DEVICE FOR PROCESSING SHEET-LIKE VALUABLE DOCUMENTS

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ABSTRACT

The present invention relates to an apparatus for processing sheet-shaped documents of value, in particular bank notes, comprising a device for diverting sheet material (4) by means of at least one diverting element (1, 2) defining a diverting axis (9a, 9b) for diverting the sheet material from one transport plane to a different transport plane. Therein the diverting axis (9a, 9b) of the at least one diverting element (1, 2) is oriented obliquely to a transport direction (A, C) of the sheet material (4). In an arrangement comprising two such obliquely oriented diverting elements (1, 2) and a diverting roller (3) in between, the sheet material (4) transported along a transport path can be turned over by 180° without any interruption of transport, using up little space. In a different aspect of the invention the obliquely oriented diverting elements (1, 2) are static and are provided with means (7, 10, 11, 12) for reducing the dynamic friction of a transport belt (5) or of the sheet material (4) on the diverting element (1, 2).
DEVICE FOR PROCESSING SHEET-LIKE VALUABLE DOCUMENTS

[0001] The present invention relates to an apparatus for processing sheet-shaped documents of value with a device for diverting sheet material.

[0002] In connection with the processing of bank notes apparatus are known in which bank notes are transported in such a manner that the bank notes are turned around one of their axes. For example the bank notes to be turned over can be clamped between two flat belts, which serve for transporting the bank notes and which, positioned on top of each other and twisted by 180°, are guided by rollers, in order to turn over the bank notes. Such apparatus are for example described in EP 0 532 217 A1 and U.S. Pat. No. 6,705,470 B2. These apparatus allow a continuous processing of the bank notes, since the turning over is carried out along their transport path. However, by the twisting of the belts the bank notes are bent in two directions simultaneously and are thereby subjected to a mechanical load during turning over, by which the bank notes may be damaged. These systems, which are also called "belt diverters", have the further disadvantage that the twisting of the belts requires a very great space for the turning of the bank notes.

[0003] Furthermore, DE 198 59 535 A1 describes an apparatus for turning over sheet material, in which a plurality of sheets can be processed continuously only on condition that a certain transport distance is kept between the sheets, since the sheets are diverted in the direction of different transport paths by an actuator, depending on whether they are to be turned over or not. Providing different transport paths requires much space, and the technical implementation is elaborate, since not only the actuator, but also the sheet supply has to be controlled, in order to avoid a collision of the sheets to be processed.

[0004] It is the object of the invention to provide an apparatus for processing sheet-shaped documents, in particular bank notes, with a diverting device of a small construction size for diverting, in particular turning over, the sheet material.

[0005] This problem is solved by an apparatus having the features of the independent claims. In claims dependent on these advantageous embodiments and developments of the invention are specified.

[0006] According to the invention the apparatus for processing sheet-shaped documents of value comprises a diverting device with a diverting element, whose diverting axis—for diverting sheet material from one transport plane to another transport plane—is oriented obliquely to the transport direction of the sheet material. The diverting axis either coincides with the intersection line of the two transport planes or is parallel thereto. The latter is the case if the sheet material is diverted along a curved path, which is to be preferred in order to prevent the sheet material from damage.

[0007] The advantage of the oblique orientation of the diverting element in relation to the transport direction of the sheet material lies in that the transport path can be twisted in a technically particularly easy way, wherein simultaneously also a change in the direction of transport can be adjusted as desired by means of the angle of the slant. Thus in the case of a diverting element which is oriented at 45° to the transport direction and which has an angle of contact of 180° not only the sheet material is turned over, but the transport direction changes simultaneously by 90°. However, at an angle of contact of 360° the transport path can be shifted parallel within the same transport plane without turning over the sheet material, by a distance which exclusively depends on the radius of the diverting element.

[0008] The diverting device is particularly space-saving, wherein it is especially advantageous that even the arrangement of one single diverting element allows many variations, namely in dependence on the angle of the oblique orientation, the arc of contact and the distance of the transport plane to the diverting axis, i.e. on the radius of the diverting element.

[0009] In a preferred embodiment not only one, but at least two such diverting elements are used, which are oriented obliquely to the transport direction of the sheet material. Thus for example, if the diverting axes are slanted by 45° and oriented in parallel, and if the arcs of contact each amount to 180°, the transport direction and the transport plane can be shifted parallel simultaneously.

[0010] Between the oblique diverting elements preferably a further diverting element is arranged. Particularly preferably the diverting axis of this further diverting element is oriented in a direction transverse to the transport direction of the sheet material and can for example be provided in the form of a rotatable roller. The advantage of using the three inventively arranged diverting elements lies in that, provided that the diverting elements are suitably arranged, both the twisting of the transport path and the transport direction are simultaneously adjustable as desired. Due to the small technical effort, such a sheet-material diverter can be implemented in a particularly compact and space-saving design. However, it may be expedient to use further diverting elements, in particular diverting rollers oriented transversely to the transport direction, upstream, between or downstream from the three diverting elements.

[0011] In one embodiment the two diverting elements are arranged obliquely to the transport direction of the sheet material at equal angles, however with different signs. The angles can for example be +45° and −45°. If in this case for example the angles of contact amount to 180° each, and the angle of contact around an intermediate diverting roller arranged transversely to the transport direction also amounts to 180°, the sheet material can be turned over without changing the transport direction. Depending on the guiding of the sheet material, the sheet-material transport plane upstream from the first obliquely oriented diverting element can be parallel to the sheet-material transport plane downstream from the second obliquely oriented diverting element, or both transport planes can be in the same plane. What is more, the diverting elements can in this case be arranged in relation to each other in such a way that the transport direction is simultaneously shifted parallel.

[0012] The advantage of this arrangement of the diverting elements lies particularly in that the sheet material can be turned around the transport axis, thus be turned by 180°, in a particularly space-saving manner. Furthermore, the turning over of the sheet material is carried out without any interruption, thus without stopping and re-starting the transport system. Thereby a great transport speed is rendered possible. Furthermore, no control of the supply of sheet material is necessary in order to prevent collisions of the sheet material or sheet-material jams. To the contrary, the sheet material is turned over in the order in which it is supplied to the diverting device.
The inventive diverting of the sheet material around an obliquely arranged diverting element is comparable to orienting a sheet of paper obliquely to a table edge and pulling it around the table edge. This diverting or turning over goes particularly easy on the sheet material, since it is deformed only in one direction during the process. Thus no multiple deformation in several directions takes place, as is the case for example in known belt diverters, in which transport belts are twisted by 180°.

The inventive diverting device is suitable both for the longitudinal transport and the transverse transport of sheet material. If the device is additionally combined with a device for changing the orientation of the sheet material, i.e. for changing from a longitudinal transport to a transverse transport of the sheet material, the complete orientation sorting of the sheet material is possible. That is, the sheet material can be turned around and/or turned over in any desired manner.

In a further embodiment at least one of the obliquely oriented diverting elements can be moved forth and back actively in relation to the transport direction. This is advantageous particularly in the case that sheet material of different dimensions is processed in the apparatus for processing sheet material. Depending on whether the sheet material is to be transported aligned flush on one side, or whether the center of each sheet is to lie on a predetermined line, the transport path is shifted parallel by a desired value by moving the obliquely oriented diverting element forth or back.

Additionally or alternatively it can be provided to adjust the angle of the oblique orientation of the diverting axis of two diverting elements. Changing the oblique orientation by equal values also results in a parallel shift of the transport path without changing the transport direction. However, if the oblique orientation of only one diverting element was changed, this would result in a change of the transport direction angle. However, this effect can be used to correct the orientation of the sheet material.

The active transport of the sheet material in the diverting device can be carried out in different ways. As transport device one or several flat or round belts or a plurality of rotatable rollers can be employed. Particularly preferably the transport device comprises at least one endless belt guiding the sheet material in the diverting device from both sides. Thereby the technical effort required for the inventive device can be further reduced.

In practice it may be necessary to arrange the diverting elements in a static, non-rotatable manner. This is primarily valid for the obliquely arranged diverting elements. If the diverting elements are provided in a static manner, this leads to a sliding friction of the transport belts for the sheet material or of the sheet material itself on the diverting elements. Corresponding friction forces act both in an axial direction and in a circumferential direction of the diverting element. According to a special inventive aspect the at least one obliquely oriented diverting element therefore has means for reducing the friction forces on a diverting surface of the non-rotatable diverting element.

According to a first alternative of this inventive aspect the diverting surface of the at least one diverting element is provided with air ducts. Preferably, for this purpose means are provided to introduce air in an area between the diverting surface and the sheet material. Thereby the diverting of the sheet material takes place with the support of compressed air, on an air cushion reducing the sliding friction. This is particularly advantageous if the sheet-material transport in the apparatus is carried out by means of belts. Through the air ducts in the surface of the guiding elements compressed air is introduced in an area between the transport belt and the guiding element, so that the transport belt glides on the air cushion and has a correspondingly greater durability.

According to a second alternative the at least one diverting element comprises rollers in the diverting surface, the rotation axes of which are arranged transversely to a transport direction of the sheet material, hence as a rule obliquely to the diverting axis. If the transport belt for the sheet material or the sheet material itself is guided over the specially arranged rollers of the diverting element, the friction forces on the diverting element can be largely eliminated, since the rollers rotate along with the transport belt or the sheet material in the transport direction. If the transport device for the sheet material comprises for example several parallel running belts and if these belts each have a width that is smaller than or equal to the width of the rollers, the belts run exclusively on the rollers of the diverting element and no friction forces whatsoever occur on the diverting element any more.

According to a third alternative the diverting surface of the at least one diverting element is disposed rotatably around the diverting axis of the diverting element and comprises rollers in the diverting surface, wherein the rotation axes of the rollers are arranged transversely to the rotation axis of the diverting element and consequently orthogonally to the rotation direction of the diverting surface. Since both the diverting surface and the rollers are disposed rotatably, friction forces both in an axial direction and in a circumferential direction of the diverting element are reduced significantly, if the transport belt for the sheet material or the sheet material itself are diverted by means of this diverting element.

Further characteristics and advantages of the invention will result from the following description of a variety of exemplary embodiments and alternative embodiments according to the invention in connection with the accompanying drawings. The figures are described as follows:

FIG. 1 a device for diverting sheet material;
FIG. 2 the device of FIG. 1, comprising a transport element for the sheet material in the form of an endless belt;
FIGS. 3A-C the path of the sheet material and the path of the belt within the device of FIG. 1;
FIG. 4 the device of FIG. 1 with an alternative path of the sheet material;
FIG. 5 the device of FIG. 1 with air ducts in a static diverting surface;
FIGS. 6A-B a diverting element with obliquely arranged rollers in a static diverting surface; and
FIGS. 7A-C a diverting element with transversely arranged rollers in a rotatable diverting surface.

FIG. 1 shows a device for diverting sheet material which can for example be used in apparatus for processing sheet-shaped documents of value. The core components of the special embodiment of the inventive diverting device shown in FIG. 1 are three diverting elements 1, 2, 3, wherein two of the diverting elements are arranged at an angle of 45° obliquely to the transport direction A, C and are static. One further diverting element 3 in the form of a rotatable roller is arranged between the two oblique elements 1, 2, and its diverting axis is oriented transversely to the transport direction B of the sheet material 4. The angle of contact around each of the three diverting elements amounts to 180°. It is consequently rendered possible by the shown diverting
device to turn sheet material 4 by 180° without interrupting transport and without changing the direction of transport, requiring only little space. The sheet material 4 is represented as a band in all figures for the sake of simplifying representation.

0031 The sheet material 4 to be turned over in the shown exemplary embodiment meets the inner surface of the first oblique diverting element 1 and is passed on in such a manner that after passing the centrally arranged diverting roller 3 it meets the inner surface of the second obliquely arranged diverting element 2. Thereby the transport planes upstream and downstream from the diverting device lie in different planes parallel to each other. If the sheet material 4, after passing the diverting roller 3, met the outer surface of the second diverting element 2, the transport planes upstream from the first obliquely arranged diverting element 1 and downstream from the second obliquely arranged diverting element 2 could lie in one common plane, provided that the diverting diameters are chosen suitably. It is thereby possible to economize space in particular in the transverse direction of the transport path.

0032 FIG. 2 shows the device of FIG. 1, wherein further more a transport belt 5 is represented as transport element for the sheet material 4. The transport path of the sheet material corresponds to the transport path shown in FIG. 1, wherein the transport path can also be chosen differently if required. In particular, the transport direction A, B, C of the sheet material 4 can be varied by changing the arc of contact on the two obliquely arranged diverting elements 1, 2 and/or by changing their angle of oblique orientation. One of the advantages of the shown diverting device is that one single or several endless belts 5 running side by side are sufficient to guide the sheet material 4 in the diverting device between two sides of the belt 5 along the diverting elements 1, 2, 3. The belt 5 is driven by means of a running gear consisting of a plurality of drive rollers 6 in the represented case, wherein the running gear is usually designed in correspondence with the type of transport element. Instead of by means of a transport belt the sheet material can also be guided between rollers and guide plates through the diverting device.

0033 FIG. 3A shows the path of the sheet material 4 through the turning-over system shown in FIGS. 1 and 2. For the sake of a better representation the transport belt 5 and the three diverting elements 1, 2, 3 were left out here. It is easily conceivable on the basis of FIG. 3A how the turning over of the sheet material 4 is carried out, if three diverting elements are provided and these are arranged as already described.

0034 FIG. 3B is an isolated view of the endless belt 5 of FIG. 2. FIG. 3B is intended to show particularly clearly in the described diverting device one single belt is sufficient to guide the sheet material.

0035 In FIG. 3C the FIGS. 3A and 3B are combined. It is clearly visible that the sheet material 4 is guided between two sides of the one endless belt 5 through the diverting device.

0036 FIG. 4 shows a path of the sheet material along the diverting elements 1, 2, 3 alternating from FIG. 1. In contrast to the variant represented in FIG. 1 the sheet material 4 meets the outer surface of the first diverting element 1 arranged at an oblique orientation of 45° and is passed on with a transport direction B changed by 90°. Also here the transport direction A, B, C of the sheet material is changed by the diverting roller 3 arranged between the two obliquely arranged diverting elements 1, 2 by 180°, and by the second diverting element 2 arranged at an oblique orientation of 45° again by 90°. The fact that the transport directions A, C upstream from the first and downstream from the second obliquely arranged diverting element are the same is due to the arc of contact of the sheet material 4 of 180° on all three diverting elements 1, 2, 3. Furthermore, due to these arcs of contact the transport planes upstream from the first and downstream from the second obliquely arranged diverting element are again parallel also in this case.

0037 In a not shown variant at least one of the obliquely arranged diverting elements 1, 2 can be moved actively forth and back in relation to the transport direction. Thereby the transport path is shifted forth or back in parallel, depending on the movement. Moving the obliquely arranged diverting elements 1, 2 is particularly advantageous if sheet material of different dimensions is to be processed, since the center of each sheet is shifted correspondingly. Therein the described parallel shift can also occur in that the angle of oblique orientation of the obliquely arranged diverting elements 1, 2 is changed by equal values.

0038 FIG. 5 shows a first special embodiment of the two static, obliquely arranged diverting elements 1, 2. The diverting elements 1, 2 are provided with air ducts 7 and air connections 8, so that air can be introduced to the inside of the diverting elements 1, 2 via the air connections 8. The introduced air is then guided out of the diverting elements 1, 2 via the air ducts 7, so that an air cushion is formed between the diverting elements 1, 2 and the sheet material 4 (not shown) or the transport belt 5 (not shown). Thereby the dynamic friction on the diverting surfaces of the diverting element is reduced.

0039 FIG. 6A shows a special embodiment of one of the obliquely arranged diverting elements 1, 2. The represented diverting element 1 comprises a plurality of rollers 10, which are arranged around the diverting element 1 in the diverting surface in rows that are parallel to each other. Therein the parallel rows of rollers preferably rotate in one direction, in which a transport belt for the sheet material or the sheet material itself is guided over the diverting element 1. Therefore the rotation axes of the rollers 10 are preferably arranged transversely to the transport direction D of the sheet material, so that the rollers rotate along in the direction of the transport direction D. It is thus achieved that friction forces are minimized both in a circumferential direction and in an axial direction of the diverting element 1.

0040 FIG. 6B shows several parallel running transport belts 5 for the sheet material are represented, wherein the transport belts 5 each run entirely across one of the parallel rows of rollers. It is thereby rendered possible in particular to eliminate the friction forces almost completely, since the transport belts 5 do not touch the diverting surface of the diverting element 1.

0041 FIG. 7A shows a third special embodiment of the diverting element 1. The diverting element 1 comprises a plurality of rotation elements 11, wherein the rotation elements 11, as becomes clear when viewing FIG. 3B, are arranged in a row along the diverting axis 9a of the diverting element 1. FIG. 7C shows a single rotation element 11. The rotation elements 11 are provided with rollers 12, whose rotation axes are arranged transversely to the diverting axis 9a of the diverting element 1. As is shown by means of the arrows in FIG. 7C, the rotation elements 11 are arranged rotatably on the axis 9a of the diverting element 1, and the rollers 12 are arranged rotatably on the rotation elements 11, wherein the rotation directions are orthogonal to each other.
If, as represented in FIG. 7A, parallel running transport belts 5 are guided across the diverting element 1, their dynamic friction on the diverting element 1 is reduced both in an axial direction and in a circumferential direction of the diverting element, since the rotation elements 11 and the rollers 12 of the rotation elements 11 are arranged rotatably in different directions and can rotate in the corresponding directions by the movement of the transport belt 5.

1. Apparatus for processing sheet-shaped documents of value, for example bank notes, comprising a device for diverting sheet material by means of at least one diverting element defining a diverting axis arranged to divert the sheet material from one transport plane to a different transport plane, wherein the diverting axis is oriented obliquely to a transport direction of the sheet material.

2. Apparatus according to claim 1, including two such obliquely arranged diverting elements along a transport path of the sheet material.

3. Apparatus according to claim 2, including a third diverting element with a further diverting axis arranged to divert the sheet material, said third diverting element being disposed between the first two recited obliquely arranged diverting elements.

4. Apparatus according to claim 3, wherein the diverting axis of the third diverting element is oriented transversely to the transport direction.

5. Apparatus according to claim 4, wherein the third diverting element oriented transversely to the transport direction comprises a rotatable roller.

6. Apparatus according to claim 2, wherein the first two recited obliquely oriented diverting elements are oriented under +45° and −45° relative to the transport direction.

7. Apparatus according to claim 2, wherein the transport plane upstream from the first recited obliquely oriented diverting element extends parallel to the transport plane downstream from the second recited obliquely oriented diverting element.

8. Apparatus according to claim 7, wherein the two transport planes lie in one plane.

9. Apparatus according to claim 1, wherein at least one of the first and second recited obliquely oriented diverting elements is movable forth or back in relation to the transport direction.

10. Apparatus according to claim 1, wherein the oblique orientation of the diverting axis of at least one diverting element is adjustable.

11. Apparatus according to claim 1, including a transport device arranged to move the sheet material along the at least one diverting element.

12. Apparatus according to claim 11, wherein the transport device comprises at least one flat or round belt or a plurality of rotatable rollers.

13. Apparatus according to claim 12, wherein the transport device comprises at least one endless belt guiding the sheet material on both sides in the diverting device.

14. Apparatus for processing sheet-shaped documents of value, according to claim 1, comprising a device for diverting sheet material by means of at least one diverting element defining a diverting axis for diverting the sheet material from one transport plane to a different transport plane and having a diverting surface, wherein the at least one diverting element comprises a friction reducer arranged to reduce friction forces on the diverting surface.

15. Apparatus according to claim 14, wherein a diverting surface of the at least one diverting element is provided with air ducts.

16. Apparatus according to claim 15, including an air introducing arrangement arranged to enable introduction of air through the air ducts to an area between the diverting surface and the sheet material.

17. Apparatus according to claim 14, wherein the at least one diverting element comprises rollers in the diverting surface, whose axes of rotation are arranged obliquely to the diverting axis.

18. Apparatus according to claim 14, wherein the diverting surface is disposed rotatably around the diverting axis and comprises rollers in the diverting surface, whose axes of rotation are arranged transversely to the diverting axis.

19. Apparatus according to claim 18, wherein the diverting surface comprises a plurality of rotation elements, which are arranged in a row along the diverting axis and which are rotatable around the diverting axis, and which carry the rollers.

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