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(71) Applicant
Heidelberger Druckmaschinen Aktiengesellschaft

(Incorporated in the Federal Republic of Germany)

Kurfürsten-Anlage 52-60, D-6900 Heidelberg,
Federal Republic of Germany

(72) Inventor
Michael Krüger

(74) Agent and/or Address for Service
Carpmaels and Ransford
43 Bloomsbury Square, London, WC1A 2RA,
United Kingdom

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G01B 13/06

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(56) Documents cited
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(58) Field of search
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INT CL[5] G01B

(54) Stack height determination device

(57) The invention concerns a device for the height detection of a cardboard or paper stack 3, e.g. at the feeder or delivery of printing machines, and which incorporates a sensor 5 sensitive to the top of the paper stack or similar area to be scanned, and which proposes for the construction of a particularly advantageous scanning arrangement that the measuring sensor takes the form of an expansion body which is driven in the direction of the scanning area by compressed air.

FIG.1

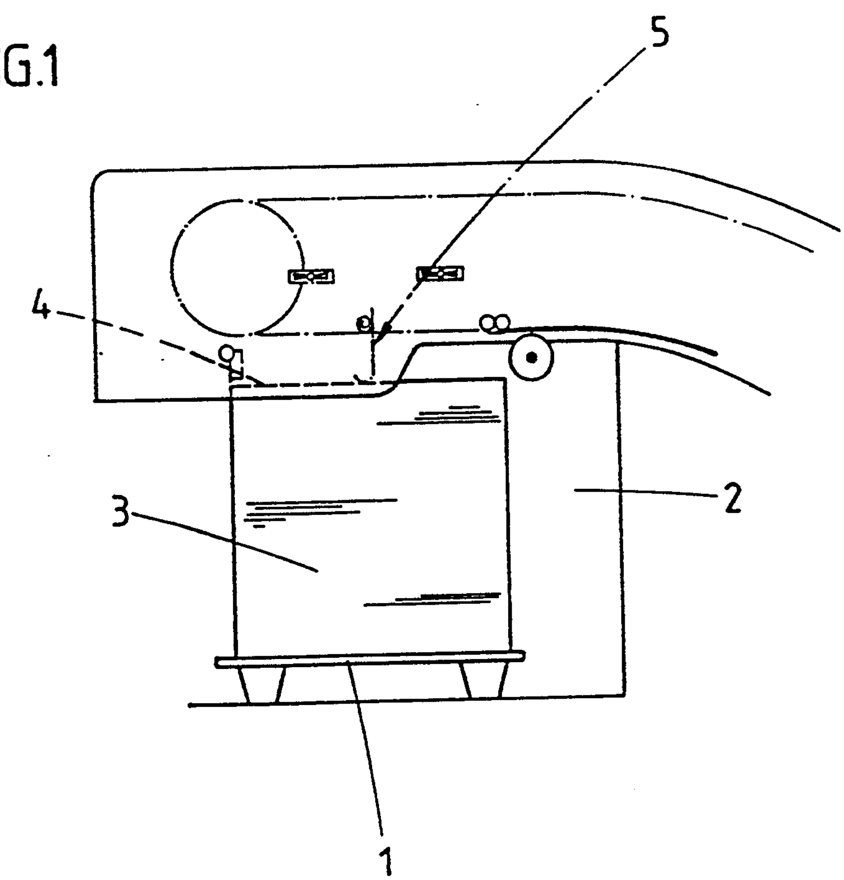

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FIG.1

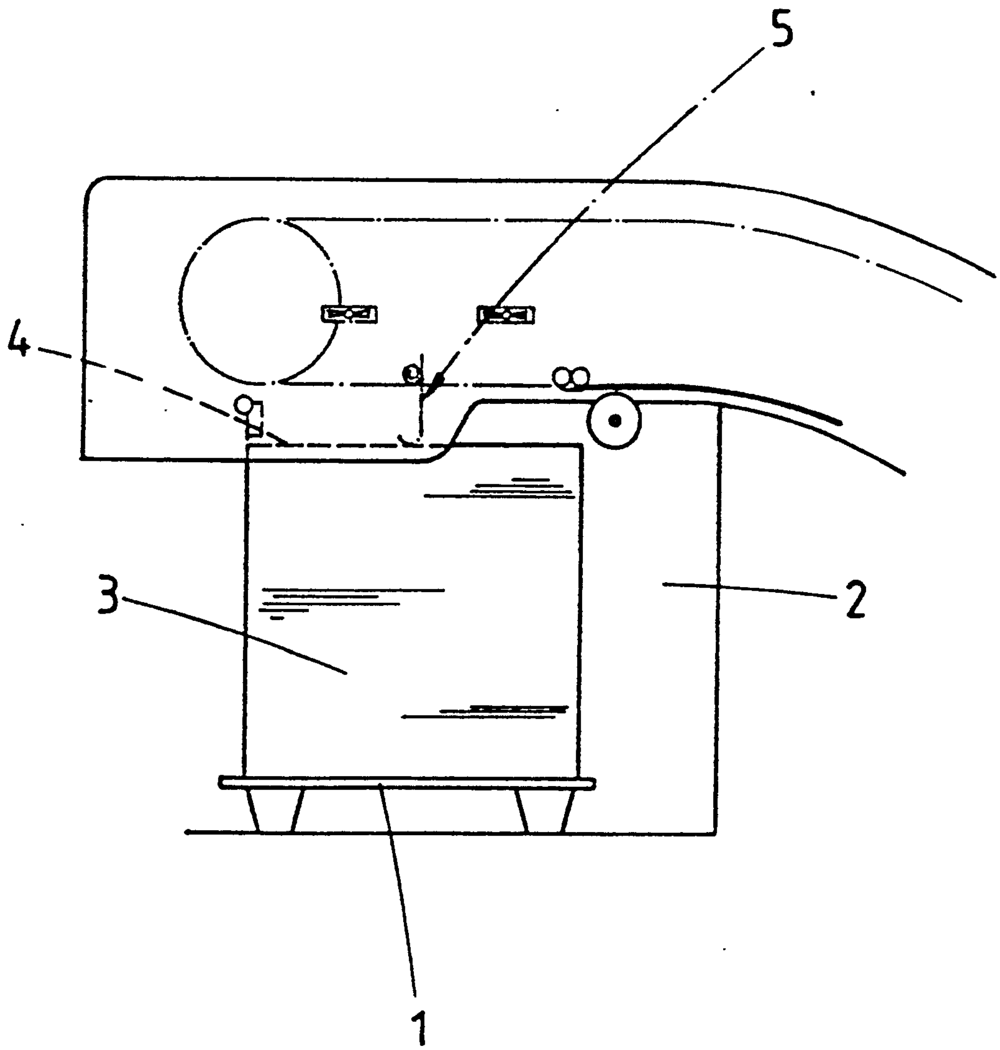


FIG.2

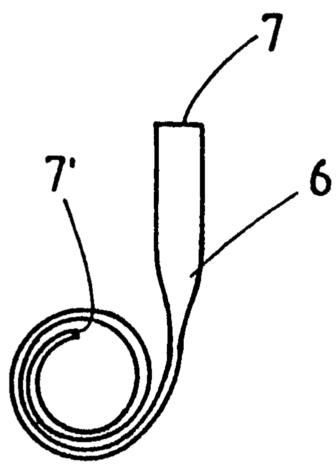


FIG.3

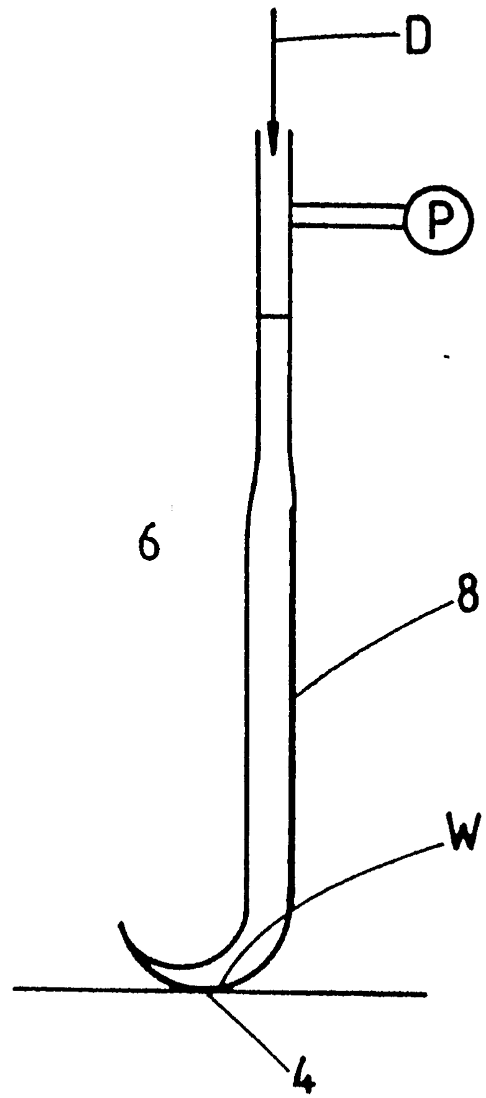
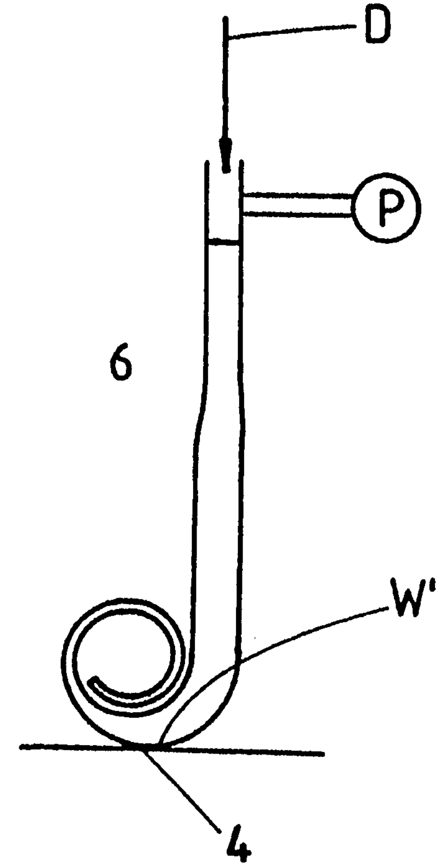


FIG.4



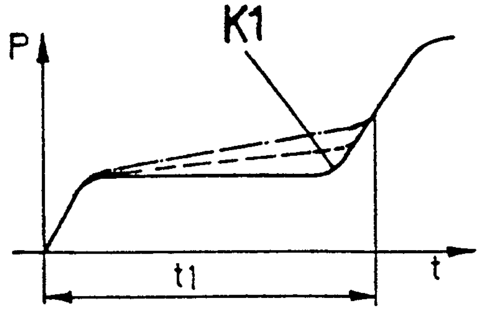


FIG. 8

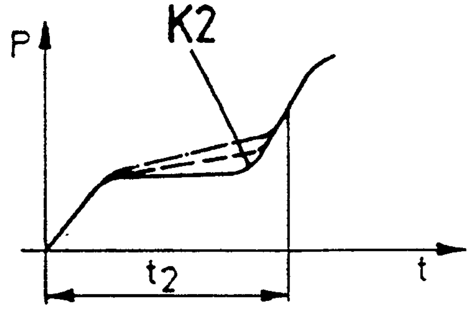


FIG.9

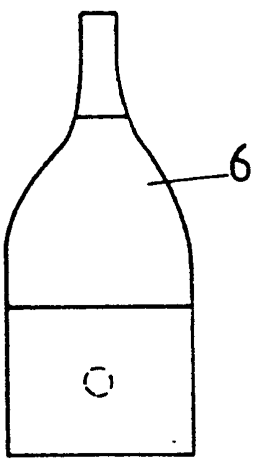


FIG.5

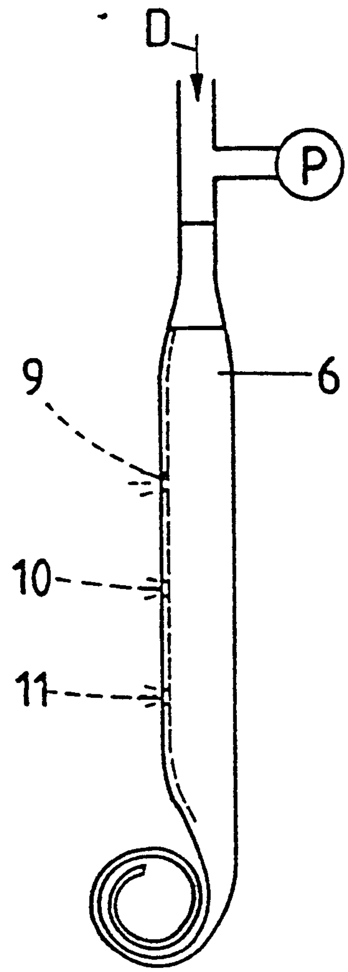


FIG.6

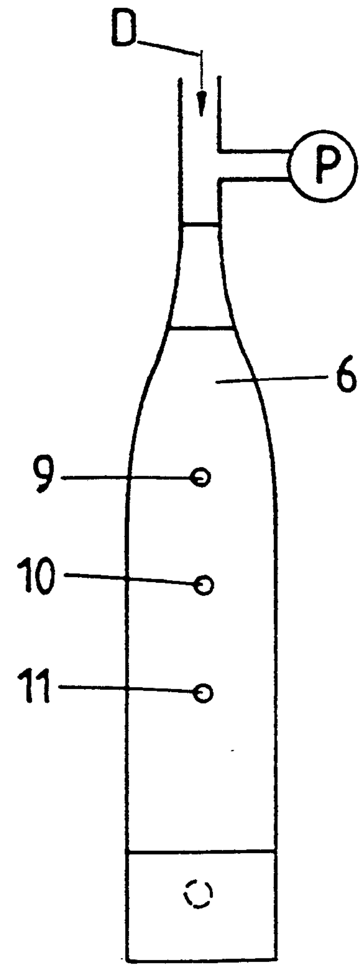


FIG.7

FIG.10

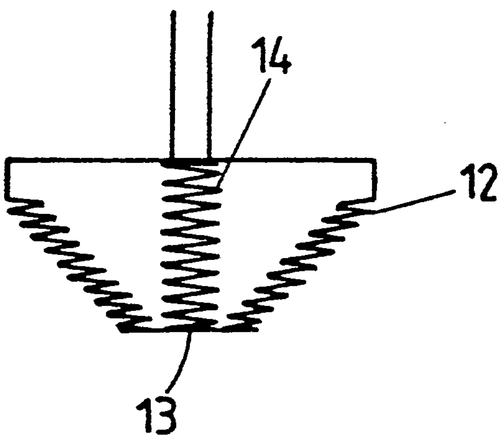
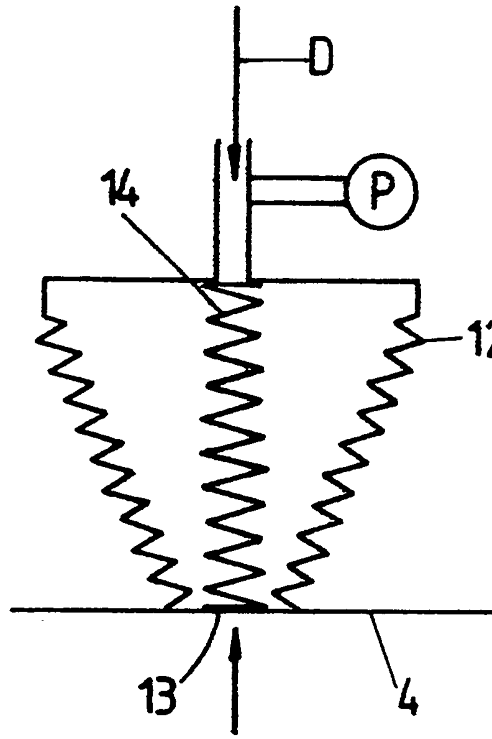


FIG.11



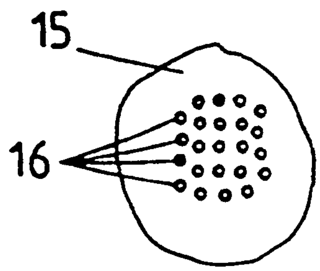
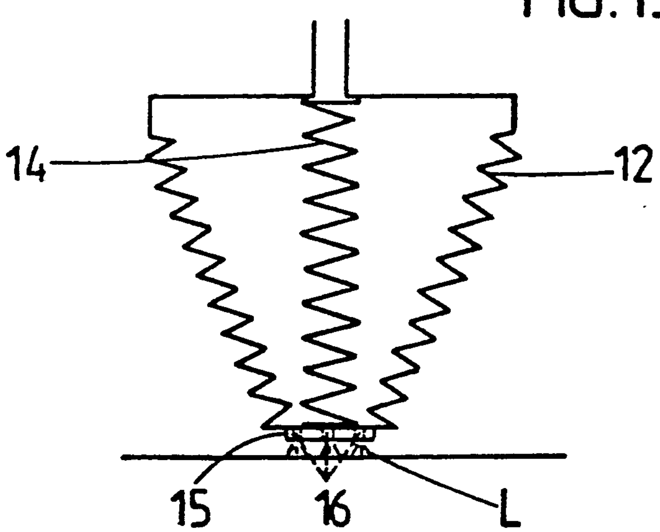


FIG.12

FIG.13



DESCRIPTION

STACK HEIGHT DETERMINATION DEVICE

This invention relates to a stack height determination device, suitable for use in determining the height of a stack of cardboard or paper accommodated in a feeder unit or delivery unit of a printing machine.

Known devices of this kind work with certain sensors in carrying out mechanical height detection. They contact the measuring surface at a definable pressure, e.g. the top of a paper or carton stack. A disadvantage of these known mechanical sensor systems are the large mechanical and considerable space requirements. Frequently, they also incorporate a certain hazard to the operating personnel and require therefore safety cladding, which renders their use, especially at a sheet delivery unit of a printing press, extremely difficult.

Other systems not relying upon any mechanical contact, e.g. making use of light barriers, optical distance sensors, ultrasonics or the like, suffer from the disadvantage that (e.g.) an undulating sheet may falsify a measuring result.

It is an object of the present invention to provide a device of the kind first mentioned which is of a simple construction and which is able to scan the top of a stack at a high measuring frequency in a most favorable manner.

This is achieved by the inventioned defined in the principal claim. The subclaims represent advantageous optional features.

Based on the above arrangement, a device is constructed to identify stack heights, e.g. at the sheet feeder or sheet delivery of printing presses, which can be used to determine the stack top and to control height adjustment there. The device features safe and hazard-free operation at a simple construction. The contacting sensor smoothens out any possible sheet undulation yet operates at a well-definable contact pressure. The rise in compressed air pressure occuring at the contact with the expansion body and the possible subsequent sheet flattening can be used as a parameter to determine the contact pressure. When the sensor reaches its proper measuring position and has completed the measurement, for example, reversal to compressed air control is possible right away. This then involves short compressed air cycles over very short timespans. A measuring arrangement can be allocated to the expansion body, either through an optical measuring device or through means to evaluate for measurement purposes the take-off point in the compressed air pressure rise after suitable approximation and contact with the measuring surface. It is advantageous if e.g. such an additional measuring device is installed within a measuring sensor, e.g. inside the feeder lines running to the expansion bellows. This duases a constant reflection of measuring signals from the same material so that intensity imprecisions due to variable paper shades cannot occur. It is possible to return the expanding body to its original position at all times by its own resilience, i.e. through its inherent restoring force, and/or by means of e.g. "converting" compressed air into suction. The latter allows a considerable increase of measuring frequency. If the compressed air which is used for the sensor travel is simultaneously used as a measuring parameter, the characteristic curve of the compressed air increase, in particular a take-off point in this curve, is evaluated in order to determine e.g. a time or height position of the measuring surface in the measuring device via a second parameter. The compressed air supplied to an expansion body moves the sensor in the direction of the measuring surface. The characteristic curve of the restoring force to be overcome is known and is input by calibrating measuring device. The restoring force is dependent on the restoring spring used. When the sensor contacts the measuring surface, an immediate rise in the characteristic curve of the compressed air increase results. The time between the supply of compressed air and this point of time is then converted by the measuring device into the corresponding height data. If the sensor is equipped with a nozzle through which the compressed air exits for the relocation of the sensor in the direction of the measuring surface, the resulting pressure increase can, after proper calibration of the device,and on reaching a certain distance between sensor and measuring surface, be passed on to the measuring device as a corresponding characteristic curve signal. The hazard-free manner of operation of the corresponding device consists in particular of the fact that, on the one hand, no large forces are required for moving the sensor in the direction of the measuring surface, and, on the other hand, any possible obstacle in the travelling path causes the immediate registration of an increase in compressed air, which is transferred as a parameter, thereby enabling the immediate cut-off of compressed air supply, with the result that the sensor regains its initial position, due to its restoring force. It has been found that any possible remaining sheet flattening can then easily be distinguished from such an obstacle through the characteristic curve of the pressure increase. The preferred solution is to select an expansion body consisting of a coiled hose with a built-in "tape mesure" spring, preferably a flat hose, which allows the uncomplicated bridging of relatively large measuring heights. A further advantage lies in the always favorable partial surface resulting from the convex shape of the final coil section which comes in contact with the measuring surface. This allows contact to be so sensitive that damage to the measuring surface, and thereby deterioration of the printed surface of freshly printed sheets, is avoided, possibly up to the extent of contact-free measurement. The choice of bellows as an expansion body, in particular of an accordion bellows in truncated cone shape, results in a considerable spatial stability in the linear movement of the sensor, even in the case of a large bridgeable measuring height. Generally speaking, it is possible to operate the sensor at a predefinable contact pressure.

Further advantages and details are indicated in the following description of certain embodiments of the invention shown in the accompanying diagrammatic drawings, in which:

Figure 1 is a side view of the sheet delivery unit of a printing machine equipped with a device according to the invention;

Figures 2-4 show the various working positions of the expansion body of this device;

Figures 5-7 show slightly modified versions thereof;

Figures 8-9 are graphs illustrating the measuring procedure;

Figures 10-11 show the expansion body of the device constructed in the form of an accordion bellows, in two different positions; and

Figures 12-13 show a modified version thereof, with the sensor operating without contact.

In Figure 1, stack 3 consisting of individual paper or cardboard sheets rests on the height-adjustable controlled surface 1 of sheet delivery unit 2. Measuring surface 4 is formed by the top of the topmost sheet; to it is assigned stack height detection and measuring device 5. The latter is firmly installed at the frame of the sheet delivery unit, or may be height-adjustable in order to avoid excessively long distances between the fastening point of measuring device 5 and measuring surface 4. It may be used for the controlled height-adjustment of surface 1 in order to guarantee the optimum working position of the top edge of the stack at all times.

In the case of Figures 2-4, the individual parts of this measuring device consist of an expansion body comprising hose 6 which can be reeled off in the direction of measuring surface 4. The hose is preferably flat or at least in a coiled state. Aperture 7 is at one end; the opposing end 7' is closed. A restoring spring 8, preferably in the form of a longitudinal spring steel strip, is assigned to it. The latter tends at all times to return flat hose 6 into its coiled position (as Figure 2). If compressed air D is supplied to hose 6 through aperture 7, the hose is unwound, and approaches measuring surface 4. The distance from its fastening position to the measuring surface is larger than the maximum unwindable length of hose 6. This means that, each time, the final coiled bulge W of the hose (see Figure 3) comes into contact with measuring surface 4. In view of the obstacle so created to any further unreeling of hose 6, this contact causes a rise in pressure in the compressed air supplied. If the measuring surface 4 is at a higher position, as e.g. in Figure 4, the hose wall area W' will contact measuring surface 4, and the moment of the corresponding increase in the compressed air supplied occurs earlier. The corresponding graphic illustration is shown in Figures 8 and 9. Both diagrams demonstrate the dependence of air pressure as a function of time. Figure 8 shows the state up to complete unreeling of the hose (without any contact with measuring surface 4). This requires time t1. For the first stage of the unrestricted unreeling of hose 6, only compressed air D is required to fill up the volume of the hose and to overcome the resilient restoring force. After complete unreeling, the characteristic curve rises sharply at point K1 of the diagram in Figure 8. After making allowance for signal delay time, this results in time t1. If the end of the coil bulge of hose 6 enters into contact with the measuring surface at an earlier time (t2 in Figure 9), a smaller value t2 will result. It is therefore possible to determine the height of the measuring surface 4 through the intermediary of time t2 which is required to reach the pressure increase point K2, after appropriate calibration or by reverse calculation following the diagram in Figure 8.

A characteristic feature of the operating method of the measuring device is its suitability for cyclical operation. Control the measuring device can be selected in such a way that ventilation and idle positioning either utilize only the restoring force of the spring or require the addition of a supplementary reduced pressure source at input D.

In the slightly modified version of Figures 5-7, the otherwise identical flat hose 6 has, in its enclosing wall, diagonal vent holes 9, 10 and 11. These are uncovered automatically one by one during unreeling, which assists in calibrating the characteristic unreeling curve.

In the version shown in Figures 10 and 11, the expansion body takes the form of an accordion bellows 12 substantially in the shape of a conic frustum which has a buffer plate 13 on its smaller cross section as a sensor, and which is urged towards the position of Figure 10 by a restoring spring 14. When compressed air D is supplied to the bellows, sensor buffer plate 13 moves in the direction of measuring surface 4. At first, only the restoring force of spring 14 (inclusive of any possible restoring force inherent in the wall of bellows 12) needs to be overcome. If, however, sensor buffer plate 13 reaches measuring surface 4, an immediate increase in the respective characteristic curve will result. This increase is passed on as a signal to the measuring device and is evaluated as a measuring parameter, e.g. by comparison with the time required for the expansion of the bellows from its original position in Figure 10 to its position in Figure 11.

In the version of Figures 12 and 13, the sensor buffer plate 15 has nozzle orifices 16. These aim at measuring surface 4. Close approach of the sensor buffer plate 15 to measuring surface 4 results in an obstruction of the compressed air output L from nozzles 16, causing a recordable increase in the characteristic curve of the compressed air, which is sufficient to permit the height measurement of measuring surface 4 without bringing the latter into contact with sensor buffer plate 15.

Further possibilities are possible in respect of the sensor device of the expansion body and the measuring method. Various measures are possible to obtain a particularly well defined contact pressure on the one hand and height measuring precision on the other. Measuring methods other than time measurement may be resorted to; thus use may be made of optical measuring methods, ultrasonic measurement or other measuring techniques.

CLAIMS

1. A stack height determination device, suitable for use in determining the height of a stack of cardboard or paper accommodated in a feeder unit or delivery unit of a printing machine, the stack resting on a supporting surface and a sensor which forms part of the said device serving (in use) to sense the upper surface of the stack whose height is to be determined, wherein the said sensor takes the form of an expandable body which is urgeable towards the surface concerned by means of compressed air admitted into its interior.

2. A device as claimed in claim 1, wherein the compressed air supply is controlled as a function of the position reached by the said expandable body.

3. A device as claimed in claim 2, wherein the compressed air supply is so controlled that it is reversed when the operative measuring position of the said expandable body has been reached.

4. A device as claimed in claim 1, 2 or 3, wherein the said expandable body is provided with a compressed air pressure measuring arrangement.

5. A device as claimed in claim 1, 2, 3 or 4, wherein the expanding movement of the said expandable body takes place (in use) in a direction contrary to its intrinsic restoring force.

6. A device as claimed in any of the preceding claims, wherein the said expandable body takes the form of a hose capable of being unreeled by compressed air in the

direction of the surface concerned, the final section of the coil coming (in use) into contact with that surface, and the compressed air increase occurring at that stage being forwarded as a signal to a measuring device.

7. A device as claimed in any of the preceding claims, wherein vent holes are provided in the wall of the said expandable body, which are uncovered one after another during unreeling.

8. A device as claimed in any of the preceding claims, wherein the sensor comprises a buffer plate carried by bellows expandable by means of compressed air in the direction of the surface concerned.

9. A device as claimed in claim 8, wherein the bellows takes the form of an accordion bellows decreasing in size in the direction of the buffer plate substantially in the shape of a conic frustum.

10. A device as claimed in claim 8 or 9, wherein a restoring spring is provided inside the bellows.

11. A device as claimed in any of the preceding claims, wherein a buffer plate is carried by the said expandable body, and has a plurality of orifices aiming at the surface concerned.

12. A device as claimed in claim 1, substantially as described with reference to any Figure or Figures of the accompanying drawings.

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