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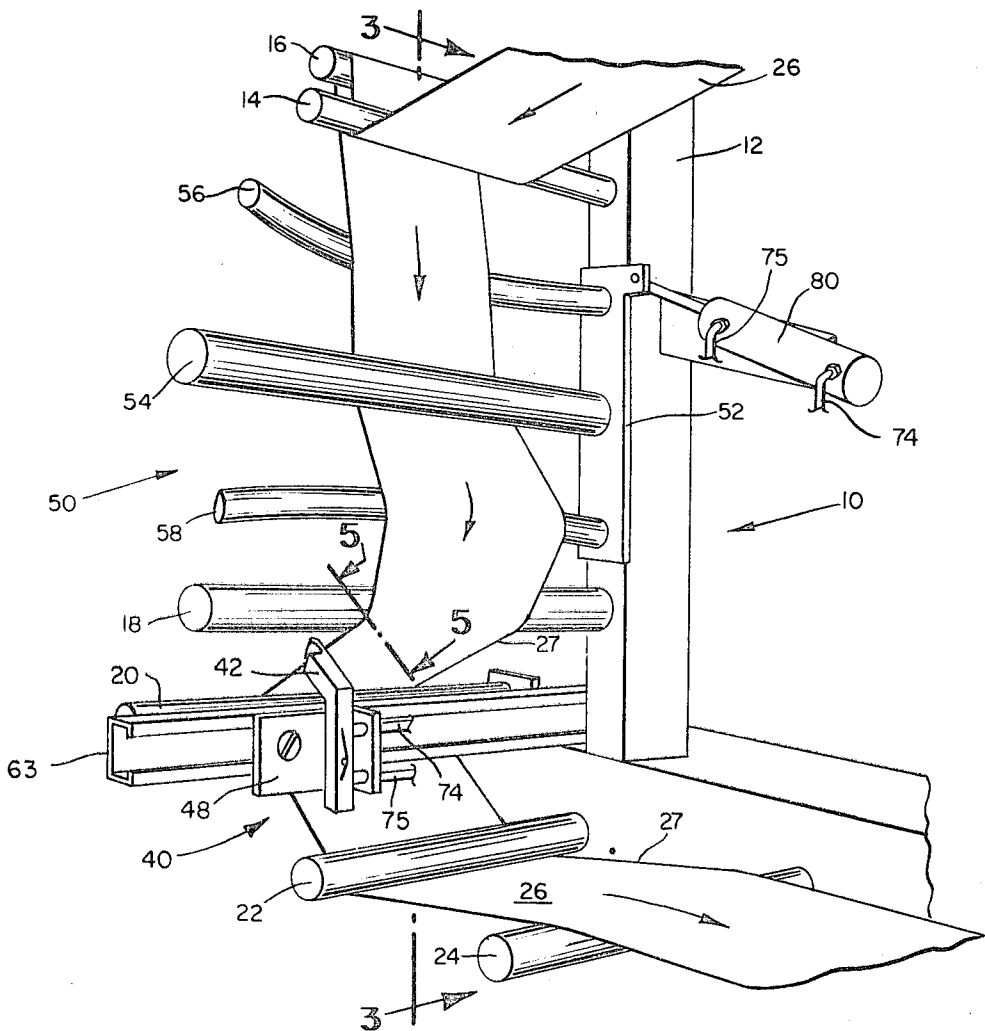
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[54] **BAND WIDTH CONTROLLER**
6 Claims, 6 Drawing Figs.

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19/65 T
[51] Int. Cl..... B65h 25/26
[50] Field of Search..... 226/11, 15,
18—23; 29/65 T, 66 T; 26/63

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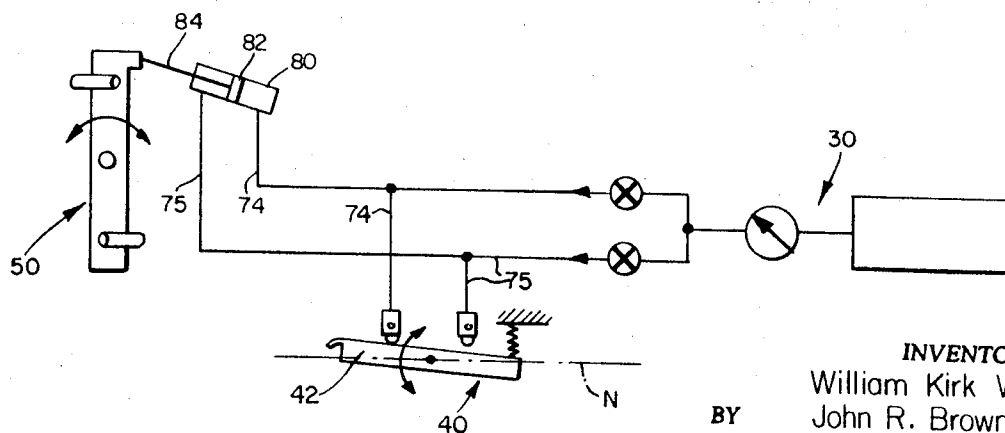
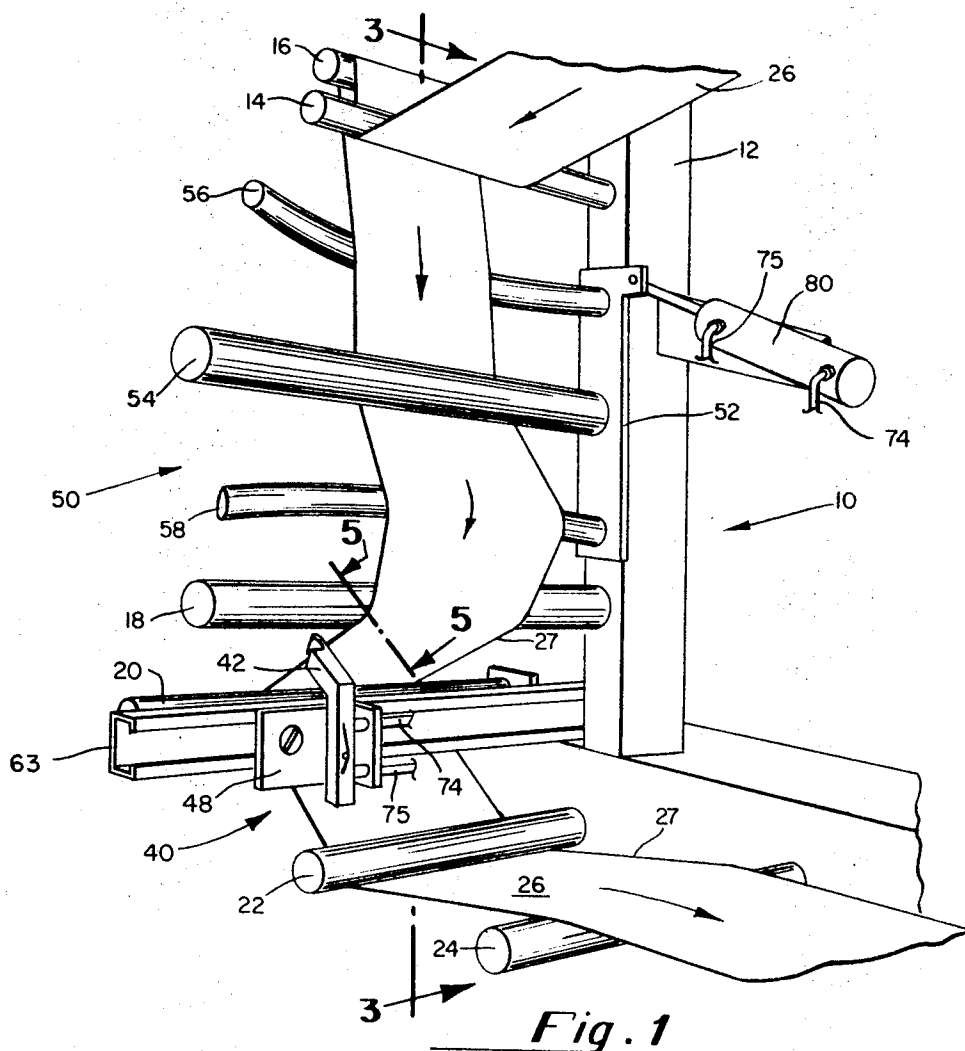
ABSTRACT: A control means for the adjustment of the band width of a moving band of continuous material which passes over a plurality of tensioning bars and is subject to deviations in its width due to its inherent properties in such an environment, comprises at least one bar presenting a curved surface to one face of the continuously moving band, said surface, upon engaging said face, causing said band to spread or become narrower in accordance with the disposition of said curved surface. The bar is actuated by an amplifier-controller and servomotor which is constantly error sensitive in that error-measuring means are provided downstream being in engagement with said band to measure the error and effect the input signal to the amplifier-controller. In alternate embodiments a plurality of curved surfaces are presented to one or more faces of said band, said surfaces being movable by means which are controlled either independently or commonly.



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SHEET 1 OF 3



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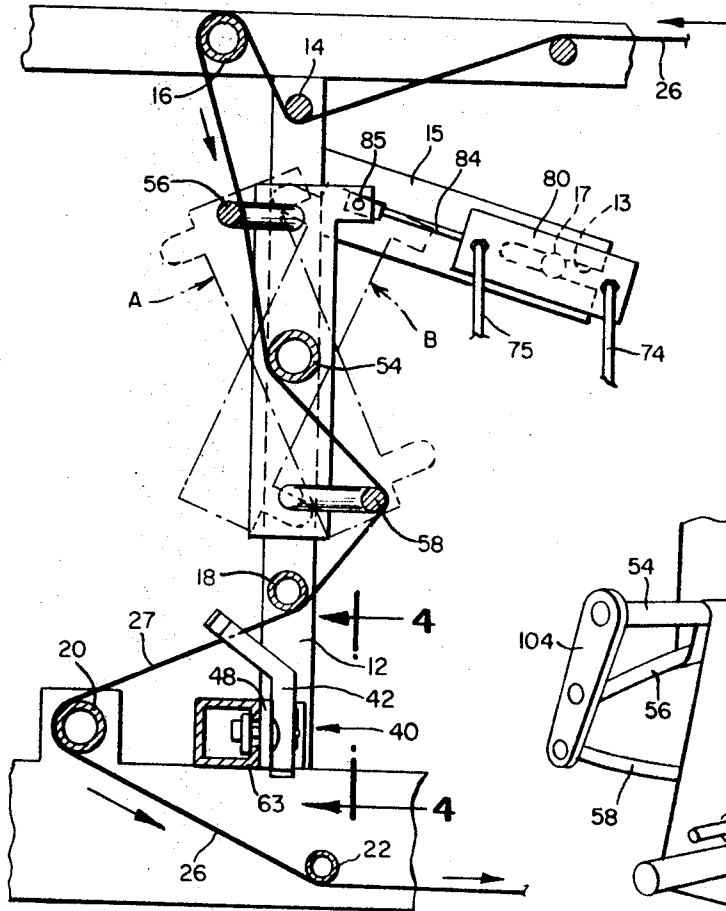


Fig. 3

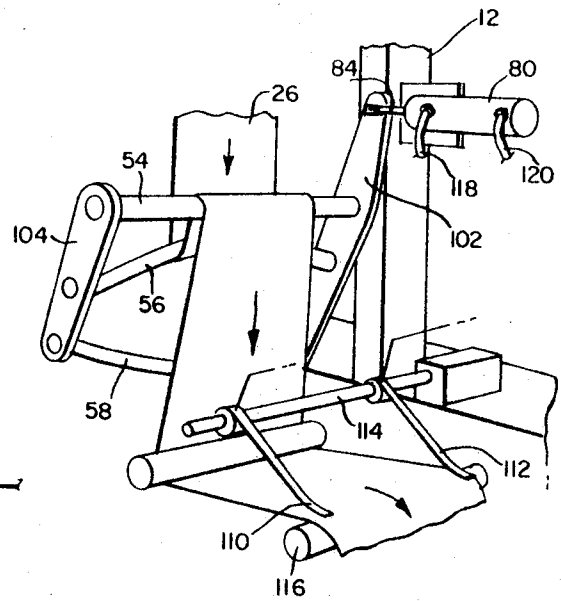


Fig. 6

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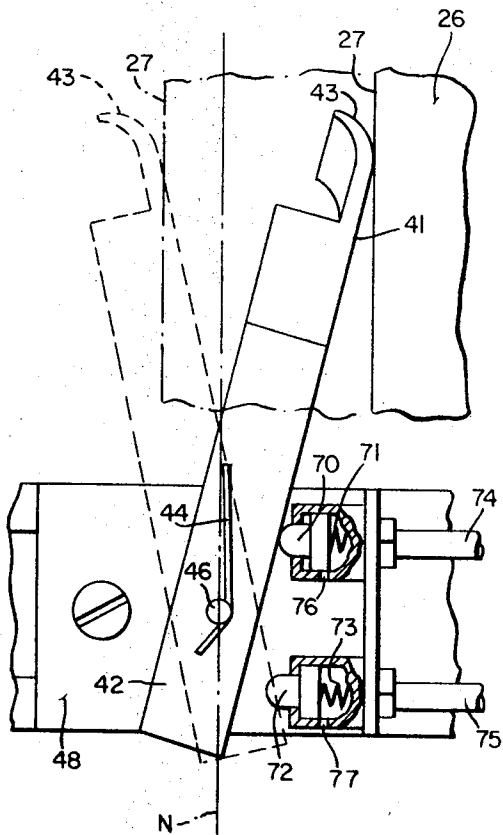


Fig. 4

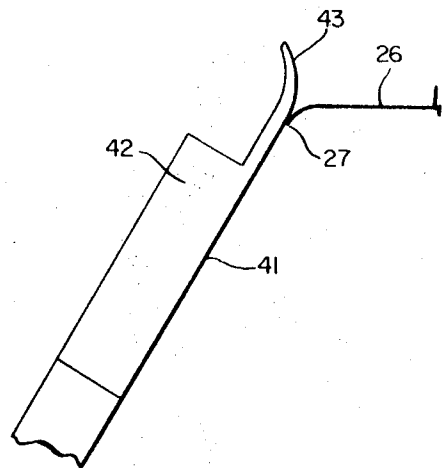


Fig. 5

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BAND WIDTH CONTROLLER

BACKGROUND OF THE INVENTION

This invention relates to servomechanisms, and more particularly to a servomechanism for use in controlling the band width of a moving band of continuous textile material.

Textile material, such as tow is commonly processed in apparatus wherein the tow is drawn from a bag or barrel and fed through a plurality of bars to apply tension to the tow and to present it to a processing apparatus in the form of a continuously moving band. In order to process the band properly, it is necessary to maintain the band width as near to uniform as possible, as for example, when it is fed into a machine, such as a stapler.

SUMMARY OF THE INVENTION

Our invention provides an apparatus for adjusting the band width of a moving band of continuous material, such as filamentary tow. It comprises a means for spreading or narrowing the tow or other similar material in response to input signals from sensors disposed between the spreading or narrowing means and the apparatus receiving the tow. This means includes one or more bars which are pivotally mounted to rock toward or away from at least one face of the band of material, and which have curved surfaces for engaging the band of material. In the most preferred embodiment of my invention, there are two bars provided on a common pivotally mounted frame; one of which presents a convex surface to a face of the band and the other of which presents a concave surface to a face of the band. In response to appropriate input signals obtained from sensing means downstream on the frame, the frame is pivoted so as to bring one or another or both bars into more or less contact with the faces of the band. The concave bar tends to compress the band together producing a smaller band width. Conversely, the convex bar tends to spread the material producing a wider band.

An error-sensing means, continuously measures the degree of error in band width from a desired norm, and the frame is pivoted in response thereto so that the band width is constantly adjusted.

Accordingly it is an object of our invention to provide a servomechanism for controlling the band width of a continuously moving band of material.

This and other objects will become apparent from the following description with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a portion of an apparatus for handling a moving band of material showing the most preferred embodiment of our invention partially broken away and in operative relation to a band of material disposed in said apparatus;

FIG. 2 is a schematic diagram of the servosystem for the embodiment shown in FIG. 1;

FIG. 3 is section taken as indicated by the lines and arrows 3-3 in FIG. 1, with alternate positions shown in phantom;

FIG. 4 is an enlarged elevation of a portion of the apparatus shown in FIG. 1, partially broken away, with alternate positions shown in phantom;

FIG. 5 is a view taken as indicated by the lines and arrows 5-5 in FIG. 1; and

FIG. 6 is a perspective view of an alternate embodiment of our invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although specific forms of the invention have been selected for illustration in the drawings, and the following description is drawn in specific terms for the purpose of describing these forms of the invention, this description is not intended to limit the scope of the invention which is defined in the appended claims.

Referring to the figures, FIG. 1 shows a portion of an apparatus generally designated 10 which is part of a larger machine (not shown in detail), such as a stapler for processing a continuous belt of textile material. In the case of the stapler the textile material treated is tow, which is removed from a barrel (not shown) and drawn over and under a plurality of guide bars which serve to both guide and tension the tow slightly prior to the time it is fed into the working mechanism of the stapler. As the tow approaches the stapler portion of the machine, the guide bars become closer and closer together and the tension increases from just a slight tension to remove the sag caused by the weight of the tow belt hanging between widely spaced-apart guide bars, to a firmer tension imparted by wrapping the tow around closely spaced tensioning bars and drawing it over the bars. The tow tends to wander on the bars transversely to the direction in which it is being drawn and the band itself, which is made of a plurality of continuous filaments, tends to vary in its band width. Our invention is concerned with the particular problem of band width control, rather than that of the wandering or control of lateral displacement of the band.

As shown in FIG. 1 the portion of the apparatus designated 10 comprises a frame 12 having mounted to it a plurality of fixed, straight guide bars 14, 16, 18, 20, 22 and 24 about which a band of tow 26 is drawn in a tortuous path as indicated by the arrows. The effect of this arrangement is to tension the band and guide it.

To control the band width, we have provided a servomechanism represented schematically by the system shown in FIG. 2. This system comprises a power source designated generally 30, an error-sensing means designated generally 40, and a controller designated generally 50. The system shown is a pneumatic system, but it will be understood that the controls could be hydraulic, electric or operated by other well known means. The system represented is a closed loop type of control in that error between the state desired and the state existing is constantly measured and if there is an error something is done about it. As previously stated, the error which we are concerned with in this application is deviation in band width. Thus the band width may be wider or narrower than the desired norm at a given point. Accordingly, to control the band width, we provided a sensor 42, FIGS. 1 and 2 upstream of this point. Through the servosystem the sensor controls the movements of the controller 50 disposed further upstream.

Referring to FIGS. 1 and 3, we shall now describe the details of the controller and its function with respect to controlling the width of the band 26. The controller 50 comprises a frame 52 which is pivotally mounted in any suitable fashion to the frame 12, as by means of the straight shaft 54, which is fixedly connected to the frame 52 and passes therethrough and is journaled in bearings (not shown) in the frame 12. The axis of the shaft 54 is parallel to the axes of the guide shafts 14, 16, 18, 20, 22 and 24. The shaft 54 is always in contact with a face of the band 26.

In the preferred embodiment, two control bars are provided to change the width of the band. These control bars can be more easily referred to by the disposition of their curvatures with respect to the faces of the tow band 26. Thus, control bar 56 can be referred to as a concave control bar and control bar 58 can be referred to as a convex control bar.

In FIGS. 1 and 3 both the convex and concave control bars are engaged with the band 26. Thus, the band is first narrowed by the concave bar and then is broadened by the convex bar, prior to reaching the sensor 42. This position is purely arbitrary and is depicted solely for the purposes of illustrating the function of the control bars. The concave surface of bar 56 tends to narrow the band width as the band runs across the bar under tension between the guide bar 16 and the shaft 54. The convex surface of control bar 58 tends to spread the band as it passes over the bar 58 under tension between the shaft 54 and the guide bar 18. It will be apparent that these bars are interchangeable in their relative positions with respect to the line of travel of the band. Thus when handling very narrow

material it is desirable to purposely keep the band wider than the desired width by using the spreader bar 58 upstream of the narrowing control bar 56, thus allowing the narrowing bar to act as the ultimate control to reduce the band width to that desired just as it passes the control point.

It will further be apparent that various other adjustments or changes in the mechanism could be made by those skilled in the art. For example, it is possible to separately mount the bars on separate pivoted frames, or to run the material over the concave bar only, keeping the convex bar out of engagement in the normal condition and bringing it into engagement only when necessary, or to reverse this procedure and place the convex bar normally in engagement with the band while maintaining the concave bar spaced from the face of the tow band and bringing it into engagement only when necessary. However, we have found that by mounting both bars in the same pivotally mounted frame and maintaining both in contact with the belt or band, we have been able to achieve the optimum degree of control of the width of the band.

We further discovered that by sensing the position of one tensioned edge of the band in close proximity to the control means we are able to accurately control the band width. In order to accomplish this, we have provided a sensor 42, shown in greater detail in FIG. 4 which is normally spring biased by the spring 44 to rotate in a clockwise direction about a shaft 46 passing therethrough. The shaft 46 is affixed to the frame 48 which is mounted in any suitable fashion in the apparatus as by welding it to the support frame 63 which is fixedly attached to the frame 12. The sensor 42 is so positioned that its lead end 43 lies against the edge 27 FIG. 1 of the band 26. The sensor is preferably on the order of one-half inch wide and curved outwardly away from the band so as not to snag on the edge 27 of the band. Spring biasing by the spring 44 is sufficient to keep the sensor in contact with the edge as the band traverses laterally, that is, transversely to the direction of travel indicated by the arrows FIGS. 1 and 3, as illustrated by the phantom positions FIG. 4.

As shown in FIG. 5 the sensor 42 is preferably disposed to overlie the upper face of the band 26. This is accomplished by mounting the sensor at an angle as shown. In this matter the edge 27 will be turned slightly downwardly as it passes the sensor, but will resume its normal orientation in the band as it passed over the next bar. This feature of the invention effectively prevents the edge from being rolled or folded upon itself.

Any error sensed by the sensor 42 is transmitted through the servosystem to the controller 50 which is moved in order to make a correction. We shall now describe this system in some detail. Referring particularly to FIGS. 2 and 4, the sensor 42 is in a position wherein the band width is narrower than the optimum desired at the sensing point. Thus the sensor has rotated clockwise slightly from the normal line designated N. The normal line is a line through the pivot point or axis of the shaft 46 which would normally be parallel to the edge 41 of the sensor 42 when that edge lies in the same plane as, and in engagement with, edge 27 of the band 26. In this position no signal is generated and this is the optimum normal position in which the band width is to be considered constant.

In the normal position the edge 41 is spaced from the surfaces of the two valve plungers 70 and 72. Each valve is spring-biased open by the springs 71 and 73 respectively so that air passing through the lines 74 and 75 respectively will exit through the bleed holes 76 and 77 respectively. The lines 74 and 75 are continuously pressurized from a source of controlled pressure 30 shown in FIG. 2. These lines are connected to the ends of a pneumatic cylinder 80 which is attached to the frame 12.

It is desirable that the cylinder be mounted so as to be able to pivot and for this purpose a track 13 is provided on the arm 15 extending from the frame 12. A shaft 17 extends from the side of the cylinder through the track 13 and is journaled in a bearing on its outer end which is retained in fixed position against the arm 15 by any suitable means (not shown) so that

the cylinder is free to pivot about the shaft 17 and yet is retained against the arm 15.

Within the cylinder there is a piston 82 FIG. 2 having a piston rod 84 extending through a suitable seal at the end of the cylinder, said rod being pivotally connected as by pin 85 FIG. 3 to the frame 52. Thus when the piston 82 is moved axially within the cylinder 80, the piston rod 84 causes pivotal movement of the frame 52 about the axis of the shaft 54.

In the normal position the pressure is equal in lines 74 and 75 and the pressure on either side of the piston 82 in the cylinder 80 is equal. Consequently the frame 52 is maintained in a fixed position. When the band 26 is narrowed as shown in the full view in FIG. 4, the end 43 of sensor 42 follows the edge 27 of the band and the sensor 42 is rotated clockwise. As it rotates, it first takes up the gap between the edge 41 and the plunger 70, and then it depresses the valve plunger 70 and closes the bleed hole 76. This causes pressure to build up in the line 74 and consequently the pressure behind the piston 82 in the cylinder 80 is greater than that ahead of the piston and in line 75. Thus the piston will be forced to the left when viewed as in FIG. 2, and the rod 84 will move to the left causing the frame 52 pivot in a counterclockwise direction about the axis of the shaft 54. The frame 52 would then assume the position shown in phantom designated A in FIG. 3. Thus the concave or narrowing control bar 56 will be removed from engagement with the band 26 and the band will pass freely from control rod 16 across shaft 54. Furthermore, the convex or broadening control bar 58 will be displaced so as to put a greater tension on the band and spread it even further. Thus the band will be widened as it passes over the bar 18 and the bar 20.

As the band gets wider the edge 27 forces the sensor 42 to rotate counterclockwise toward its normal position. When it is once again in its normal position, both vent holes are open and the pressure on either side of the piston is the same. The piston will then remain in this position until a further error is sensed.

If the band should get wider than desired, the sensor would move to the position shown in phantom in FIG. 4 causing the valve plunger 72 to close the vent hole 77 and increase the pressure in the line 75 thereby forcing the piston to the right and rotating the frame 52 in a clockwise direction. This would have the effect of reducing the contact which the control bar 58 has with the face of the band and increasing the contact which the control bar 56 has with the face of the band as shown by the phantom position designated B in FIG. 3. Thus the band would be narrowed and the sensor would return to its normal position.

When a sensor of the type described is used the spacing between the face 41 of the sensor and the valve plungers 70 and 72 to an extent determines the sensitivity of the device. Thus if the face 41 was constantly in contact with the valve plungers, the range or permissible deviation which the band width could take would be very narrow, since response to pivotal movement of the sensor would be almost instantaneous. However, when a gap or space is left between the face 41 and the valve plungers (as previously described), permissible deviation range is provided whereby the band width can vary within acceptable limits without any correction being made by the apparatus. Of course, other factors can be changed in order to affect this range. For instance, the respective distances between the points of contact of the face 41 with the valve plungers and the axis of the shaft 46, and the point of contact of the band with the lead end 43 and the axis of the shaft 46 can be varied within the scope of this invention to affect the range.

FIG. 6 shows an alternate embodiment of our invention in which a plurality of sensors are used and in which the band width is strongly permanently biased in one direction while being controlled in the other direction.

In this embodiment a modified frame 102 is provided wherein the shaft 54 is fixedly connected to the frame 102 and is mounted in bearings in the frame 12. However, the outwardly disposed end of the shaft 54 is interconnected by

means of member 104 with the outwardly disposed ends of the shafts 56 and 58. The member 104 increases the fixed stability of the shafts with respect to one another and allows the shaft 56 to bear a greater load. Further, while the frame 102 pivots about the axis of the shaft 54 as in the previous embodiment, both control shafts are disposed to the same side of the pivot shaft, rather than on opposite sides thereof. Herein the web 26 is always drawn across the narrowing concave control arm 56 and then across the shaft 54. Thus the band 26 is constantly narrowed. The pneumatic piston and cylinder 80 is the same as that previously described and is connected to frame 102 to pivot it about the axis of the shaft 54. Upon appropriate movement, the broadening control arm 58 is brought into contact with the face of the band 26 to spread the band. Thus the upper bar is constantly trying to converge the tow to a minimum width, whereas the lower bar 58 intermittently contracts the tow in order to widen it out again.

A pair of feelers or sensors 110 and 112 are mounted on and insulated from a rod 114 which is fixedly connected to the frame 12 (in any suitable manner) so as to extend across the band 26. These feelers are preferably made of spring steel or similar material and are spring biased to lay against the band or to come in contact with the metal bar 116 if a band is not disposed between them and the bar. The bar 116 and the feelers 110 and 112 are connected by means of an electrical circuit (not shown) in which each feeler coacts with the rod as a switch. The electric circuit controls the air pressure in the lines 118, 120 to the air cylinder 80 by any suitable means, such as a three-way solenoid-actuated valve (not shown) and thus controls the positioning of the piston 82 within the cylinder.

The system shown is a make-or-break system in that the control bar 56 is constantly condensing the material flowing past it and it is only when this material contracts beyond a predetermined acceptable limit that any change is made in the position of frame 102. In the normal condition, the bar 56 constantly narrows the band 26 and the bar 58 either widens the band to a desired limit or does not engage the band at all. Should the band become too narrow and slip from its position between either or both of the feelers 110, 112 and the bar 116, the feelers would make a circuit to cause movement of the frame 102 in a counterclockwise direction about the shaft 54. This movement brings the convex bar 58 into engagement with the band 26. As the band widens it will eventually run between the feelers and bar 116 thereby breaking the circuit and allowing the frame to return to its original position.

It will be apparent to those skilled in the art that various changes in the functions performed by the switch circuits 110—116 and 112—116 could be made in order to vary the reactions on the frame 102. Further additional feelers and circuits could be used to obtain results similar to those previously described. For example the switch circuit 112—116 could be used to widen the band while the switch circuit 110—116 could be used to rock the frame 102 in a clockwise direction about the axes of the shaft 54 and thereby disengage the convex control bar 58 from the face of the band 26 and allow the concave control bar 56 to once again narrow the band. Additional modifications could be made within the scope of our invention, as for instance by providing a second set of feelers spaced parenthetically from the first set of feelers to set an outer limit for the width of the band. Once again these could be used to remove or lessen the contact of the control bar 58 with the band 26.

Thus it is apparent that the controls can be used in a variety of on-off ways, as by way of further example, where the band is normally widened by the bar 58 and maintained between the feelers and the circuits are normally closed, so that when the

band becomes wider and breaks one of the circuits, this actuates the frame 102. As the band width decreases to a position within the feelers again, the switches will close a circuit thereby allowing the frame to return to its original position.

Any of these actions will continue in a pulsing manner, thus maintaining a constant band width range as the tow flows continuously through the machine. By placing the control frame 102 as far upstream as practicable from the point in which the tow is to be delivered at an acceptable band width, it is possible to minimize the effects of any small deviations in band width. Further the point at which error is sensed should be downstream of the control frame, and as close to it as practicable.

The principle shown in the alternate embodiment (FIG. 6 of the drawings) of having sensors along both edges of the band can easily be applied to the preferred embodiment by those skilled in the art within the principle and scope of this invention.

It will be understood that various other changes in the details, materials and arrangement of parts which have been herein described and illustrated in order to explain the nature of this invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the following claims.

It will further be understood that the "Abstract of the Disclosure" set forth above is intended to provide a nonlegal technical statement of the contents of the disclosure in compliance with the Rules of Practice of the United States Patent Office, and is not intended to limit the scope of the invention described and claimed herein.

What we claim is:

1. In an apparatus handling a moving band of continuous material passing over a plurality of bars, the improvement comprising:

- a. a frame pivotally mounted in said apparatus;
- b. a plurality of bars extending from said frame to pivot therewith, said bars comprising at least one bar having a convex curve with respect to a face of said moving band, at least one bar having a concave curve with respect to a face of said moving band and at least one substantially straight bar disposed between said convex and concave bars in the path of travel of said band;
- c. means engaging said frame for pivoting said frame and bringing the curved portion of at least one of said curved bars into contact with said band; and
- d. sensor means for monitoring the width of said band and controlling said last mentioned means.

2. The invention of claim 1 wherein said sensor means comprises at least one member engaging and overlying the edge of said band and being movably mounted in said apparatus; means for holding said member against said edge so that said member follows the movements thereof, and means engaging said member and responsive to the movements thereof for controlling said means for pivoting said frame.

3. The invention of claim 1 wherein at least one curved bar and said substantially straight bar are maintained in continuous contact with said band, and said means engaging said frame is responsive to said sensor means for bringing the curved portion of said other curved bar into contact with said band.

4. The invention of claim 3 wherein said concave bar is maintained in continuous contact with said band.

5. The invention of claim 1 wherein said convex and concave bars are on opposite sides of the pivot point of the frame.

6. The invention of claim 1 wherein the ends of at least some of said bars remote from said frame are fixedly connected to one another.