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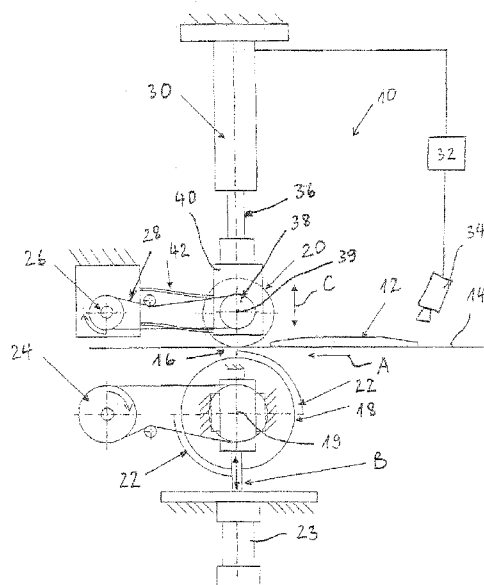


Fig. 1

(57) Abstract: An apparatus (10) for treating products continuously fed to the apparatus comprises a first roller (18) rotatable around a first rotation axis (19) and a second roller (20) rotatable around a second rotation axis (39) parallel to the first rotation axis (19). The first roller (18) is a cutting roller and the second roller (20) is an anvil roller. A treatment gap (16) is formed between the cutting roller (18) and the anvil roller (20). The apparatus further comprises an adjusting means (30) for in-line adjusting the nominal size of the treatment gap (16), wherein the adjusting means comprises at least one piezoelectric element (30) for shifting the position of the first rotation axis (19) and/or the second rotation axis (39).

Apparatus and Method for treating products

Field of the Invention

The invention relates to an apparatus for treating products continuously fed to the apparatus with the features of the pre-characterising part of claim 1. Further, the invention relates to a method for operating such an apparatus according to the features of claim 11 and a use of a piezoelectric element with the features of claim 16.

The apparatus for treating products continuously fed to the apparatus comprises a treatment roller rotatable around a first rotation axis and an anvil roller rotatable around a second rotation axis parallel to the first rotation axis, wherein a treatment gap is formed between the treatment roller and the anvil roller. The treatment roller is a cutting roller.

Prior Art

Apparatus with a treatment gap formed between a treatment roller and an anvil roller are known in the art. Examples of such devices are printing devices or cutting devices as well as any applications in which a substrate to be treated is locally pressed. Examples for such pressing operations are any devices in which products should be brought to a uniform or predetermined thickness, mechanical press bonding, compression or embossing processes treating soft and yieldable products.

In all the above exemplified processes and apparatus, two distinct problems arise. Firstly, products might have a

varying thickness in the feeding direction of the products, i.e. the machine direction. Such thickness profile can e.g. in printing operations lead to uneven printing results because the contact pressure of a printing roller onto the substrate to be imprinted is higher in zones of a higher product thickness than in zones of a lower product thickness. A second problem in such treating apparatus is the deflection of the whole treatment unit. This deflection is influenced by the nip contact area between the product and the treatment roller, the elasticity of the unit and the hardness of the product if this property should change within one product. When the nip contact area in an embossing unit increases, there is more material squeezed in the nip between an embossing roll and an anvil roll. Consequently, the force increases which gives rise to a deflection of the unit. Only if the apparatus for treating products was totally stiff without any elasticity, the unit deflection would not occur. However, it is not possible to exclude a certain degree of unit deflection which widens the gap between a treatment roller and an anvil roller.

US 6,733,605 B1 discloses an apparatus for dynamically friction bonding plural workpiece layers together with a support roll and an anvil roll. The outer circumferential portions of the support roll and the anvil roll define a nip for receiving corresponding workpiece layers to be bonded together. A linear servo motor apparatus is provided for applying a predetermined force of the rollers toward each other such that the outer circumferential portions of the support roller and the anvil roll bond together predefined portions of workpiece layers passing through the nips. This servo motor apparatus comprises first and second linear servo motors which can be operated such that the force applied to the plural workpiece layers can follow a predefined force profile. Additionally, a sensor may be provided for sensing suitable indicia on the workpiece sections corresponding to a

predefined location such as the leading or trailing edge of the workpieces.

Disclosure of the Invention

It is an object of the invention to provide an apparatus and a method for treating products continuously fed to the apparatus between a first roller and a second roller such that products can be processed with high quality.

This object is solved by an apparatus with the features of claim 1, a method with the features of claim 11 and the use of piezoelectric element with the features of claim 16.

According to the invention, an apparatus for treating products continuously fed to the apparatus comprises a first roller rotatable around a first rotation axis, the first roller being a cutting roller, and a second roller rotatable around a second rotation axis parallel to the first rotation axis, the second roller being an anvil roller. A treatment gap is formed between the first roller and the second roller. The apparatus is characterized in that it further comprises an adjusting means for in-line adjusting the nominal size of the treatment gap, the adjusting means comprising at least one piezoelectric element for shifting the position of the first rotation axis and/or second rotation axis.

Reference to the in-line adjusting of the nominal size of the treatment gap indicates that such gap would not change if no product was treated in the gap. When a product is treated, the adjusting operation could lead to the result that the existing treatment gap remains of the same size, because the adjustment only serves to compensate for a change of the size of the gap due to bending forces acting on and play in the apparatus. The treatment gap defines the distance between the knife edge and the surface of the anvil roller. The size of the treatment gap can also have a negative value.

An important aspect of the invention is that the adjusting means comprising at least one piezoelectric element is suitable for an in-line adjusting of the nominal size of the treatment gap. Since the products to be treated can be continuously fed to the apparatus, and each individual product might require one or a series of adjustment operations of the adjusting means, repeated or even continuous adjusting operations when using the inventive apparatus are possible. It is the general idea of the invention to provide an apparatus to keep the treatment gap at a desired value.

Another important aspect is the very short response time of piezoelectric elements which makes it possible to run the inventive apparatus with high line speeds. Such short response time can even be achieved under high load or pressure. It is possible to almost make a stepwise change of the gap over the whole adjustment range.

According to a preferred embodiment, the piezoelectric element is attached to one or more bearings guiding a shaft of the first roller or second roller. This specific measure reduces the overall mass to be moved compared to attaching the piezoelectric element to a frame element rotatably holding the first or second roller.

Further it is preferred that the at least one piezoelectric element shifts the second rotation axis, the second roller having a lower weight than the first roller. The second roller is an anvil roller running against a treatment roller. In comparison to most types of treatment rollers, the anvil rollers may have a smaller mass so that the actuation forces necessary to shift the position of the rotation axis of the anvil roller can be kept smaller. Hence, vibration forces generated by the moving mass of the anvil roller can be kept small.

Preferably, the adjusting means is coupled to a control device for operating the adjusting means in a predetermined timely sequence. Such control device is preferably an electronic component having access to a data storage in which, depending on the specific conditions of treatment, a sequence of adjusting operations for the treatment gap can be stored. If an electromechanically operated control device is contemplated, a cam element synchronized with the apparatus could be used which is in contact with a plunger element which translates a translational movement into an electric signal to operate the piezoelectric element.

According to a preferred embodiment, the control means is functionally coupled to a sensor for determining at least one characteristic property of the products treated or of the apparatus. Such characteristic property could be the thickness of a specific product or of specific parts of the product. In such a way, the sensor could determine the thickness profile of each product and transmit such data to the control device which operates the adjusting means using information provided by the sensor. In such a way, it is possible to treat products, e.g. cut into products, which are not uniformly shaped but could have an individual and varying thickness in the machine direction. The gap between the anvil roll and a cutting roll could then be adjusted such as to always ensure the correct contact pressure of the cutting operation.

A sensor for determining at least one characteristic property of the products treated could also be used to determine the exact position of the leading end or trailing end of a product fed to the treatment apparatus. According to a preferred embodiment of the invention, the sensor comprises a line camera system. A sensor may also be used for determining at least one characteristic property of the apparatus, when a product is presently treated. According to

another embodiment, the sensor can be a gap sensor or a load cell.

According to a preferred embodiment, the camera system is arranged and adapted for determining the quality of the product downstream of the treatment gap. Such camera system can provide input data to the control loop for actuating the piezo actuator. The downstream quality control combines a conventional quality control with an optimized operation of the inventive treatment or apparatus.

The quality feature of the product could be the cut quality or the visibility and shape of an cutting pattern. The cut quality allows to draw conclusions on the cutting pressure and a possible wear of the cutting knife. Both effects can be accounted for in a suitable way.

Another preferred possibility is the provision of a camera system which is arranged and adapted for measuring the edge quality of a cutting element of the cutting roller. Such a camera system allows a direct assessment of the edge quality, whereas in the above discussed downstream arranged camera system, the quality of the product only gives an indirect information about the edge quality.

A further possibility according to the invention is to provide a sensor which is a gap sensor arranged and adapted to determine the gap width. Such gap sensor also allows for very direct collection of relevant data because, as soon as the gap width increases either due to dynamic forces created by a high contact area or by progressive wear of the cutting edge, information about the gap width can immediately be used to carry out an in-line adjustment of the size of the treatment gap.

A further preferred sensor is a load cell attached to the apparatus. Such load cell determines the force acting on the

apparatus and gives information on the corresponding deflection and variation of the treatment gap. Again, an in-line adjustment by means of the piezo actuator is possible.

In view of the fact that the stroke of commercially available piezoelectric actuators is relatively small, the inventive apparatus according to a preferred embodiment further comprises a second adjusting means for shifting the position of the first rotation axis or a second rotation axis. In other words, the second adjusting means serves to provide a rough adjustment of the treatment gap, whereas the fine adjustment is carried out by means of the first adjusting means with the piezoelectric actuator. Further, the rough adjusting by means of the second adjusting means is preferably carried out with the cutting roller so that the construction of the anvil roller and its framework can be kept simple and with a low weight.

According to the invention, the inventive apparatus and the piezoelectric element for shifting the position of the rotation axis of the anvil roller can be used for a line pressure adjustment in order to generate a cutting line pressure which is as uniform as possible over the length of the product in its feeding direction. However, it is possible to generate any desired local cutting pressure. The apparatus including a cutting roller can also be used for an intermittent cutting in which the anvil roller is moved up and down relative to the cutting roller in a specified timely frequency.

The inventive method for operating an apparatus as described above comprises the steps of continuously directing products to be treated into the treatment gap between the rotating first roller and the rotating second roller, the first roller being a cutting roller and the second roller being an anvil roller; transmitting data describing at least one

characteristic property of the products or of the apparatus to a control unit; and operating the adjusting means for in-line adjusting the size of the treatment gap based on output signals from the control units, so as to vary the size of the treatment gap within each product to be treated. What is meant by a characteristic property of the process could be the position of individual products to be treated, the shape and thickness profile of the individual products or specific information on the treatment itself like line pressure differences, the size of the gap or the edge quality of the cutting element. It is important to note that the size of the treatment gap is varied within each product to be treated and within a continuous process. This is also reflected by the term "in-line adjusting the size of the treatment gap".

According to a preferred embodiment of the process, the characteristic property of the process is the local contact area between the cutting roller and the product to be treated. The local contact area describes at any line perpendicular to the machine direction the sum of the contact areas between cutting roller and the product on such a geometric locus. This is related to the so-called line pressure and reflects the fact that, the larger the local contact area or line pressure is, the higher are the bending forces acting on the apparatus. The higher the bending forces are, the larger becomes the treatment gap between the rollers, i.e. the cutting roller and the anvil roller. Consequently, a large local contact area needs a higher degree of adjustment in a way to reduce the width of the treatment gap.

Preferably, the method further comprises, before the step of transmitting data, the determining of at least one characteristic property of the individual products to be treated, preferably the cut quality of the products. Such method step is carried out by means of a sensor positioned upstream or downstream of the apparatus. The sensor

determines the at least one characteristic property of the individual products and uses such property or a numeric value representing such property for the computing of the correct adjustment of the size of the treatment gap. The control unit could use data from two different sources and compute the degree of gap adjustment based on both given basic information already stored in an electronic storage means and in-line information obtained by means of a sensor arranged upstream or downstream of the treatment gap. To give an example, the local cutting area of the products could be stored in an electronic memory means and the position of individual products like the leading end or trailing end of the products could be determined by means of a sensor. The data of both the sensor and the memory means are compiled into an adequate operation of the piezoelectric actuator in order to control the individual starting times and adjustment process for each individual product. Other data which could be fed to the control unit are e.g. the line speed of the apparatus which implies the correct adjusting speed of the piezoelectric apparatus.

Preferably, the data describing at least one characteristic property of the products or of the apparatus are optical data from a sensor measuring the edge quality of a cutting element of the cutting roller. According to an alternative or additional preferred embodiment of the inventive method, the data describing at least one characteristic property of the products or of the apparatus are related to a gap width or the load acting on the apparatus during cutting operation.

The products to be treated are preferably absorbent articles.

Brief Description of the Drawings

In the following, the invention will be briefly discussed with reference to the drawings in which:

- Fig. 1 schematically shows the inventive apparatus and a product to be treated;
- Fig. 2a shows the core profile of an example product to be embossed;
- Fig. 2b schematically shows the actuator position of the piezoelectric element according to the core profile as shown in Fig. 2a;
- Fig. 2c shows an example cutting pattern on the product as shown in Fig. 2a;
- Fig. 2d schematically shows a degree of deflection of the cutting apparatus over the length of the cutting pattern as shown in Fig. 2c when no gap compensation is made;
- Fig. 2e shows the actuator position of the piezoelectric element in order to compensate the deflection pattern as shown in Fig. 2d;
- Fig. 2f gives a superposition of the actuator positions as given in Fig. 2b and Fig. 2e;
- Fig. 3 shows a top view of a flat product with a cutting pattern and qualitatively shows the corresponding nip contact area over the length position of the product or web to be cut;
- Fig. 4 schematically shows a cutting station in which the position of the anvil roll can be actuated by means of piezo actuators and how the change of the cutting force with the rotation translates into a piezo movement with the rotation;

Figs. 5a, 5b, 6a and 6b

schematically show a cutting station in a side view (Fig. 5a, Fig. 6a) and a front view (Fig. 5b, Fig. 6b); wherein in Figs. 5a and 5b, the treatment roller is provided with thrust rings, whereas in Figs. 6a and 6b the treatment roller is without thrust rings;

Figs. 7a, 7b 8a and 8b

correspond to Figs. 5a, 5b, 6a and 6b but show in an exaggerated way the deformation of the cutting roller and anvil roller when applying a high cutting force;

Figs. 9a and 9b

are a schematical side view and front view of the cutting station and demonstrate the deflection compensation in the embodiment according to Figs. 7a and 7b;

Fig. 10

shows the use of a gap sensor;

Fig. 11

shows an alternative position of a gap sensor;

Fig. 12

schematically shows the position of a sensor being a load cell;

Fig. 13

schematically shows a downstream vision system for cut quality control; and

Fig. 14

schematically shows the use of a sensor for measuring the edge quality of a cutting edge.

Description of preferred embodiments

In the following drawings, the same or similar elements are represented by the same reference numerals.

Fig. 1 schematically shows the inventive apparatus for treating products continuously fed to the apparatus 10. Individual products 12 are positioned on a conveying means 14, which can be of any conventional type and which conveys and feeds product 12 through the apparatus.

The products are treated in a gap 16 which is formed between a treatment roller 18 and an anvil roller 20. The treatment roller 18 in the specific example as shown is a cutting roller and there is schematically shown a cutting edge 22 on the outer circumferential surface of the roller 18. The cutting roller rotates around rotational axis 19 and is driven by a suitable conventional drive 24.

The vertical position of the treatment roller 18 can be roughly adjusted in the directions as indicated by arrows B. Such rough adjustment can be achieved by a pneumatic actuator 23 and the use of distance plates to fix the vertical position of the treatment roller 18.

The anvil roller 20 has a smooth yielding outer circumferential surface. It rotates around rotational axis 39 and is driven by an anvil roller drive 26 which, in the present example, uses a belt drive 28.

The anvil roller 20 can be lowered and lifted in the vertical directions as indicated by arrow C which symbolises the dynamic stroke of the anvil roller. To this end, the anvil roller is attached to a piezo actuator 30 which, at its upper end is mounted at a fixed position as schematically indicated in Fig. 1. The piezo actuator can be of a commercially available type like those available by Piezomechanik GmbH in Germany with a stack of single piezo elements which can provide an overall stroke of about 0.3 mm. Such piezo actuator system shows a linear relationship between the voltage applied and the extension. Due to the linear

extension behaviour and the very short response time, a quick and accurate extension of the piezo actuator can be realised. As an example, such piezo actuators have a response time of 8 milliseconds for a stroke of 0.3 mm at a force of at least 5 kN. The piezo actuator is provided with driving signals by a control means 32 which preferably is also provided with a memory device. The control means 32 can additionally process information received from a sensor 34 which, in the schematic drawing of Fig. 1 is exemplified as a line camera system.

The extendable plunger 36 of the actuator 30 is fixedly attached to the rotation shaft 38 of the anvil roller 20. This attachment can be realized in a conventional way, for example by fixing the plunger 36 of the piezo actuator 30 to a bearing element 40 of the rotation shaft 38. In order to account for the up and downward movement of the anvil roller 20 relative to the anvil roller drive 26 which is at a fixed position, the anvil roller drive 26 and the bearing 40 of the anvil roller 20 are connected by means of a plate spring 42 which acts as a hinge.

In the specific example as shown in Fig. 1, one piezo actuator 30 is shown. However, it is also possible to use two or more piezo actuators which could be attached to individual bearings holding the rotation shaft 38 of the anvil roller. If two piezo elements are attached to the rotation shaft, both piezo actuators 30 are spaced apart in a direction perpendicular to the plane of Fig. 1. In such a case it would even be possible to account for products having a core thickness profile which does not only vary in the machine direction A but also in a direction perpendicular to this.

The operation of the device as shown in Fig. 1 will now be explained by means of a specific example as given in Figs. 2a to 2f.

Fig. 2a shows product 12 and the conveying direction A through the inventive device. As can be seen in Fig. 2a, the core profile in the machine direction A of the product 12 is not constant. The leading end section 12a and the trailing end 12b have a smaller core thickness. Starting from the trailing end the core thickness continuously increases in section 12c and reaches a constant thickness in the middle section 12e. Starting from leading end section 12a with constant thickness, there is a steep increase in core thickness in section 12d reaching middle section 12e with constant core thickness. Section 12c has a slow increase, whereas section 12d is a very sharp increase which is nearly a stepwise change of thickness.

If a constant cutting depth is desired, the cutting operation in the device according to Fig. 1 has to account for the core thickness profile. Therefore, as is schematically shown in Fig. 2b, the actuator position of the piezo actuator 30 has to be adjusted over the length of the product. The curve 43 as shown uses the same dimension of length as the core profile as given in Fig. 2a. It shows that the actuator has to be at the lowest position at a position 43a corresponding to the leading end section 12a and the trailing end 12b of product 12, is sharply lifted up in section 12d of the product where the core thickness steeply increases starting from the leading end section 12a, reaches a constant level in section 43b of the actuator position in which the actuator is lifted up to constant height and for the constant core thickness in section 12e of the product and finally is continuously lowered again to reach again position 43a.

Figs. 2c, 2d and 2e show the second function of the piezo actuator which can be used alternatively or in addition to the function as explained with regard to Figs. 2a and 2b accounting for a core profile.

Fig. 2c shows product 12 from above a cutting pattern 44 to be used on the product as shown in Figs. 2a and 2c. There are two linear cuts 44a and 44b which, close to the trailing end 12b of the product 12 are connected by means of an arc-shaped cut 44c.

In regions 44a and 44b, where the cut is applied in machine direction A (see Fig. 2a), the bending forces acting on the cutting station consisting of the treatment roller and the anvil roller are relatively small. This is exemplified in the schematic diagram of Fig. 2d which gives the relative deflection of the cutting device over the length of the product in machine direction. The length dimension is the same as that used in all Figs. 2a to 2f, whereas the deflection is just a schematic value which is influenced by many constructional details of the cutting apparatus as well as the cutting depth and hardness of the product to be treated. However, it can be seen that the deflection curve 46 shows a low deflection in section 44a and 44b, whereas in the arc-shaped region 44c with a cutting pattern which has an increased line pressure in a direction perpendicular to the machine direction, the deflection curve 46 forms a peak 46c. Such deflection has the effect that the gap between the cutting roller and the anvil roller is widened. In order to account for such widening of the gap, the piezoelectric actuator can be operated in order to compensate for this. This is shown in Fig. 2e which schematically shows the actuator position for compensating the deflection over the length of the product in the machine direction. The actuator position curve 48 is a mirror image of the deflection curve 46 because, as outlined above, the deflection leads to a widening of the gap which the actuator position has to compensate. Therefore, in regions where the deflection is highest, the actuator position curve 48 has to be lowest which means that the gap between the cutting roller and anvil roller is closed to the extent in which it is widened by the deflection. This is why in region 48c, the

actuator position has to be lowest close to the trailing end of the product.

Fig. 2f shows a combined curve 50 which gives the actuator position accounting for both the thickness profile of the core of the products and the actuator position in order to compensate deflection effects. It should be noted that Fig. 2f simply uses a superposition of schematic actuator position data given in drawings 2b and 2e, both of which in themselves were only schematic. However, when correct actuator positions accounting for a thickness profile of the products and correct actuator positions accounting for deflections effects have been determined and quantified, it is a superposition of the actuator positions of both individual effects which, in combination, lead to a combined actuator position curve 50 as shown in Fig. 2f and which takes into account and corrects both effects.

Fig. 3 shows a top view on a flat product 12 or web to be processed using a cutting operation. The cutting pattern 44 is shown. It can be roughly subdivided in different sections depending on its orientation relative to the machine direction as given by arrow A. In the diagram of Fig. 3, there are regions in which the cutting is parallel or essentially parallel to the machine direction. This is exemplified in zone G. In this region, the nip contact area which is the area in contact with the web or product to be treated is relatively small. In the arcuate region between position G and H as shown in Fig. 3, the nip contact area increases and reaches a peak at the length position H in which the cutting is crosswise to the machine direction. This is the position in which there is the highest line contact area and, correspondingly, the highest deflection acting on the cutting device.

Fig. 4 schematically shows the inventive treatment apparatus 10 with treatment roller 18 and anvil roller 20. The

treatment roller is a cutting roller provided with a cutting edge 22 which is very similar to that as shown above in Fig. 3. The device is provided with piezo actuators 30 associated to the anvil roller which move the position of the rotation shaft 38 of the anvil roller by changing the vertical position of the bearings 40 of the anvil roller by means of a very quick micro movement C.

Depending on the rotation of the treatment roller 18 and the orientation of the cutting edge relative to the machine direction, the nip contact area and correspondingly the cutting force changes over the rotation of the cutting roller. This is schematically shown in the top diagram on the right hand side of Fig. 4. The change of the cutting force over the rotation of the treatment roller 18 is processed by means of a control algorithm within control means 32 which outputs a signal for an appropriate piezo movement over the rotation as shown in the schematic bottom diagram on the right hand side of Fig. 4. This piezo movement over the rotation of the treatment roller 18 is used to compensate a deflection of the apparatus 10 and especially the widening of the gap between the treatment roller and the anvil roller because of a non-constant cutting force. A further measure to compensate variations in the cutting force is schematically shown in Fig. 4. These are thrust-rings as known in the art.

Figs. 5a and 6a show side views and Figs. 5b and 6b show end views, respectively, of a cutting roller 18 and a corresponding anvil roller 20. In the embodiment as shown in Figs. 5a and 5b, there are provided thrust-rings 52, whereas in the embodiment of Figs. 6a and 6b, there are no thrust-rings. Machined thrust-rings 52 are a conventional means to account for a variation of the pressure acting on the treatment gap 16. Because of its two additional bearing surfaces, thrust-rings arranged on both longitudinal sides of a treatment roller prevent an unsymmetrical deflection of the treatment roller. Further, thrust-rings can be machined so as

to reduce their contact area to the anvil roller in those regions where the contact area between the treatment roller and anvil roller is higher, e.g. because of a high nip contact area of a cutting knife or an embossing tool. As can be seen at position A_T , there is a tangential contact between the thrust-rings and the anvil roller 20. If there are no thrust-rings, there is only the contact between the cutting edge 22 and the anvil roller 20 as can be seen in Figs. 6a and 6b.

Figs. 5a, 5b, 6a and 6b represent the case in which there is a low cutting force. Accordingly, there is a small deflection due to such low cutting force. Therefore, a cutting operation with high quality can be achieved, since no gap tends to form between the cutting edges 22 of the knife and the anvil roll 20.

The situation changes as soon as high cutting forces are involved. This situation is shown in Figs. 7a, 7b, 8a and 8b. In order to explain the undesired bending of the rollers and its effect on the cutting operation, the deflection of the rollers has been highly exaggerated.

Figs. 7a and 7b show this situation with thrust-rings 52 at the cutting roller. Due to the high cutting force, a considerable deflection of the treatment roller 18 occurs which negatively influences the cutting operation leading to a bad quality cutting. If there is a large cutting area, the cutting force also becomes high and tends to form a gap between the cutting edge and the product 12. Between the thrust-rings 52 and the anvil roller 20, there is a tangential contact surface A_T which is close to line contact between the thrust-rings and the anvil rollers only.

Figs. 8a and 8b show the same situation as in Figs. 7a and 7b but with the difference that there are no thrust-rings. Again, a high cutting force is applied and, accordingly, a

gap 54 can form between the cutting edge 22 of the treatment roller 18 and a web or product supported by the anvil roller 20.

Figs. 9a and 9b show the deflection compensation in a system as shown in Figs. 7a and 7b, i.e. a cutting station with a cutting roller 18 with thrust-rings 52. At a point of time where there is a large deflection between the rollers, a dynamic compensation is carried out by means of the piezo actuators 30. This leads to a very quick micro movement C of the piezo actuator, in the specific case of a deflection compensation in an upwards direction to press the anvil roller against the cutting roller. As a result of this, there is either no gap at all or the gap 54 between the cutting edge 22 of the cutting roller 18 and the anvil roller or, depending on its thickness, product or web supported by the anvil roller, is minimized. In order to achieve this, the thrust-rings have to be pressed against the anvil roller so that flattened a contact area forms between the thrust-rings and the anvil roller.

The example as shown in Figs. 9a and 9b is given in the context of a dynamic change of the nip contact area and resulting cutting force. However, it is also possible to use the piezo actuator to compensate long term wear of the cutting edge. Such long term wear compensation can also be used in addition to a dynamic compensation for force-induced deflections.

Figs. 10 to 14 show different sensors which can be used to give input information into the control means for calculating and outputting the correct amount of piezo movement. Although such sensors are explained separately in Figs. 10 to 14, it is also possible to use more than one sensor in combination and also in combination with the sensor as shown in Fig. 1 which serves to identify the leading or trailing end of each product directed toward the treatment gap.

In the embodiment according to Fig. 10, gap sensors 56 are mounted to the apparatus 10, preferably to the bearing housing of the cutting apparatus. Depending on the size of the gap, the piezo actuators 30 are operated to bring the size of the gap to the exact value. Alternatively, gap sensors could also be positioned differently, e.g. as shown in Fig. 11 in which the optical field of optical gap sensor 58 is parallel to the machine direction A. In order to successfully obtain information about the gap width, such gap sensors 58 should be arranged outside the edge of the web 12 to be processed. Depending on the size of the gap, the same operations as described above with reference to Fig. 10 are carried out. A control means calculates an adequate response signal to operate the piezo actuators 30 in order to carry out a stroke C to compensate for changes in the gap size.

Fig. 12 shows an alternative sensor arrangement using a load cell 60 which gives information on the forces presently acting on the cutting roller 18. Such force as determined by the load cell 60 is translated into a resulting deflection and a required stroke C of the anvil roller to keep the treatment gap at the desired value.

Fig. 13 shows a further alternative which can be used also in combination with one of the above described sensors. The optical sensor 62 is arranged downstream of the treatment gap. It is a vision system for cut quality control and optically evaluates the quality of the cut made in the product or web. If, for example, the edges have a blurred optical appearance or if the fibers of the material are no longer cut but torn, such optical sensor 62 can be used to determine wear of the cutting edge and also to trigger an adequate counter measure by increasing the pressure of the anvil roller 20 acting on the cutting roller 18.

Fig. 14 shows another alternative using a vision control system 64 which measures the edge quality of the cutting edge. This is a direct evaluation of a possible wear of the cutting edge which, in addition to the dynamic control of the gap width, could be used to account for wear effects of the cutting knives in order to increase the lifetime of the cutting roller still maintaining a high quality output.

As described above in detail, the piezo actuator can be used exclusively or in addition to conventional technology, e.g. thrust-rings to account for pressure variation and deflection effects. Further, a piezo actuator can also be used to account for progressive wear of the cutting knife so that the operable lifetime of the cutting roller can be increased.

It can be seen that by means of the piezoelectric actuators having an extremely short response time and the ability to provide for an extremely accurate positioning even under high pressure or load, even products continuously processed and treated with a high conveying speed can be accurately treated leading to a high quality processing of the products.

Claims

1. Apparatus for treating products continuously fed to the apparatus (10), comprising:

- a first roller (18) rotatable around a first rotation axis (19); the first roller (18) being a cutting roller and
- a second roller (20) rotatable around a second rotation axis (39); the second roller (20) being an anvil roller; wherein
- a treatment gap (16) is formed between the first roller (18) and the second roller (20),

characterized in that

the apparatus (10) further comprises:

- an adjusting means (30) for in-line adjusting the nominal size of the treatment gap,
- the adjusting means comprising at least one piezoelectric element (30) for shifting the position of the first rotation axis (19) and/or the second rotation axis (39).

2. Apparatus according to claim 1, characterized in that the piezoelectric element (30) is attached to one or more bearings (40) guiding a shaft (38) of the first (18) or second roller (20).

3. Apparatus according to claim 1 or claim 2 characterized in that

- the piezoelectric element (30) shifts the second rotation axis (39), the second roller (20) having a lower weight than the first roller (18).
4. Apparatus according to any of the preceding claims, characterized in that the adjusting means (30) is coupled to a control device (32) for operating the adjusting means (30); the control means (32) being functionally coupled to a sensor (34) for determining at least one characteristic property of the products (12) treated or of the apparatus.
 5. Apparatus according claim 6 or claim 7, the sensor comprising a line camera system (34) for vision control.
 6. Apparatus according to claim 5, wherein the camera system (34) is arranged and adapted for determining the quality of the product (12) downstream of the treatment gap (16).
 7. Apparatus according to claim 5, wherein the camera system (34) is arranged and adapted for measuring the edge quality of a cutting element (22) of the cutting roller (18).
 8. Apparatus according to claim 4, wherein the sensor is a gap sensor (34a) arranged and adapted to determine the gap width.
 9. Apparatus according to claim 4, wherein the sensor is a load cell (34b) attached to the apparatus.
 10. Apparatus according to any of the preceding claims, further comprising a second adjusting means (23) for shifting the position of the first rotation axis (19).

11. Method for operating an apparatus according to any of the preceding claims, comprising the steps:
 - (a) continuously directing products to be treated into the treatment gap between the rotating first roller and the rotating second roller, the first roller being a cutting roller and the second roller being an anvil roller;
 - (b) transmitting data describing at least one characteristic property of the products or of the apparatus to a control unit;
 - (c) operating the adjusting means for in-line adjusting the size of the treatment gap based on output signals from the control unit, so as to
 - (d) vary the size of the treatment gap within each product to be treated by means of at least one piezoelectric actuator.
12. Method according to claim 11, wherein in step (b) the characteristic property is the local contact area between the cutting roller and the product to be treated.
13. Method according to claim 11 or claim 12, further comprising the step
 - determining at least one characteristic property of the individual products treated, preferably the cut quality of the products.
14. Method according to any of the claims 11 to 13, characterized in that

the data according to step (b) are the optical data from a sensor measuring the edge quality of a cutting element of the cutting roller.

15. Method according to any of the claims 11 to 13, characterized in that the data according to step (b) are related to a gap width or the load acting on the apparatus during cutting operation.
16. Use of a piezoelectric element for shifting the rotation axis of an anvil roller in an apparatus treating continuously fed products between a rotating cutting roller and the anvil roller.

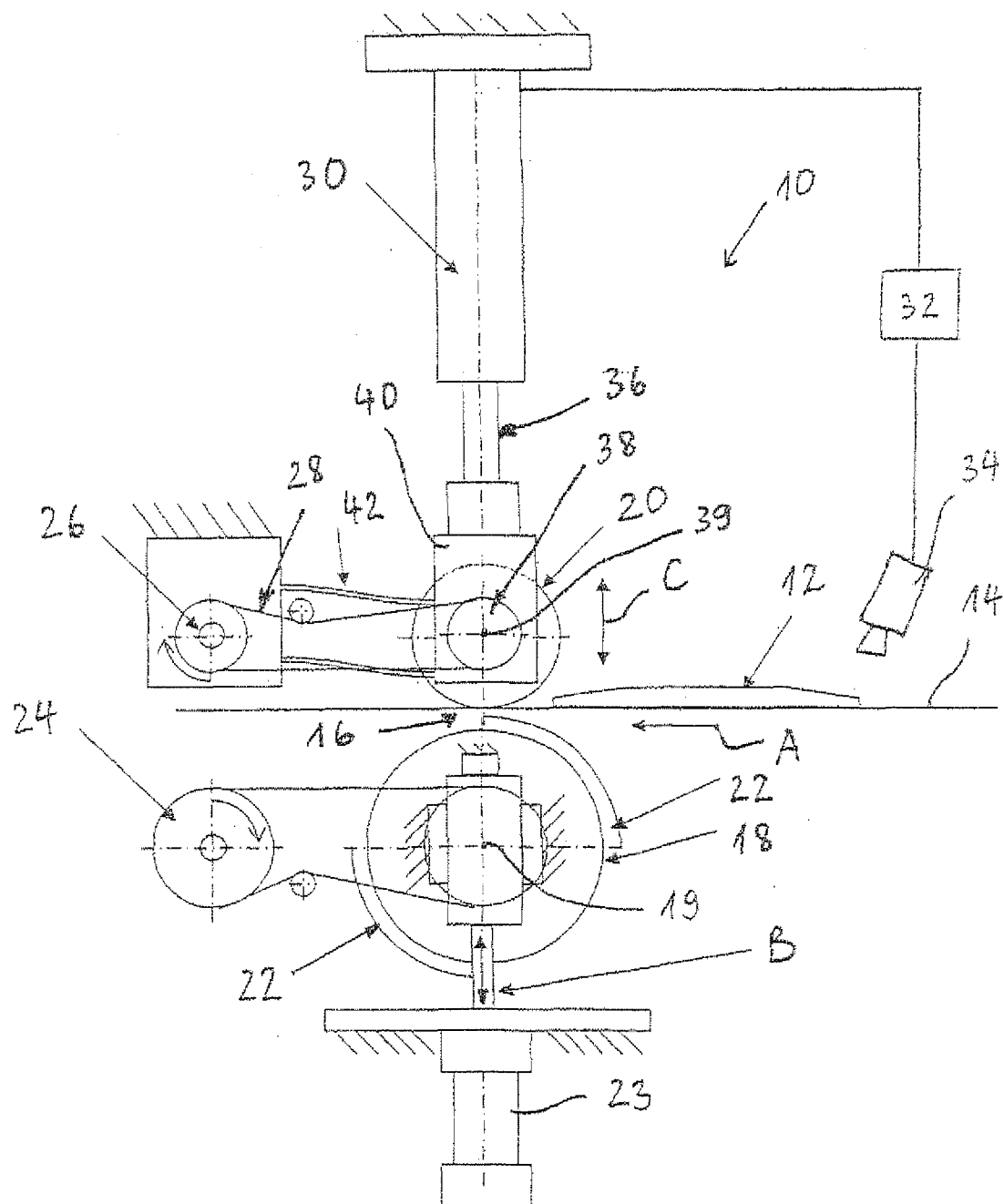
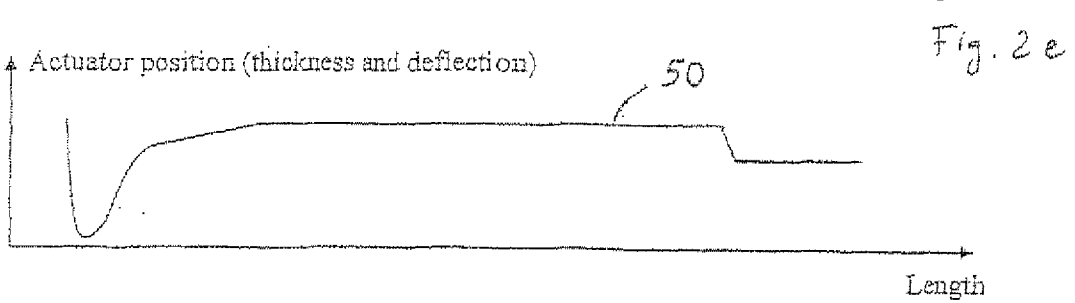
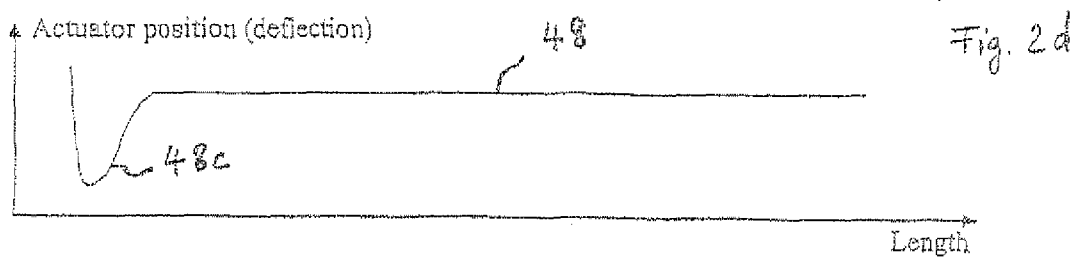
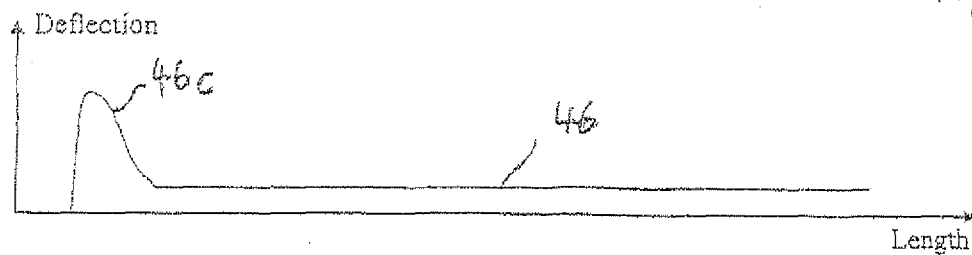
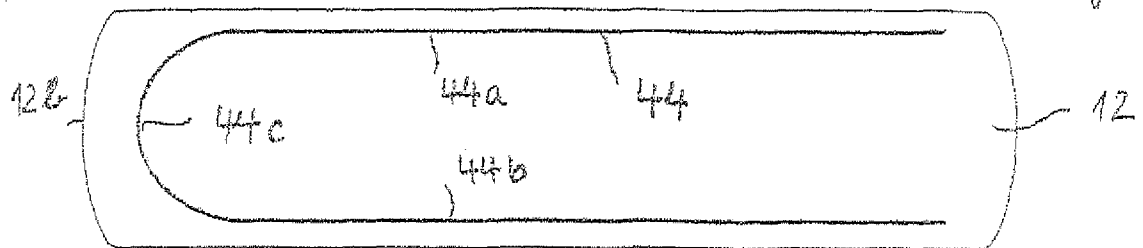
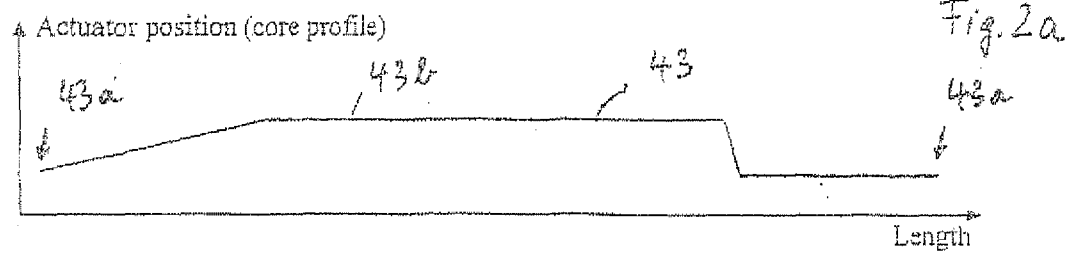
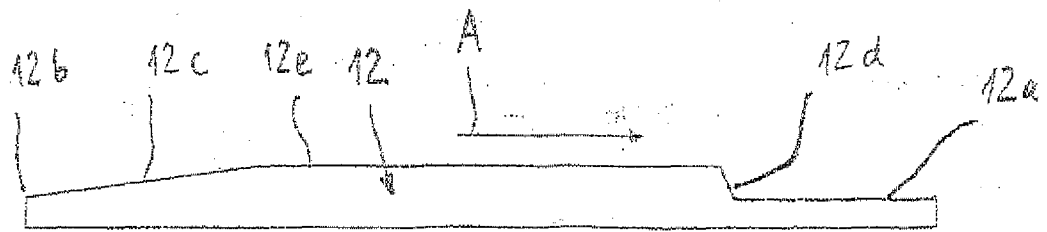


Fig. 1



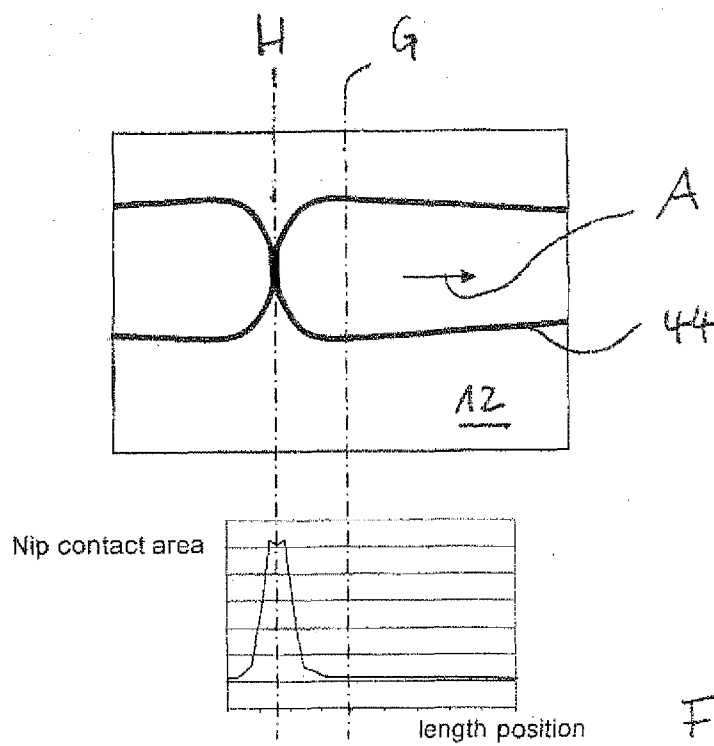


Fig. 3

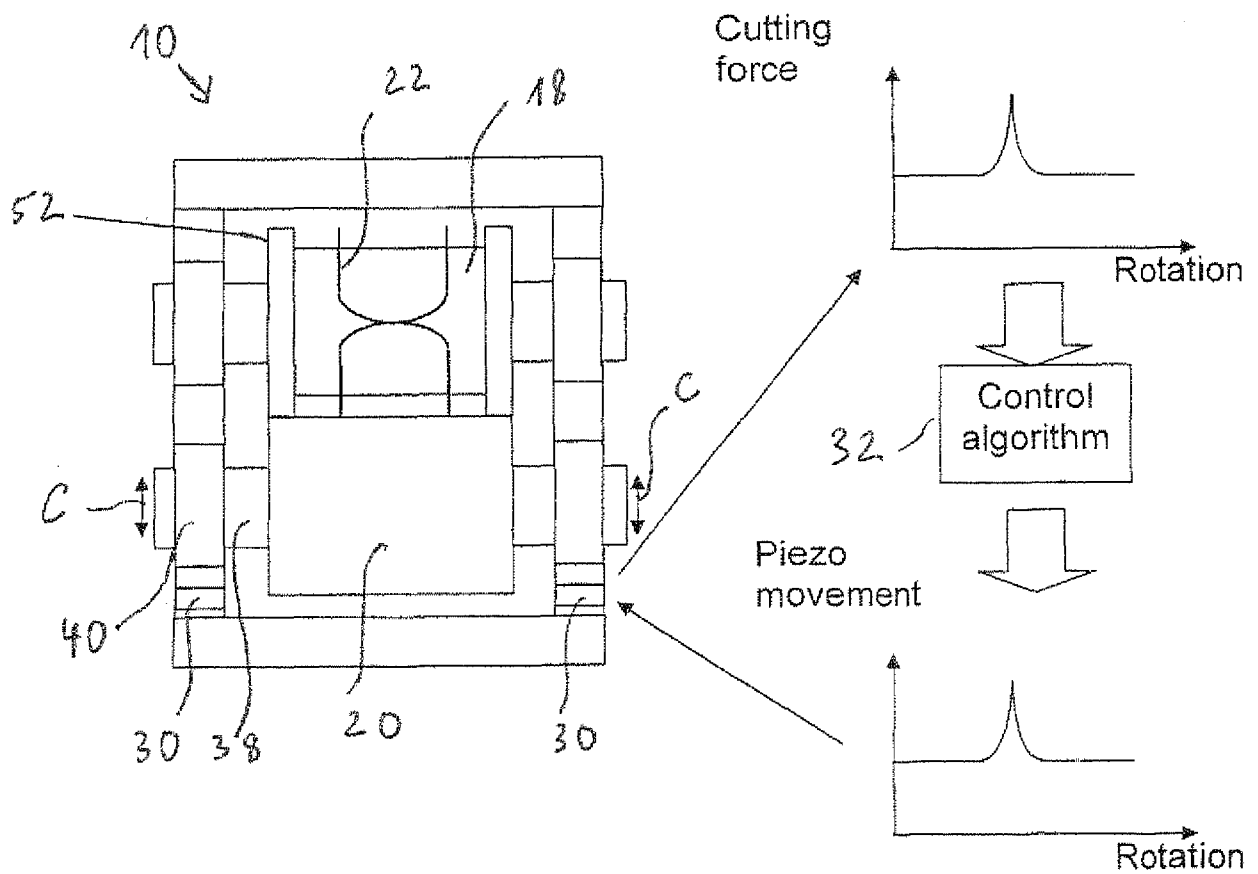


Fig. 4

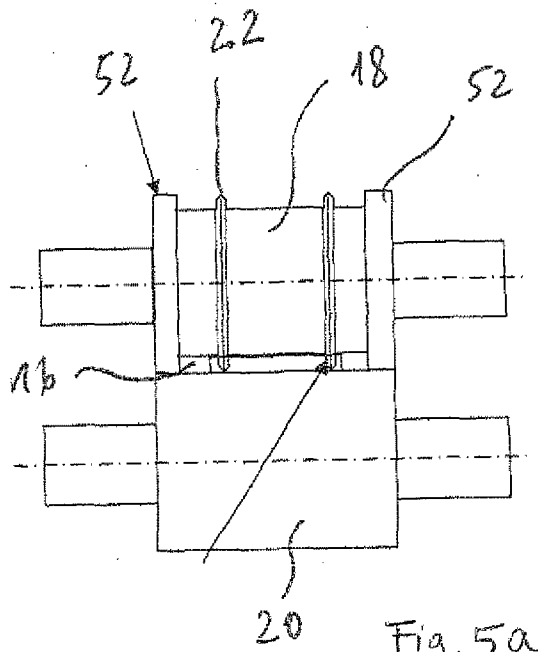


Fig. 5a

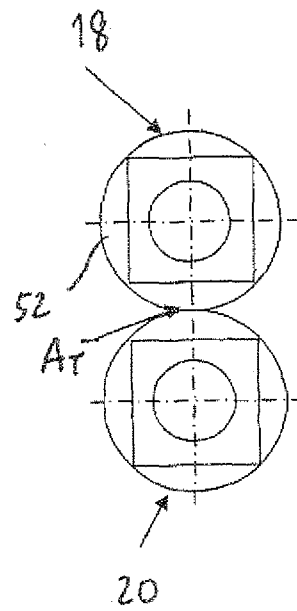


Fig. 5b

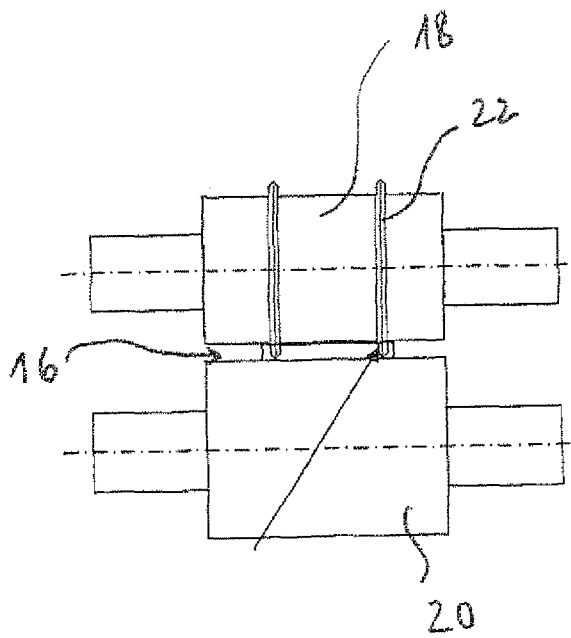


Fig. 6a

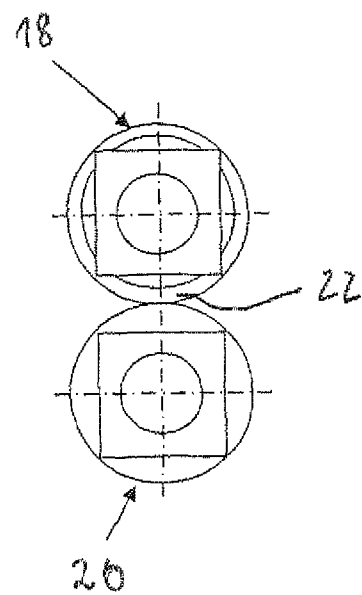


Fig. 6b

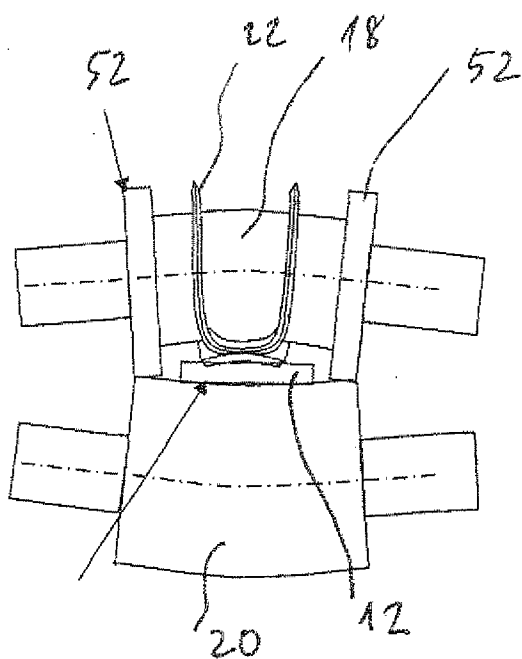


Fig. 7a

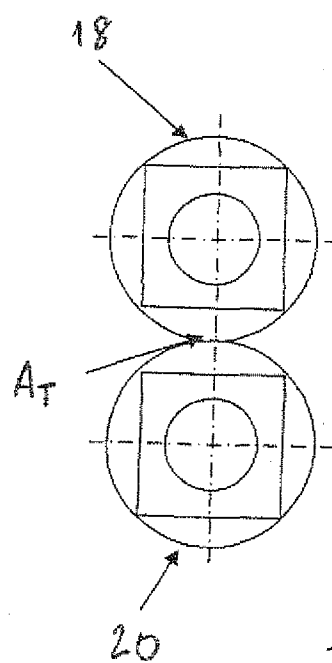


Fig. 7b

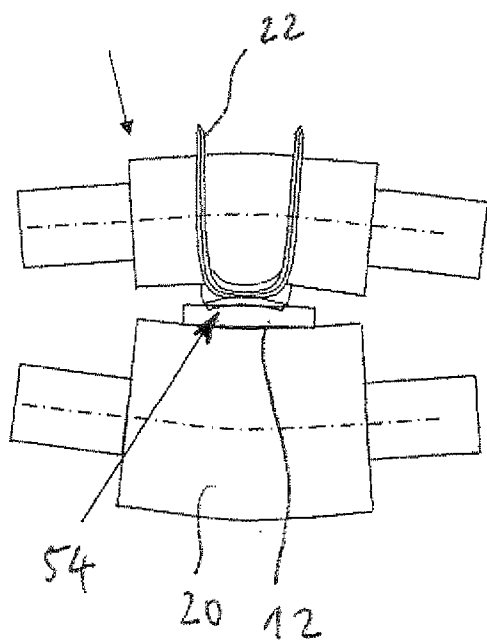


Fig. 8a

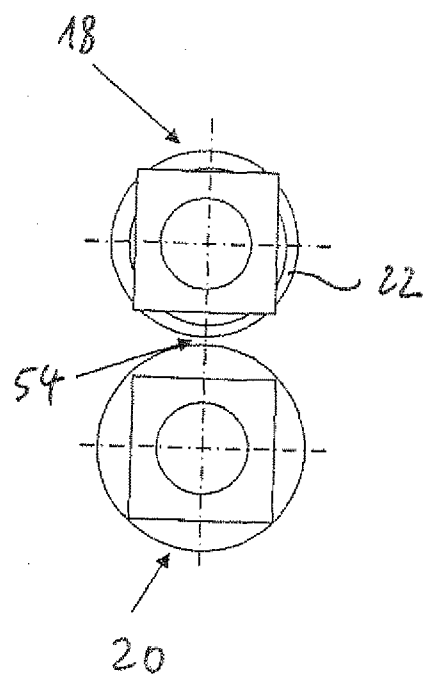
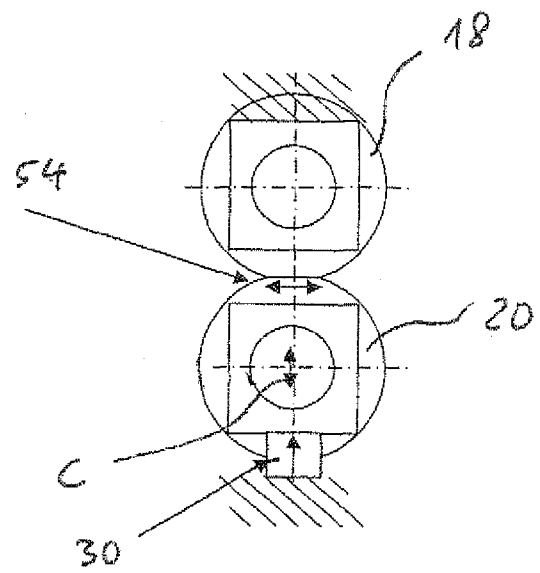
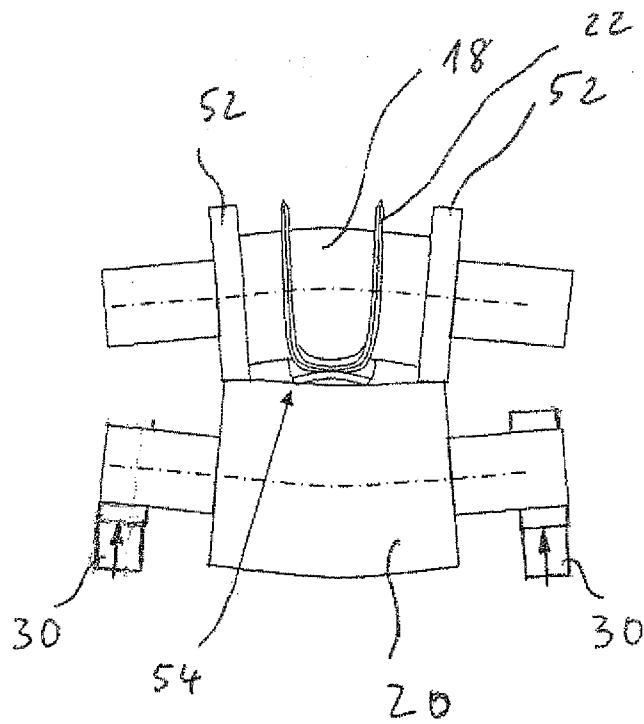
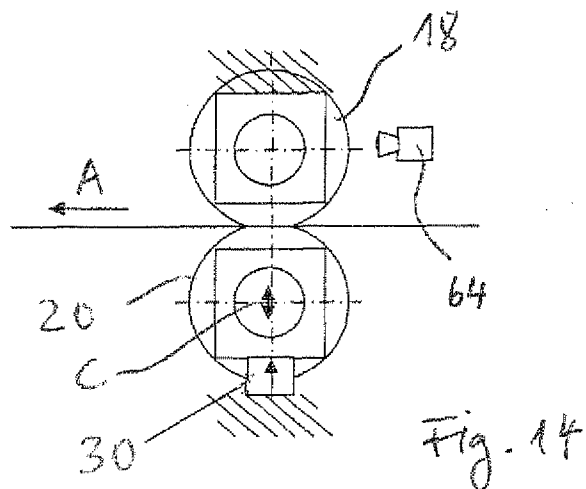
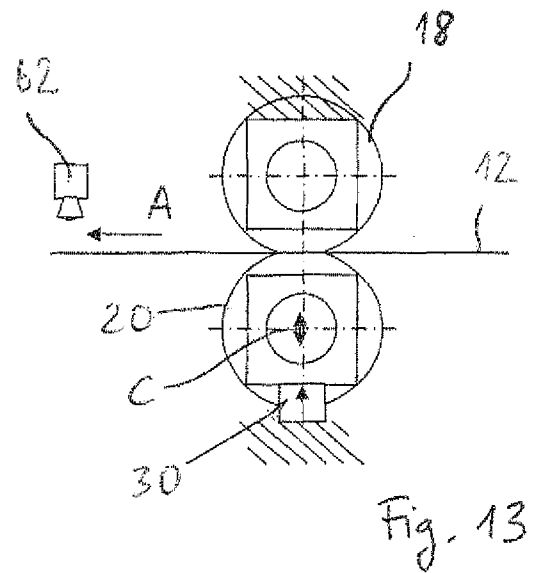
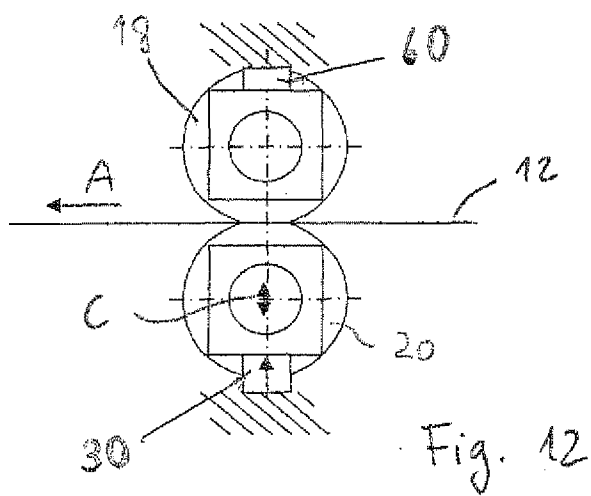
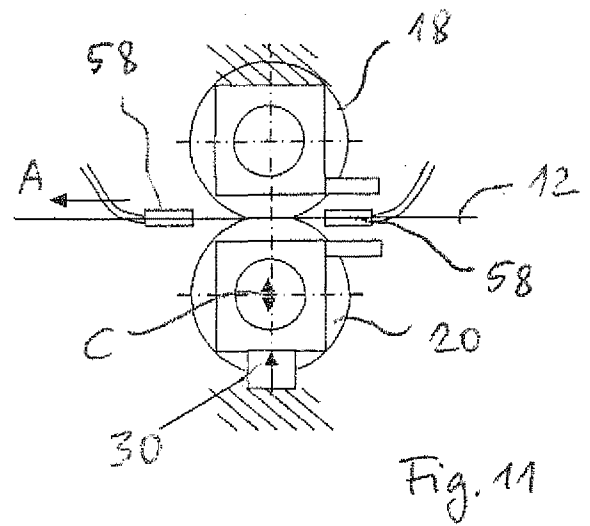
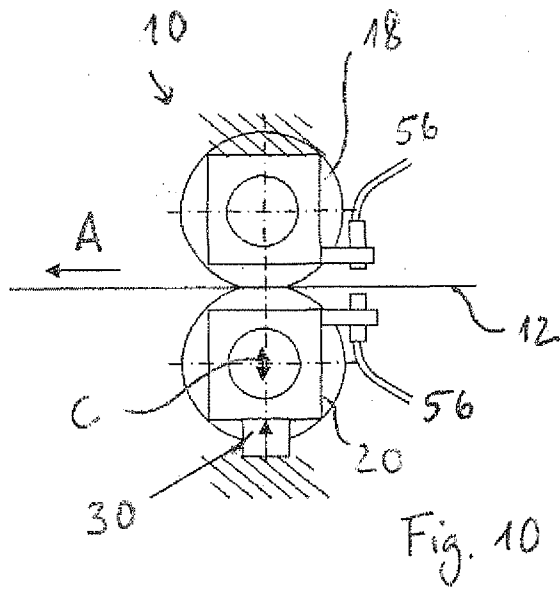


Fig. 8b





INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/051798

A. CLASSIFICATION OF SUBJECT MATTER INV. B26F1/38 B26D7/26 B26D5/34 H01L41/09 B23Q1/34 ADD. B29C65/02 B29C65/08 B30B3/04 B29C59/04 B41F7/40 B26D1/14 D21G1/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B29C H01L D21G B26F B26D B23Q		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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Y	claims; figures page 8 - page 10	5-7, 13, 14

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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search	Date of mailing of the international search report	
2 May 2011	17/05/2011	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Cordenier, Jozef	

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International application No

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