_2) of the sheet.

13. A system according to Claim 11, characterised

in that the optical monitoring means operate by the reflection of radiation by a screen (4) which can be covered to a variable extent by the respective longitudinal edge (P_1, P_2) of the strip.

14. A system according to any one of Claims 11 to 13, characterised in that the monitoring means comprise:

- a generally elongate light source (1, 3) arranged transverse the respective longitudinal edge (P_1, P_2) of the strip (P), and

- photodetector means (2, 3) substantially coextensive with the light source.

15. A system according to Claim 14, characterised in that at least one of the light source (1, 3) and the photodetector means (2, 3) comprises an array of elements.

16. A system according to any one of Claims 11 to 15, characterised in that the optical monitoring means include an array of CCD photodetectors as the photosensitive element.

17. A system according to Claim 9, characterised in that the monitoring means are pneumatic monitoring means.

FIG. 1

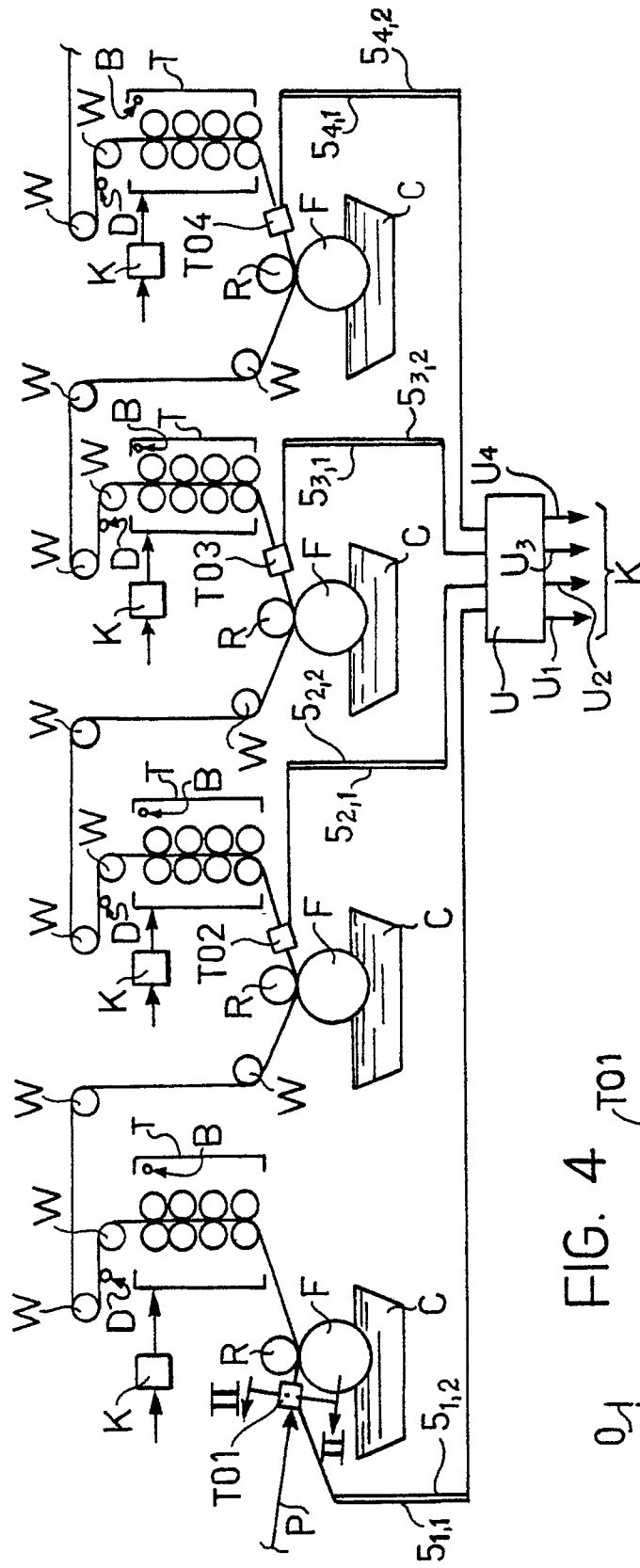


FIG. 3

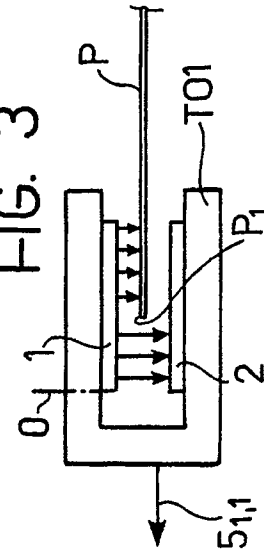


FIG. 4

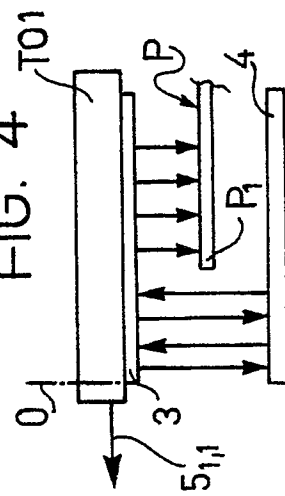


FIG. 2

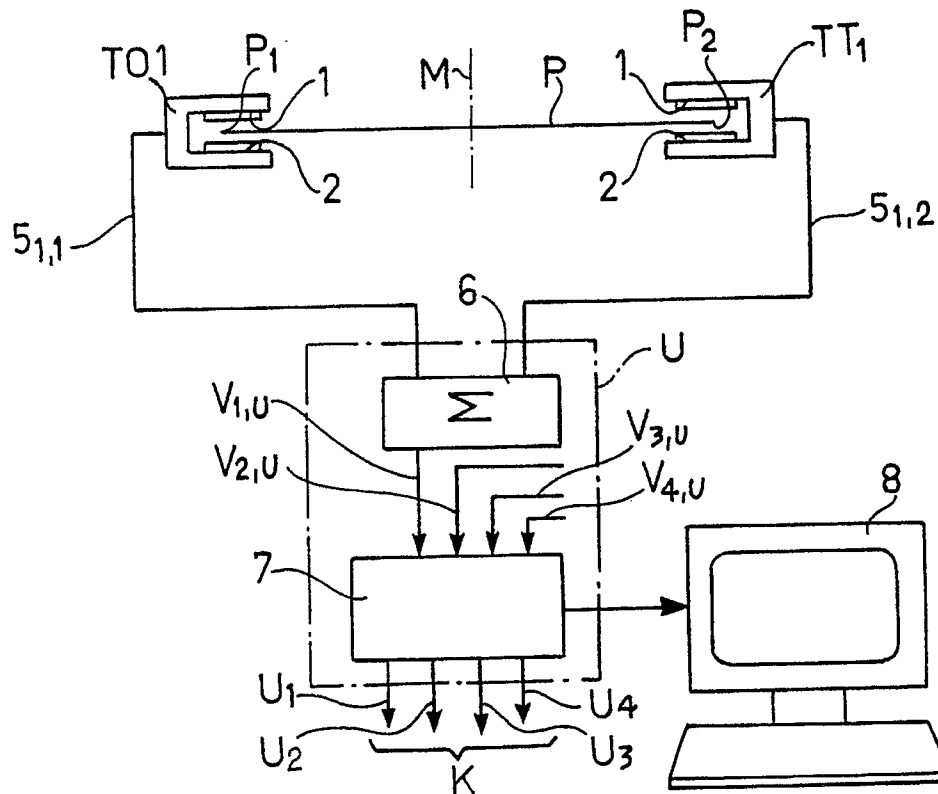


FIG. 5

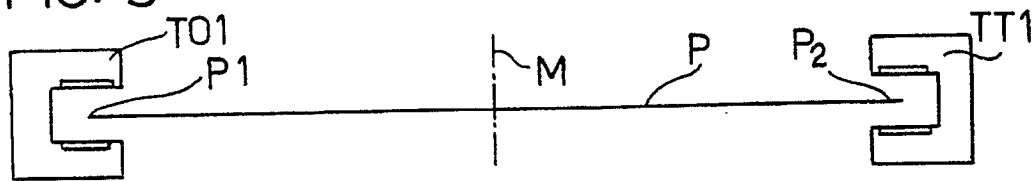


FIG. 6

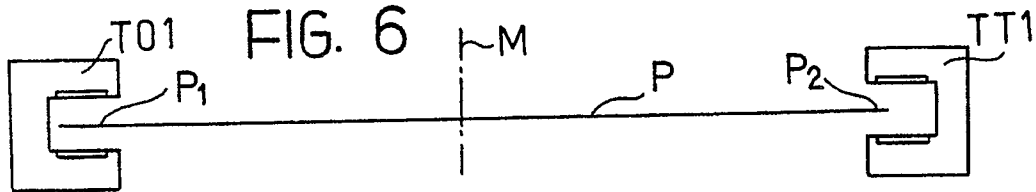


FIG. 7

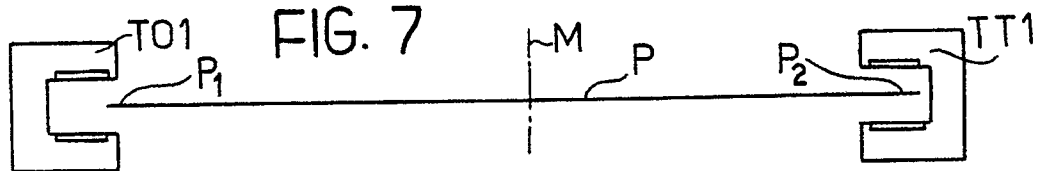


FIG. 8

