Dec. 27, 1938. R. HAAS 2,141,433

PROCESS AND APPARATUS FOR VARYING THE WIDTH OF PAPER WEBS OR THE LIKE, IN PARTICULAR FOR THE LONGITUDINAL CREPING OF PAPER

Filed May 1, 1936 3 Sheets-Sheet 1

Fig. 1

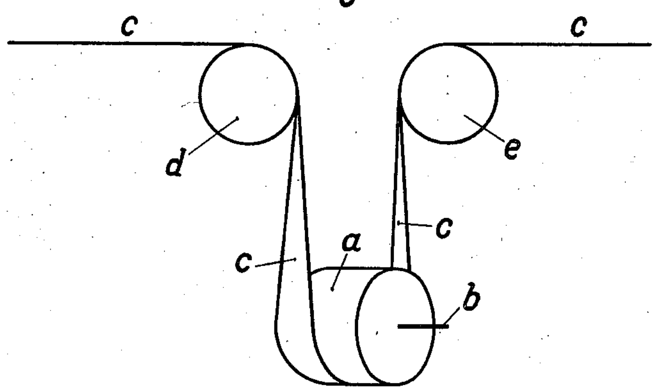


Fig. 2

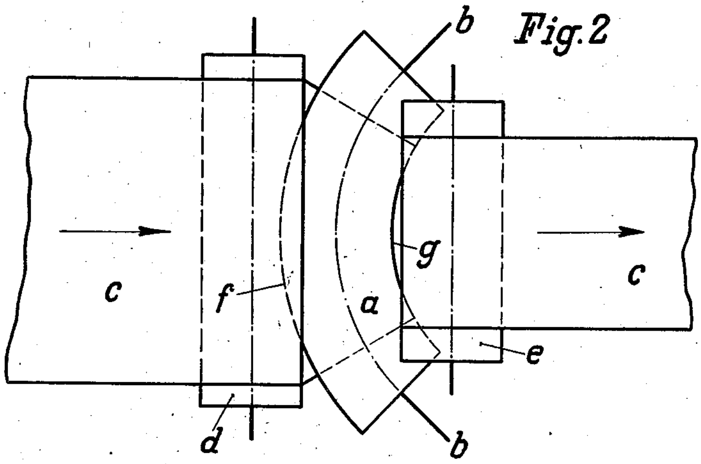


Fig. 3

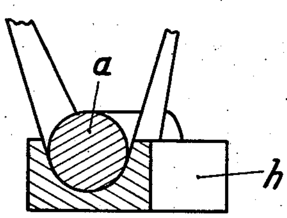
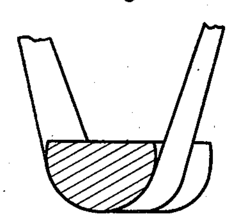


Fig. 4



Inventor:
Rudolf Haas,
By Watson, Coit, Morse & Grindle
Attys.

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Fig. 5

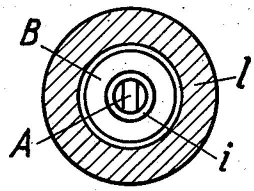
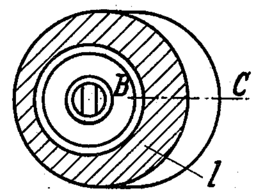


Fig. 6



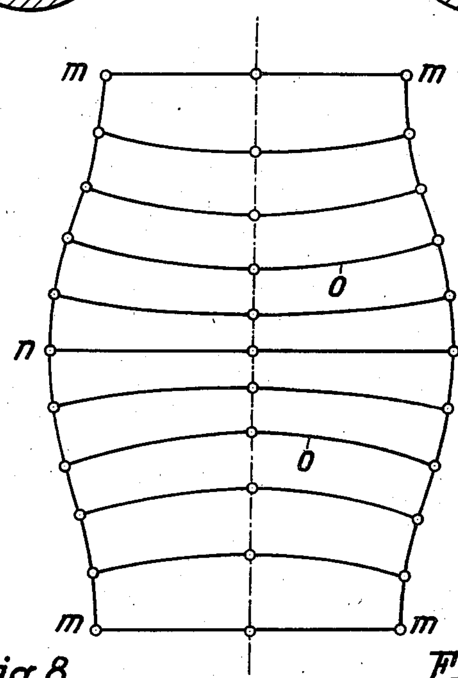


Fig. 7

Fig. 8

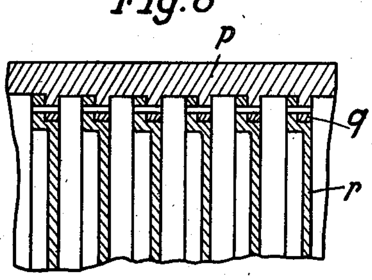
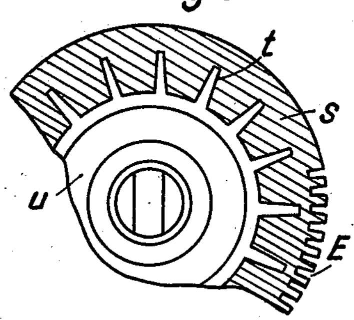


Fig. 9



Inventor:
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By Watson, Coit, Morse & Grindle
Attys.

Fig. 10

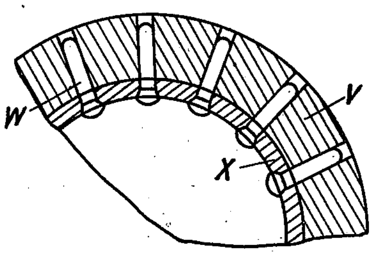


Fig. 11

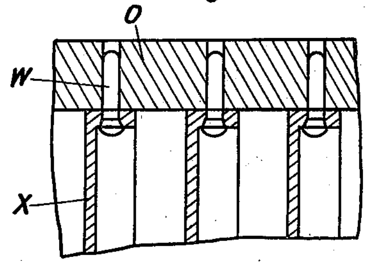


Fig. 12

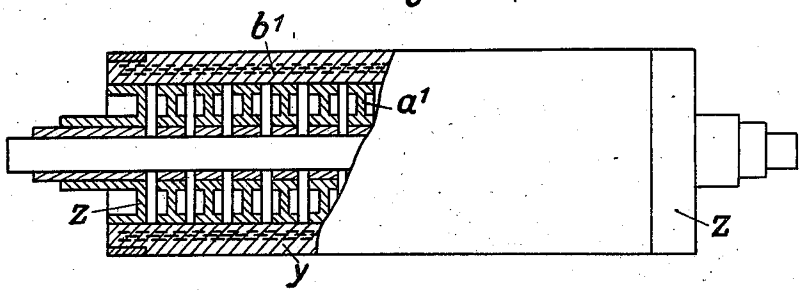


Fig. 13

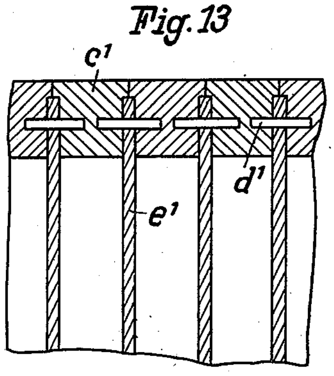
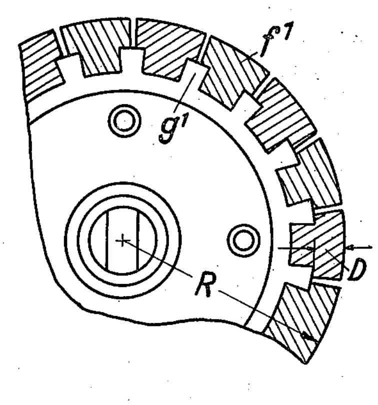


Fig. 14



Inventor:
Rudolf Haas,
By Watson, Coit, Morse & Grindle
Attys.

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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR VARYING THE WIDTH OF PAPER WEBS OR THE LIKE, IN PARTICULAR FOR THE LONGITUDINAL CREPING OF PAPER

Rudolf Haas, Berlin-Dahlem, Germany, assignor of one-half to Zellstoffabrik Waldhof, Mannheim-Waldhof, Germany, a joint-stock company of Germany

Application May 1, 1936, Serial No. 77,430
In Germany May 6, 1935

9 Claims. (Cl. 154—30)

The present invention relates to a process and devices for the longitudinal creping of webs of sheet material, more particularly paper.

The process consists in that the web is passed round part of the periphery of a body of revolution having a curved axis, and on this path is pressed against the body of revolution by pressure means specially provided for that purpose.

Such a body of revolution has the property that, during its rotation about the curved axis, its meridian lines alternately shorten and lengthen again, in other words, the body itself being resilient becomes alternately narrower and wider again to an extent which is greater, the smaller the radius of curvature of its axis and the greater its diameter. If now a web of sheet material is applied by pressure to such a body of revolution sufficiently firmly during its rotation, the web will be obliged to participate in the variation in width, due to the friction between it and the surface of the body.

According to the points on the periphery of the body of revolution at which the web is introduced and removed, greater or lesser creping will take place. The maximum creping is produced when the web is introduced at the widest part of the body, as it were at the top of its back or convex part, and is removed at the opposite or concave part.

The process is illustrated diagrammatically in Figures 1 to 4 of the accompanying drawings by means of examples of devices of the simplest kind.

In Figures 1 and 2, which show in elevation and plan an arrangement according to the invention, *a* denotes a rotatable roller, in the present case of uniform diameter, having its axis *b* curved for example according to the arc of a circle. The web *c* which is supplied and removed over the guide rollers *d* and *e* is now forced to pass round the curved roller *a*, and on running in the direction of the arrow it is contracted in accordance with the shortening of the meridian line from *f* to *g*. The body or roller *a* may be described as having a stationary curved axis *b* as a reference line.

So that the web will not run together in coarse creases, but will receive the desired fine and regularly distributed crepe creases, it is applied according to the invention with a powerful pressure against the surface of the roller, which latter if desired may have its own drive. The light tension such as is produced for instance when guiding a paper web over the guiding or tensioning rollers of a paper-making machine, is not sufficient. Therefore, the known stretching devices comprising rollers with curved axes, such as are employed in the textile art for the stretching of fabrics also cannot be utilized for the longitudinal creping of webs of sheet material, for instance by allowing the web to run through them in the opposite direction.

The construction of the body of revolution itself is optional within wide limits. It may be stated generally that the body may consist for example of rubber, either of solid rubber or of hollow rubber, with or without the application of internal pressure after the manner of a motor car tire. Instead, however, it may be composed of a large number of thin discs of metal or other suitable material positioned at an angle relatively to each other. Furthermore, a construction comprising a combination of the aforesaid features may be employed. The curved axis is essential.

If the body of revolution is formed of individual discs, it is obvious that, the number of the discs employed will determine the degree of fineness of the creping. The greater is the number of individual elements into which the "movable" surface of the body of revolution is divided, the finer will be the effect. The finest and most uniform effect will occur when detectable individual elements are no longer present at all in the surface of the body of revolution, that is to say, when the surface consists of a uniform deformable material, for example rubber.

The simplest case of such a body of revolution is provided when a rubber tube is drawn over a plurality of rotatable hub members arranged at an angle relatively to each other, and is preferably secured at both ends in end discs or the like.

During the rotation of this curved roller, the distance between any two corresponding peripheral points on the end discs varies once per revolution between a maximum value and a minimum value, and the resilient tube participates in this variation in its individual meridian lines. The position of the entry and exit point of the web within the surface region of the body of revolution determines the intensity of the creping effect.

Figure 5 of the drawings represents a section through such a simple body of revolution consisting of internal discs and a flexible tube. A is a bent axle consisting for example of spring steel, *i* one of the bearing bushes placed thereon in a sufficient number, B one of the internal discs rotating thereon and *l* a rubber tube drawn over the system of discs. Figure 5 represents an imaginary condition in which the rubber tube is situated before the axle A has been bent. In this condition, the cross-section of the rubber tube is perfectly symmetrical in all directions.

Figure 6 now shows the body of revolution in its actual, i. e. bent condition. The curvature is assumed to be in a horizontal plane in a direction such that the left-hand side of the cross-section shown is stretched while the right-hand side is compressed. Since the material of the resilient mantle has the tendency not to alter its volume the result is that all the cross-sectional elements on the left-hand side become smaller, while those on the right-hand side become larger.

In the first place, the effect of this variation is that the radius of the body of revolution becomes smaller on the left and larger on the right. Hence, for the same angular velocity of the roller, the peripheral speed affecting the web also varies in the sense that it increases from the left to the right. This results in distortion of the web.

This however does not exhaust the deformation of the roller, since relative movement of the elementary parts of the mantle does not take place in the radial direction alone, but also in the tangential direction.

In order to make this latter deformation better understood, it has been imagined that the rubber tube of Figure 6 has been cut open along the line B—C and shown "developed" in Figure 7. Figure 7 is not, of course, a true development but must be imagined as being produced by developing the straight roller of Figure 5 and then distorting the development to correspond with the curved roller of Figure 6. The two undulatory sides of the development indicate the lengthening and shortening of the meridian lines. At *m—m* the meridian line is a minimum and at *n—n* it is a maximum. The meridians themselves are denoted by *o* and are distributed over the developed peripheral surface of the roller, so that at the ends of the roller, which correspond to the undulatory boundary lines *m—n—m* of the figure, they are spaced apart equally. The consequence of the tangential deformation of the rubber cross-sections is now that the meridians undergo relative displacements towards the centre of the roller so that they tend to approach the line *n—n*, while they tend to move away from the line *m—m*. There is thus produced over the entire effective surface of the body of revolution a distortion which, although it does no damage to the intended creping effect in the transverse direction of the web, results however, in an unintended and disadvantageous irregular stretching or compressional effect in the longitudinal direction.

Experiments have shown that this subsidiary effect may be so great that paper effectively creped by the new method tears in the transverse direction, or that paper previously creped in the transverse direction loses its transverse creping again in the course of the longitudinal creping. The disadvantageous subsidiary effect may be minimized by treating according to the new process paper which has been particularly creped in the transverse direction, the transverse creping then being reduced to the desired degree by the longitudinal creping.

The undesirable subsidiary effect may also be prevented or reduced or rendered harmless according to a feature of the invention by the application of means whereby the changes in cross-section of the deformable material are either limited as far as possible or are rendered as ineffective as possible.

These means are very numerous and varied. They may be applied either in the case in which the deformable mantle of the body of revolution is made of one piece or in the case of a mantle composed of a plurality of individual parts.

In the first case, the tangential cross-sectional variation may be limited for example by the following means:—

By providing the deformable mantle with inwardly directed flanges or the like, which are connected with individual, internal discs, rings or the like.

By providing the inner face of the mantle with slots, grooves or the like which engage correspondingly formed discs, rings or the like.

By the application of pins, screws or the like which project to a greater or lesser depth into the deformable mantle, if desired are passed through the mantle from outside, and are held in discs, rings or the like.

By insertion of wires, bands, cords, fabrics or the like, which prevent or limit any extension in the tangential direction without impeding the desired deformation in the direction of the meridian lines.

In the second case, the resoultion of the deformable mantle may be effected for example as follows:—

By resolution of the mantle into individual rings, secured in the tangential direction by means of flanges, slots, grooves, pins or the like.

By resolution of the mantle into strips parallel to the axis and guided in grooves or otherwise, so that they cannot move relatively to each other in the tangential direction.

By resolution of the mantle in the form of a helix.

All these methods of resolution produce a more or less considerable clearance within the effective surface of the body of revolution, and such clearance either prevents the occurrence of undesired deformations or renders its effect harmless by subdividing such effect into a large number of small separate deformations.

So that the resulting clearances will not have any detrimental effect, for example by nipping the web, they may be arranged in such manner that the individual parts of the surface project into or over each other after the manner of teeth.

The radial variations of the cross-sectional elements of the deformable mantle in most cases can only be prevented to a slight extent or not at all. In some points, they will even be increased more or less by the prevention of the tangential deformation. However, they also may be rendered harmless to a considerable extent according to a feature of the invention by making the thickness of the deformable mantle so small in comparison with the diameter of the body of revolution that the residual influence of the variation in diameter remains within narrow limits. If for example the radial variation of the cross-section of the mantle is 20% and the thickness of the mantle is 30 mm., the effect of the radial variation on the peripheral speed of the paper web may be reduced to 2%, if the radius of the roller is made $10 \times 30 = 300$ mm., that is to say, the diameter is made 600 mm.

Figures 8 to 14 show diagrammatically a few particularly simple and characteristic constructional examples of the invention, it being pointed out that any other construction, provided it corresponds to the meaning of the invention, must be included in the scope of protection.

Figure 8 shows a section of a portion of the periphery of a roller body sectioned parallel to the axis, which is imagined to be straight. p is a mantle for example of rubber. It is provided with inwardly projecting flanges q which are secured to the discs r of inextensible material.

Figure 9 shows a partial cross-section of a body of revolution, the deformable mantle s of which is provided with slots t into which project the star-shaped internal discs u. These internal discs may be simply pushed into the mantle s or may be secured firmly to it, for example they may be vulcanized in. If desired, the outer surface of the roller may be discontinuous, as indicated at E.

Figures 10 and 11 show in partial cross-section and longitudinal section a body of revolution, of which the deformable mantle v is connected by pins w to the hub parts x, so that only the undesired tangential deformations of the mantle are prevented, while the meridianal deformations can be freely effective due to the mutual angular setting of the hub parts x.

In Figure 12 is shown the whole of a roller, partly in longitudinal section. Its deformable mantle y is secured on the right and left in end discs z and in the interior is supported on the discs a^1. In the case of this mantle, the tangential deformations are prevented by providing it with insertions b^1 which may consist of rings, cords or the like and which extend around the roller, but which, on the contrary, in the axial direction, do not offer any obstruction to the meridianal deformations occurring when the roller is curved.

The three insertions drawn one above the other show that it is possible for example to produce the whole of the deformable mantle by the winding on of a fabric which is inextensible in the peripheral direction, while being yieldable in the axial direction. Such fabrics are often used for example for sanitary purposes although only in small widths.

Figure 13 shows by way of example the resolution of the deformable mantle into individual rings c^1 which are secured in the internal discs e^1 in such a manner as to impede the tangential freedom of movement while ensuring the meridianal freedom of movement.

Finally, Figure 14 indicates the resolution of the mantle into individual profile strips parallel to the axis. These strips f^1 are arrested in the tangential direction by the tooth-shaped projections g^1 on the internal discs. When the roller is curved, its effective thickness D varies. Since this thickness is small, however, relatively to the external radius R of the roller, this radial variation remains within supportable limits.

The slots between the individual strips f^1 may be straight, undulatory or of any other shape so that meshing or overlapping takes place.

The pressing of the web to be treated on the periphery of the body of revolution may be effected in various ways. Figure 3 shows for example a case where the curved roller a is surrounded by a stationary counterpart h having preferably a smooth inner surface and adapted to exert a pressing effect on the resulting creases of the web.

Furthermore, the guiding of the web relatively to the roller may be effected by means of a band of resilient material, for example rubber, felt, fabric or the like, moving with it and guided in known manner by guiding and tensioning rollers. This band may be provided with or without its own drive.

Instead of a continuous band, it is also possible to employ a plurality of cords, wires or the like which vary their mutual spacing on their passage around the curved roller. In the case of the guide rollers (d and e) of Figures 1 and 2, if desired they may also be guided by grooves machined in the rollers.

If the band or the cords or the like carrying the web possess their own drive, it is possible to dispense with a separate drive for the curved roller.

Finally, the curved roller itself may also be stationary, provided merely the arrangement is so contrived that the band or system of cords carrying the web describes on the periphery of the roller paths corresponding to a variation in the length of the meridian line of the roller. In this special case, the roller may also be merely provided in part, as shown in Figure 4. Also if the body of revolution does not itself rotate, accuracy in the shape of the body may be dispensed with, provided only the axis of the body is curved in the meaning of the invention.

Even though Figure 2 shows that a considerable alteration in width is possible upon the passage of the web through a single roller system, a plurality of units may of course be disposed in series for increasing the effect.

Since the creping process according to the invention is continuous, it may be included directly in the running of a paper-making machine or any other continuously operating apparatus, for example a reeling apparatus, a cross-cutter, a calender or the like. Thus, the preliminary passage of the web on to a separate re-reeling apparatus, for example may be obviated.

Particular advantages are afforded in this direction when it is a matter of producing longitudinally and transversely creped paper, because it is hereby possible to add the new creping process in one and the same working operation to the known creping process acting at right angles thereto by means of creping cylinders and doctors.

The new process and the new device may also be employed for creping metal foil.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A process for the longitudinal creping of a web of sheet material, particularly paper, which comprises passing the web over a body having a curved surface which corresponds to part at least of the curved surface of a roller having a stationary curved axis as a reference line and in a direction from the convex toward the concave part of said surface, and pressing the web against said surface while passing it over the same.

2. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a body having a curved surface which corresponds to part at least of the surface of a roller with a stationary curved axis as a reference line, means for passing the web over said surface in a direction from the convex toward the concave part thereof, and a pressure means which presses the web against the said body.

3. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a resilient roller over which the web is passed, said roller having a curved stationary axis as a reference line on which it is adapted to rotate, means for causing the web to travel over the surface of said roller in a direc-

tion from the convex toward the concave part thereof, and a pressure means which presses the web against the roller.

4. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a curved roller in the form of a plurality of discs mounted for rotation on a common curved stationary axis as a reference line, means for causing the web to travel in a direction from the convex toward the concave part of the roller, and a pressure means which presses the web against the roller.

5. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a roller including a series of juxtaposed independent discs mounted for rotation on a common curved stationary axis as a reference line, an envelope of resilient material covering said discs and forming the roller surface, and a pressure means which presses the web against the roller.

6. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a roller including a series of juxtaposed independent discs mounted for rotation on a common curved stationary axis as a reference line, an envelope of resilient material covering said discs and forming the roller surface, said envelope being fixed to the discs at a plurality of points to prevent tangential deformations of the roller surface, and a pressure means which presses the web against the roller.

7. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a roller including a series of juxtaposed independent discs mounted for rotation on a common curved stationary axis as a reference line, an envelope of resilient material covering said discs and forming said roller surface, said envelope consisting of a series of rings fixed to the discs at numerous points to prevent tangential deformations of the roller surface, and a pressure means which presses the web against the roller.

8. A device for the longitudinal creping of webs of sheet material, particularly paper, comprising, in combination, a roller having a series of juxtaposed independent discs mounted for rotation on a common curved stationary axis as a reference line, an envelope of resilient material covering said discs and forming the roller surface, said envelope consisting of a series of strips held in the circumference of the discs to avoid tangential deformation of the roller surface, and a pressure means which presses the web against the roller.

9. A device for the longitudinal creping of sheets of material, particularly paper, comprising, in combination, a roller having a series of juxtaposed independent discs mounted for rotation on a common curved stationary axis as a reference line, an envelope of resilient material covering said discs and forming the roller surface, said surface being provided with longitudinal grooves, and a pressure means which presses the web against the roller.

RUDOLF HAAS.