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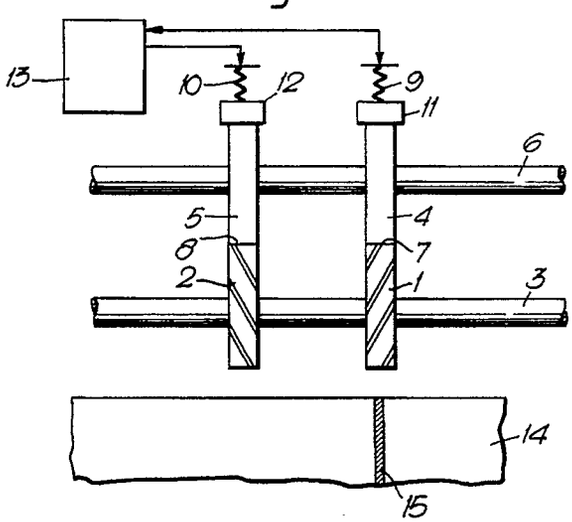
(54) Sheet thickness detector.

(57) A sheet thickness detector comprises first and second moveable guide surfaces (1,4-2,5) defining a nip (7,8) through which a sheet passes in use. A sensor (32) senses relative separation movement between the guide surfaces. The first surface carries a rib (16,17) extending generally along but at an angle to the direction of movement of the surface whereby the rib moves laterally relative to the second guide surface at the nip, and whereby any portion of a sheet extending in the direction of movement of the sheet and having a thickness greater than the majority of that section of the sheet passing through the nip, the thickness of the portion being no greater than the depth of the rib, will cause substantially no change in the relative separation of the surfaces except when the portion is sandwiched between the rib and the second surface.

Fig.1.



EP 0 429 184 A1

SHEET THICKNESS DETECTOR

The invention relates to a sheet thickness detector of the kind comprising first and second moveable guide surfaces defining a nip through which a sheet passes in use; and a sensor for sensing relative separation movement between the guide surfaces. Such detectors are hereinafter referred to as of the kind described.

An example of a thickness detector of the kind described is illustrated in EP-A-0130824. This detector has proved very successful but a problem can arise in some circumstances when detecting the thickness of sheets such as banknotes which carry an elongate feature having a thickness greater than that of a sheet. For example, banknotes commonly carry security threads which in themselves have a thickness corresponding to that of the banknote itself with the result that if the security thread passes through the nip, a double thickness will be measured. This might either be used to set up a thickness datum for a "single sheet" which would be incorrect or would cause the apparatus making use of the detector to reject the sheet as a double sheet. Similar problems arise with sheets which have tape on them.

In accordance with the present invention, a sheet thickness detector of the kind described is characterized in that the first guide surface carries a rib extending generally along but at an angle to the direction of movement of the surface whereby the rib moves laterally relative to the second guide surface at the nip, and whereby any portion of a sheet extending in the direction of movement of the sheet and having a thickness greater than the majority of that section of the sheet passing through the nip, the thickness of the sheet being no greater than the depth of the rib, will cause substantially no change in the relative separation of the surfaces except when the portion is sandwiched between the rib and the second surface.

We have devised a modified form of detector in which one of the moveable guide surfaces carries a rib which effectively accommodates any additional thickness due to an elongate feature on the sheet such as a security thread except where that thread passes directly under the rib. This will cause a sudden and short duration increase in the relative separation of the surfaces which can be detected by the sensor and thereby compensated for.

Preferably, the guide surfaces are defined by respective rollers, one of which defines a datum position and the other of which is moveable in response to the passage of a sheet through the nip. Typically, the rib will be provided on the datum roller. Other cooperating guide surfaces are possible, however, such as conveyors.

Although a single rib may be adequate, in the preferred example a number of ribs are provided and spaced along the guide surface and typically the end of one rib overlaps the start of the next rib in the direction of movement. In general, the ribs will define at least part of a spiral or helix.

The invention is particularly applicable to banknote monitoring systems for example for use in banknote dispensing, counting or sorting machines so as to accommodate problems due to security threads and the like.

Some examples of detectors according to the invention will now be described with reference to the accompaning drawings, in which:-

Figure 1 is a schematic front elevation of the detector;

Figure 2 is a schematic side elevation of the detector shown in Figure 1:

Figure 3 illustrates one example of a profiled datum roller;

Figure 4 illustrates the output signal from the detector incorporating the Figure 3 datum roller;

Figure 5 illustrates the output signal from a conventional detector; and

Figures 6 and 7 illustrate two further examples of datum rollers.

The detector shown in Figures 1 and 2 may form part of an otherwise conventional sheet processing system such as a banknote counter or sorter in which sheets are fed in series to the detector. The detector shown in Figure 1 comprises a pair of datum rollers 1,2 mounted non-rotatably to a shaft 3 which is itself rotated by a motor (not shown). Each of the datum rollers 1,2 is in pinch with a respective detect roller 4,5 non-rotatably mounted on a shaft 6. Shafts 3 and 6 are geared together (not shown). Each of the detect rollers 4,5 can move towards and away from the respective datum rollers 1,2 and is urged against the respective datum roller to define nips 7,8 under the action of respective springs 9,10; or the nips may be achieved by the detect rollers 4,5 being internally sprung so that springs 9,10 act purely in a follower role. As can be seen in Figure 2, each spring, for example the spring 9 as shown in Figure 2, urges a respective pivoted bar 11,12 against the respective detect rollers 4,5. Linear movement of bar 11 is detected in a conventional manner similar for example to that described in WO-A-82/01698. The bar 11 is pivoted at 30 and is connected at its end remote from the roller 4 to a core 31 of a linear variable differential transformer (LVDT) 32 which is activated by an oscillator 33. A voltage signal representative of the angular displacement is output by the LVDT 32 and is applied to a micro-

processor 13 which monitors the signal to determine the separation between the respective detect and datum roller pairs in order to detect the passage of a banknote through the nips 7,8. An example of a banknote 14 is indicated schematically in Figure 1 and it will be seen that this banknote carries a security thread 15 in alignment with the nip 7.

In a conventional arrangement (not shown) the datum and detect rollers 1,2,4,5 each have smooth outer surfaces. This means that if a security thread passes through the nip between a pair of these rollers, they will be deflected throughout the passage of the banknote by an amount corresponding to the thickness of the thread and the banknote together. This will result in a single profile from the nip defined by rollers 1,4 of the form shown in Figure 5 in which t represents the thickness of the banknote 14, T represents the thickness of the security thread, and L is the length of the banknote 14 in the direction of feed. Clearly, in this conventional case, it will appear to the microprocessor 13 that an overthick sheet has passed through the nip leading to the generation of an error message.

To overcome this problem, each of the datum rollers 1,2 is profiled. A simple profile is illustrated in Figure 3 in which the roller carries a spiral rib 16 extending fully around its circumference as also shown again in Figure 6. Although in the present example the rib is provided on the datum roller, it may alternatively be formed on the detect roller. When the datum roller of Figure 3 rotates with a corresponding detect roller, the rib 16 will appear to precess, traversing backwards and forwards cyclically across the lateral width of the nip and thus across the area of the sheet passing through the nip which is detected. Consequently, if the security thread arrives at the nip, for example the nip 7 in Figure 1, at a point at which the rib is displaced laterally from the thread, then a part of the sheet will be received between the rib and the detect roller forcing the detect roller to separate from the datum roller by an amount corresponding to the thickness of the sheet alone. This will cause a corresponding output signal to be generated which is sent to the microprocessor 13, that part of the signal corresponding to the section labelled "a" in Figure 4. The rib 16 will precess across the nip until it reaches the security thread at which point it will ride up over the security thread causing a greater separation between the detect and datum rollers. This will cause an increase in the linear deflection signal as indicated at "b" in Figure 4. This additional deflection will only last for a short time, however, while the rib precesses over the security thread and then returns into engagement with the main part of the banknote, with the result that the seperation between the datum and detect rollers decreases and the output signal returns to the level shown at "c" in Figure 4.

It will be seen therefore that with the invention it is possible to detect the presence of the security thread and to compensate for it. The microprocessor 13 is programmed to detect short term excursions of the outputs from some mean level and to exclude those excursions from its decision making proceedure.

In a modified form, the datum roller may comprise a number of helical threads 17, for example four such threads as illustrated in Figure 7. It is preferred that there is always an overlap in the lateral direction between successive, circumferentially spaced threads or ribs.

Claims

1. A sheet thickness detector comprising first and second moveable guide surfaces (1,4-2,5) defining a nip (7,8) through which a sheet passes in use; and a sensor (32) for sensing relative separation movement between the guide surfaces characterized in that the first surface carries a rib (16,17) extending generally along but at an angle to the direction of movement of the surface whereby the rib moves laterally relative to the second guide surface at the nip, and whereby any portion of a sheet extending in the direction of movement of the sheet and having a thickness greater than the majority of that section of the sheet passing through the nip, the thickness of the portion being no greater than the depth of the rib, will cause substantially no change in the relative separation of the surfaces except when the portion is sandwiched between the rib and the second surface.
2. A detector according to claim 1, wherein the guide surfaces are defined by rollers (1,4,2,5).
3. A detector according to claim 1 or claim 2, wherein the first guide surface carries a number of ribs (17) spaced apart along the guide surface.
4. A detector according to claim 3, wherein the end of each rib overlaps in the lateral direction with an end of the same or another rib.

Fig.1.

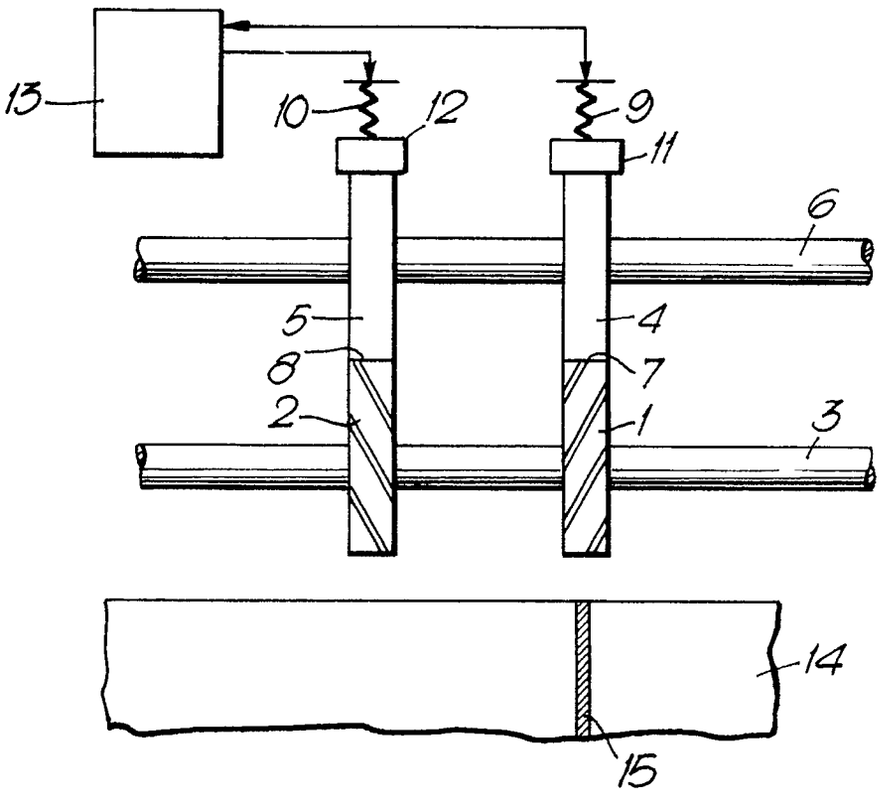


Fig.2.

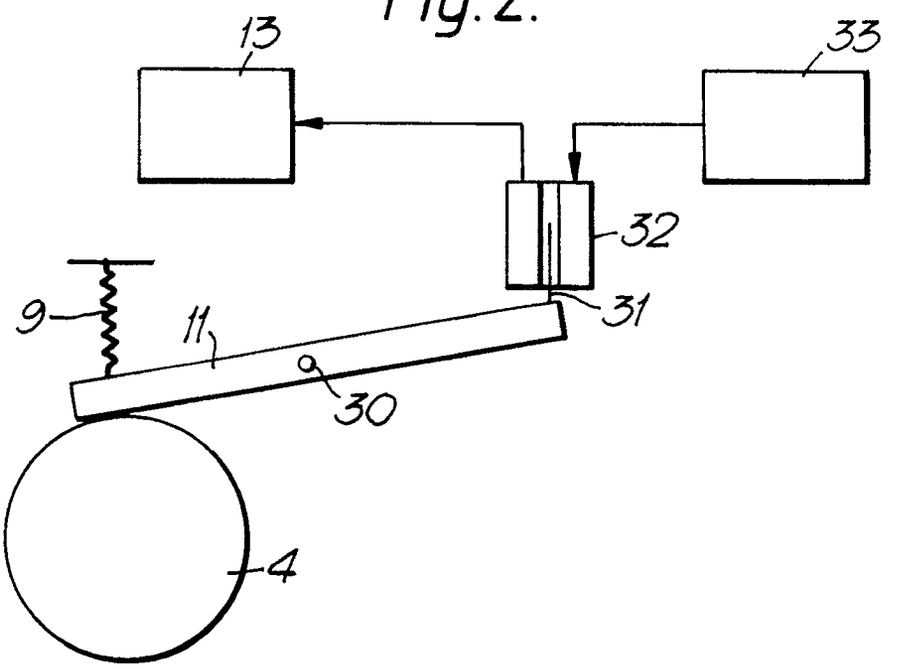


Fig.3.

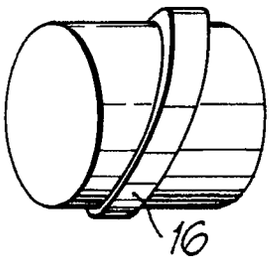


Fig.4.

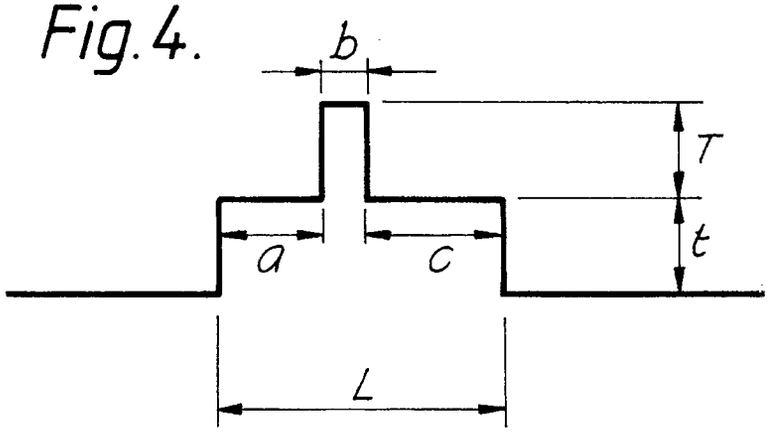


Fig.5.

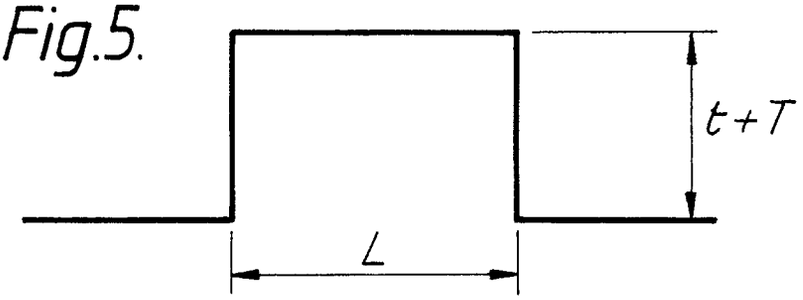


Fig.6.

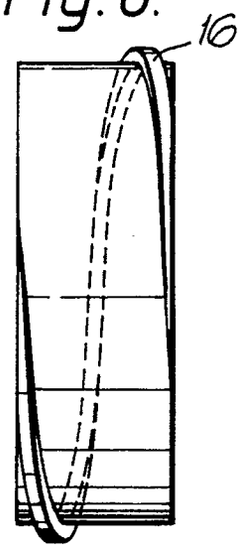
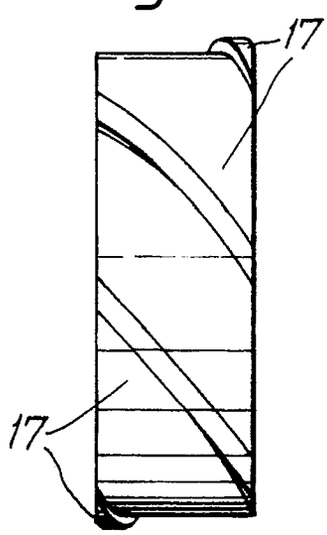


Fig.7.



European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 31 1698

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.5)
A,D	EP-A-0 064 523 (DE LA RUE SYSTEMS LTD) * the whole document *	1	B 65 H 7/12
A,D	EP-A-0 130 824 (DE LA RUE SYSTEMS LTD) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 65 H
G 01 B
G 07 D

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	12 February 91	EVANS A.J.

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
Y: particularly relevant if combined with another doument of the same catagory
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