ABSTRACT: A control means for directing the traverse of a moving band of continuous material which passes over a plurality of tensioning bars and is subject to deviations in its transverse position due, in part, to its inherent properties in such an environment, comprises a bar contacting the face of the band of material and capable of being tilted with respect to the dominant moving plane of said face by means disposed of the end of said bar, and most preferably by means connected to said bar spaced from the axis thereof, to pivot said bar. The bar is moved by an amplifier-controller servosystem which is constantly error sensitive.
BACKGROUND OF THE INVENTION

This invention relates to servomechanisms, and more particularly, to a servomechanism for use in laterally positioning 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 moving band. In order to process this band properly, it is often necessary to maintain the band in a particular lateral position, for instance, where it is desired to maintain one edge of the band along a certain line or where it is desired to maintain the center of the band as near as possible to a desired central position, as it is fed into a machine such as a stapler.

SUMMARY OF THE INVENTION

Our invention provides an apparatus for adjusting the lateral position of a moving band of continuous material, such as filamentary tow. It comprises a means for impressing a controlled tension gradient across said moving band material, most preferably in combination with a means for shifting the entire band laterally. These means include at least one pivotally mounted bar, preferably pivoted at a point within the range of contact of the band with the bar, and spaced from the bar. The bar is constantly in contact with the moving face of the band of material and is most preferably a straight cylindrical bar. In response to appropriate input signals obtained from sensing means downstream of the bar, the bar is pivoted and thereby applies a greater or lesser tension across the moving band. The bar, therefore, tends to traverse laterally on the bar as it continues to move longitudinally. In alternate embodiments the inclination of the bar can be adjusted by means disposed at one or both ends of the bar.

In the preferred embodiment of the invention the bar is pivoted about a point spaced from the bar, so that the entire band is displaced laterally instantaneously, thereby providing a step function in the servosystem.

A sensing means continuously measures the degree of error in the position of the band from a desired position, and the bar is pivoted in response thereto, so that the position of the band is constantly monitored and adjusted as needed.

Accordingly, it is an object of our invention to provide a servomechanism for controlling the lateral position of a moving band of continuous material.

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

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a portion of the apparatus shown in FIG. 7 with the parts disposed in an alternate position.

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 the apparatus generally designated 10 which is a part of a larger machine (not shown in detail), such as the stapler for processing a continuous band of textile material. In the case of a 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 a 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 a slight tension caused by the weight of the tow band 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. Our invention is concerned with the particular problem of controlling the wandering, traversing, or 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 guide bars 14, 16, 18, 20 and 22 about which a band of tow 26 is drawn in a tortuous path in the direction indicated by the arrows. The effect of this arrangement is to tension the band and guide it.

To control the position of the band 26 we have provided the servomechanism represented schematically by the system shown in FIG. 5. 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, electromechanical, or 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 measured and if there is an error sensed something is done about it. As previously stated, the error which we are concerned with in this application is deviation in the lateral position of the band. Thus either the right or left edge of the band may have to be positioned within certain desired limits in order for the band to be properly accepted into the machine for further processing, or perhaps it would be desirable to center the band within a given range. In most instances it is necessary to adjust the position of the band within desired limits at a given point. Accordingly, to control the position of the band we provide a sensor 42, FIG. 1, 2, 3, 5, and 6 upstream of this point. Through the servosystem the sensor controls the movements of the controller 50 further upstream.

Referring to FIGS. 1 through 6, we shall describe the details of the controller and its function with respect to controlling the position of the band 26. The controller 50 comprises a bar 52 which is preferably a straight cylindrical piece of polished steel connected at one end to a bracket 53 which is pivotally connected as at 54 to a movable piston rod 55.

In the most preferred embodiment of our invention shown in these figures, the bar 52 is supported to pivot about a point removed from the axis thereof. The support means includes a yoke comprising the support members 60 and 61, FIG. 4 which are welded or otherwise suitably affixed to the rod 52 and which embrace the support frame 63 which is fixedly attached to the frame 12 by any suitable means (not shown). The yoke is retained for pivotal movement with respect to the
support frame 63 by means of the pin 65 which passes through both of the members 60 and 61 and the frame 63 and is peened over at both ends in the matter of a rivet.

The bar 52 is normally in contact with the entire face of the moving band 26. By tilting the bar, that is by changing the angle of inclination of the bar with respect to the surface of the moving band (as shown by the phantom positions A and B in FIG. 3) it is possible to vary the tension in the moving band. This variation can be expressed as a tension gradient across the band. This tension gradient causes the band to travel from a region of high tension to a region of lower tension as it continues to run in a longitudinal direction over the bar 52. If the bar was simply supported at one or the other or even both ends, so as to pivot about one end the sole function of the pivoting of the bar would be to cause a migration of the band to a transverse to its longitudinal direction of travel. However, by pivoting the bar at a point intermediate the ends thereof at a distance removed from the axis thereof, the entire band is shifted transversely immediately upon pivotal movement of the bar. Thus there is provided an instantaneous change in position or what is known as a step function in the migratory rate. This instantaneous reaction greatly improves the ability of the device to respond to deviations from the norm and quickly make suitable corrections.

To measure the deviations from the norm we have provided a sensing mechanism along one tensioned edge of the band and in close proximity to the control means. The sensor 42, shown in greater detail in FIG. 6, is a bar mounted for pivotal movement about a pin or shaft 46 and spring biased by the spring 48 to engage the edge 27 of the band 26. The shaft 46 is affixed to the frame 48 which is mounted in any suitable fashion in the apparatus as by welding to the frame 12. The sensor 42 is so positioned that the lead end 43 lies against the edge 27 of the band 26. The sensor is preferably on the order of one-half inch wide and curved outwardly away from the band as so not to snag on the edge 27 of the band. Spring biasing by the spring 48 is sufficient to keep the sensor in contact with the edge 27 as the band traverse laterally, as illustrated by the phantom position in FIG. 6.

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. The sensor 42 FIG. 6 is in a position wherein the band is pivot and for this purpose a bearing block 13 is provided, fixedly attached to the frame by any suitable means (as shown), in which there is journaled a swivel-type bearing 15 which is connected to extension 17 of the frame of cylinder 80. The bearing is retained on the extension 17 by means of the spacer element 19 and the nut 21 threaded thereon.

Within the cylinder there is a piston 82 having a piston rod 55 extending through a suitable seal at the end of the cylinder and through the members 15, 17, 19 and 21. When the piston 82 is moved axially within the cylinder 80 the piston rod 55 causes pivotal movement of the bar 52 and also pivots the cylinder within the bearing 15.

In the normal position the pressure is equal in the lines 74 and 75 and the pressure on each side of the piston 82 in the cylinder 80 is equal. Consequently the bar 52 is maintained in a fixed position.

When the band 26 has wandered to a position beyond acceptable limits as shown in the full view in FIG. 6, the end 43 of the sensor 42 follows the edge 27 of the band and the sensor 42 is rotated counterclockwise. As it is rotated, it first takes up the gap between the edge 41 and the plunger 70, and then 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 ahead of the piston 82 in the cylinder 80 is greater than that behind the piston in the line 75. Thus the piston will be forced to the right when viewed as in FIG. 5 and the rod 55 will move to the right when viewed as in FIG. 3, causing the bar 52 to pivot in a clockwise direction (when viewed from above) about the axis of the pin 65. The bar 52 would then assume a position similar to that shown in phantom designated A in FIG. 3.

Thus the tension gradient across the band will be changed and the tension will decrease from a state of relatively higher tension at the free end, to a region of relatively lower tension at the end of the bar nearest the piston rod 55, thereby causing the band to migrate toward the latter end with time. Further the rate of migration is not the only factor which causes the band to be shifted transversely. As previously stated, the step function provided by the pivot mechanism causes an instant response in that the band is constantly shifted as a whole transversely to the direction in which it is being driven.

As the band shifts, the edge 27 forces the sensor 42 to rotate clockwise toward its normal position. When it is once again in its normal position both vent holes 76 and 77 are open and the pressure on both sides of the piston 82 is the same. The piston will then remain in this position until a further error is sensed.

If the band should move to the position shown in phantom in FIG. 6 causing the valve plunger 72 to close the vent hole 77 and increase the pressure in the line 75, then the piston would be forced to the left and the bar 52 would be rotated counterclockwise when viewed as in FIG. 3. This would have the effect of changing the tension gradient across the face of the band and also shifting the band in its entirety to the left when viewed as in FIG. 3 and the control bar 52 assumes the phantom position designated B in FIG. 3). As the band once again returns to its normal position, the vent holes are opened and the pressure on both sides of the piston is equalized, so that the piston remains in position until a further error is sensed.

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 through which the band could move would be very narrow, since response to pivotal movement of the sensor would be almost instantaneous. However, when a gap of the sensor assuming the position shown in phantom FIG. 6 and the control bar 52 assumes the phantom position designated B in FIG. 3), a permissible deviation range is provided whereby the position of the band 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. 7 shows an alternate embodiment of our invention in which the control bar is supported at both ends and can be pivoted by either or both support means in response to signals generated by a plurality of sensing elements in the control.
system. In this embodiment a modified control bar 102 is provided which is relieved at both ends, as at 104, 106 to accommodate fixedly attached blocks 105, 107 respectively. The blocks serve as a base means for pivotally attaching (in any suitable manner, as by pins) the piston rods 110, 112 to the ends of the control bar 102. Each rod is actuated by an cylinder 114, 116 respectively which are mounted in bearings similar to the bearings 15 in the previous embodiment, said bearings being retained in the frame member 118 which is fixedly attached to the frame 12 as by welding. The cylinders depicted are single acting, that is the position of the piston and piston rod in the cylinder is determined by the pressure exerted against the bar 102 on the one hand and the back pressure behind the piston in the cylinder (which is supplied by a pneumatic source through the lines 120, 122), on the other hand.

A pair of feelers or sensors 210 and 212 are mounted on and insulated from a rod 214 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 216 over which the band is being drawn, if a band is not disposed between them and the bar. The bar 216 and feelers 210 and 212 are connected by means of an electrical circuit (not shown) in which each feeler can coast with the bar 216 as a switch. The electrical circuit controls the air pressure in the lines 120, 122 to the air cylinders 114, 116 by any suitable means, such as a three-way solenoid actuated valve (not shown) and thus controls the positioning of the piston rods 110, 112.

The system shown is a make or break system in that the control bar 102 responds to an on-sensing means in the form of the electrical switches previously discussed. Thus the impulse signals to the pistons are either on or off and the rods are either fully raised or fully lowered. Where, as here, a plurality of feelers are used, both edges of the band are sensed. The band normally runs in the space between the two sensors, and the sensors normally contact the bar 216 to close their circuits. If the band runs wide or shifts to one side or the other between a sensor and the bar 216, a circuit would be opened and an appropriate air input signal would be sent to one cylinder or the other in order to change the angle of inclination of the bar 102 with respect to the face of the band 26.

This will change the migration of the band as it continuously moves over the bar 102. Where the pistons are independently controlled, both sides may be raised or both sides may be lowered or one side or the other may be raised while the opposite side is lowered. In comparing FIG. 7 with FIG. 8, note that when the right end of the bar 102 is raised and the left end is lowered the band tends to shift to the left (as shown by the arrow FIG. 7), while when the left end is raised and the right end is lowered as in FIG. 8, the band tends to shift to the right. This embodiment represents a rate device wherein the migration of the band is controlled solely by the tension gradient. There is no provision for shifting the band as by way of the step function described in the previous embodiment.

It will be understood that various changes in the details, materials, arrangements and 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 claims. In particular the type of sensors whether electrical, mechanical or otherwise can be varied. The position and number of the sensors can be varied as where a single sensor is used on the left side or the right side or a plurality of sensors are used on both sides. The mode of operation of the piston and cylinder arrangements can also be varied as were double acting cylinders are used in the embodiment shown in FIGS. 7 and 8 in accordance with the operation discussed with respect to the first six figures. Additional sets of contacts or sensors may be used in order to perform additional functions, such as turning off the machine in case the band becomes too wide.

What we claim is:

1. In an apparatus for handling a moving band of continuous material which passes over a plurality of bars, the improvement comprising: means mounted in said apparatus for impressing a tension gradient across said band and for shifting said band laterally, said means comprising a bar pivotally mounted in said apparatus continuously contacting a face of said band and being tiltable with respect to the plane of travel of said band, said pivotal mounting being disposed between the limits of travel of the edges of said band and being spaced remotely from the axis of said bar so that said bar pivots about a point remote from its axis and between the limits of travel of the edges of the band toward and away from the plane of travel of said band thereby shifting said band and its plane of travel, said bar being pivoted in response to a servomechanism connected to said bar to tilt it about said pivot in response to deviations sensed in the lateral position of said band within a predetermined range.

2. The invention of claim 1 wherein said servomechanism comprises at least one sensor contacting the edge of said band downstream in the path of travel of said band from said tiltable bar, said sensor being mounted to follow the lateral movement of the edge of said band, and means engaging said sensor responsive to the movements thereof for supplying signal inputs through a servomechanism to control the movements of said tiltable bar.

3. The invention of claim 2 wherein said servomechanism comprises a pneumatic system including a source of continuous pressure connected to a plurality of conduits connected to a valve means for engaging said sensor and supplying signal inputs to a pneumatic double acting cylinder having a piston mounted therein pivotally connected to one end of said tiltable bar to tilt it about said pivotal mounting, said cylinder being pivotally mounted in said apparatus.