Oct. 30, 1962 P. W. JACOBSEN 3,061,159

AIR ACTUATED SELF-ENERGIZING TENSIONING SYSTEM

Filed Sept. 15, 1958 3 Sheets-Sheet 1

Fig. 1.

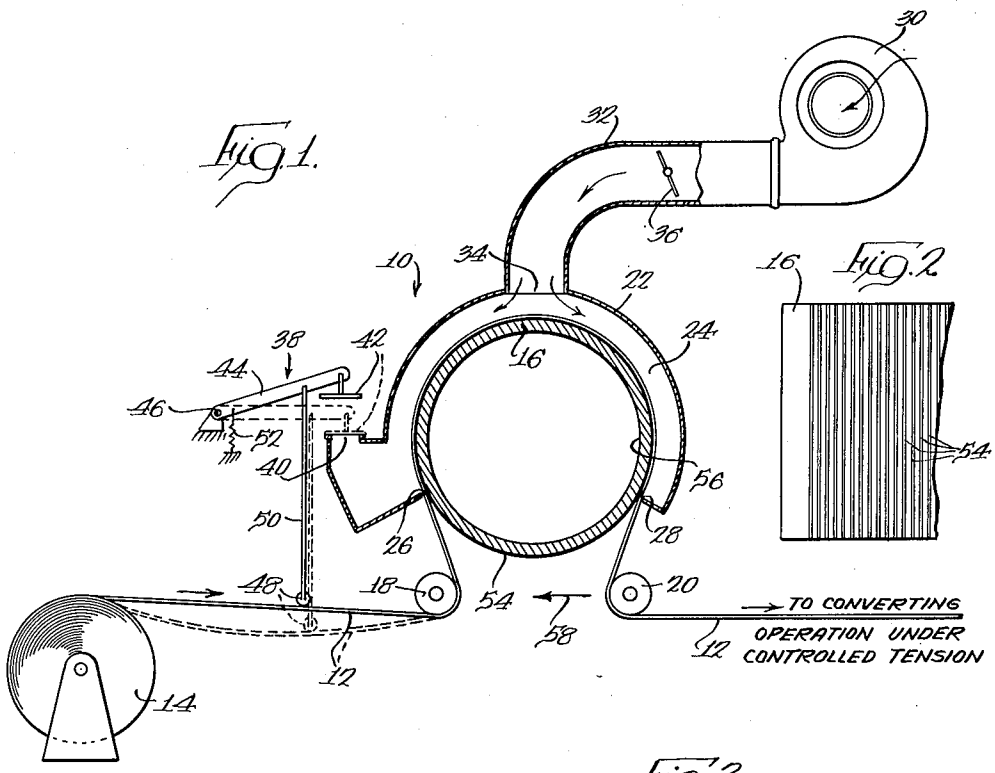
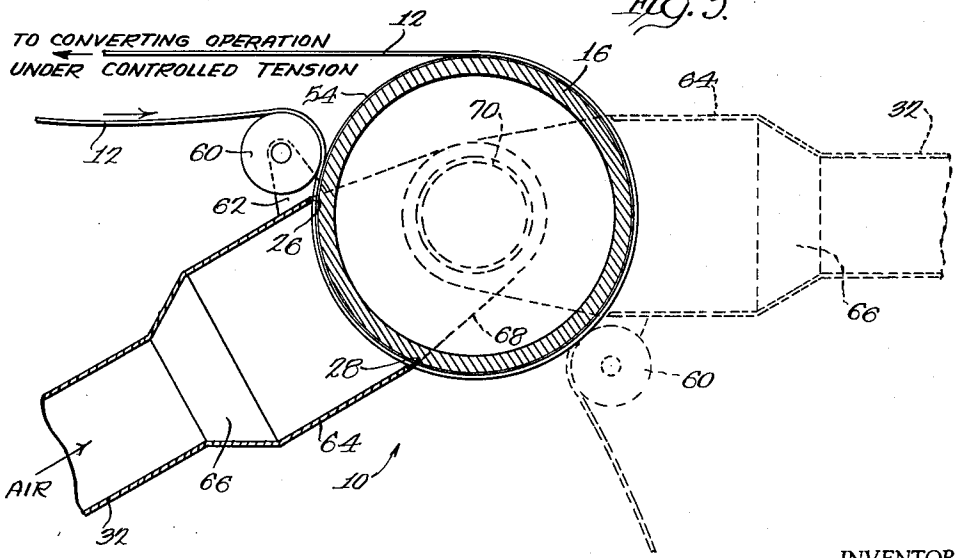


Fig. 2.

Fig. 3.



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Fig. 4.

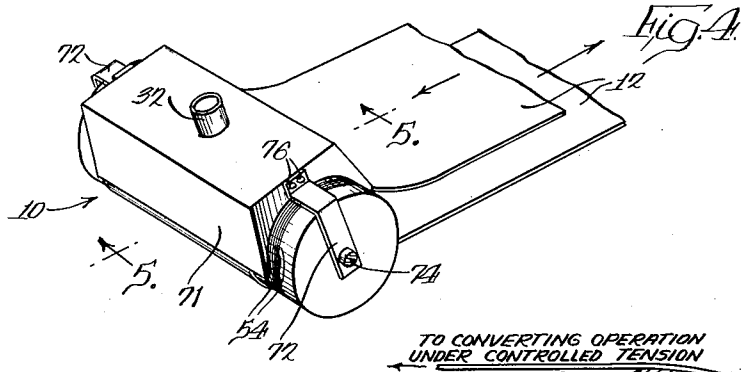


Fig. 5.

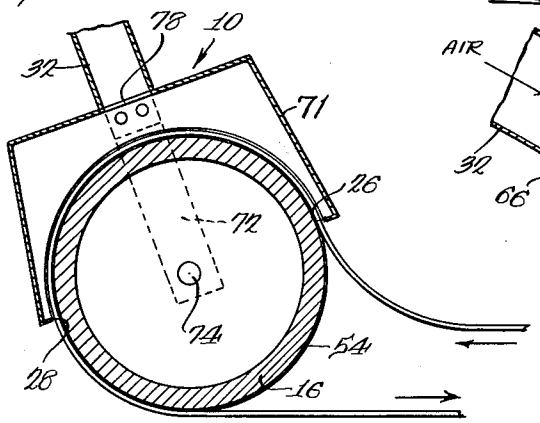


Fig. 6.

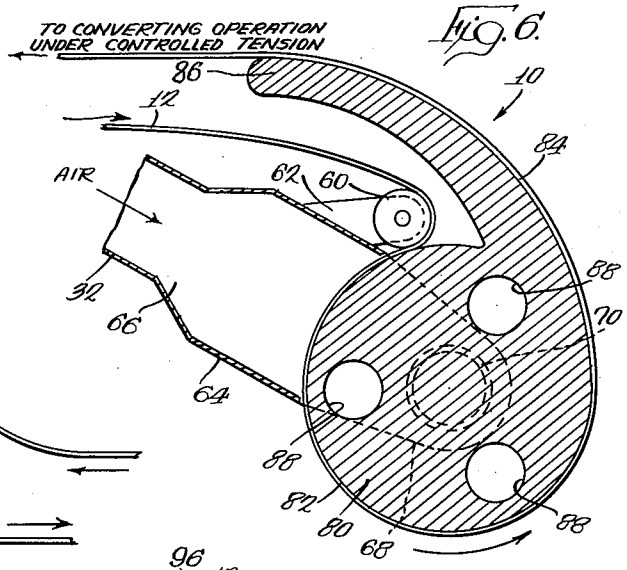
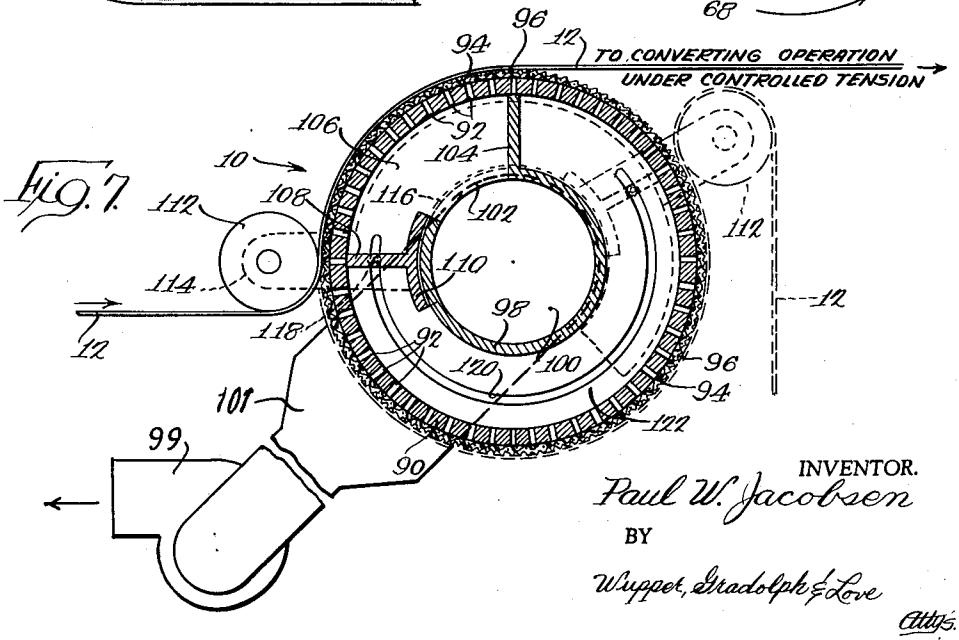


Fig. 7.



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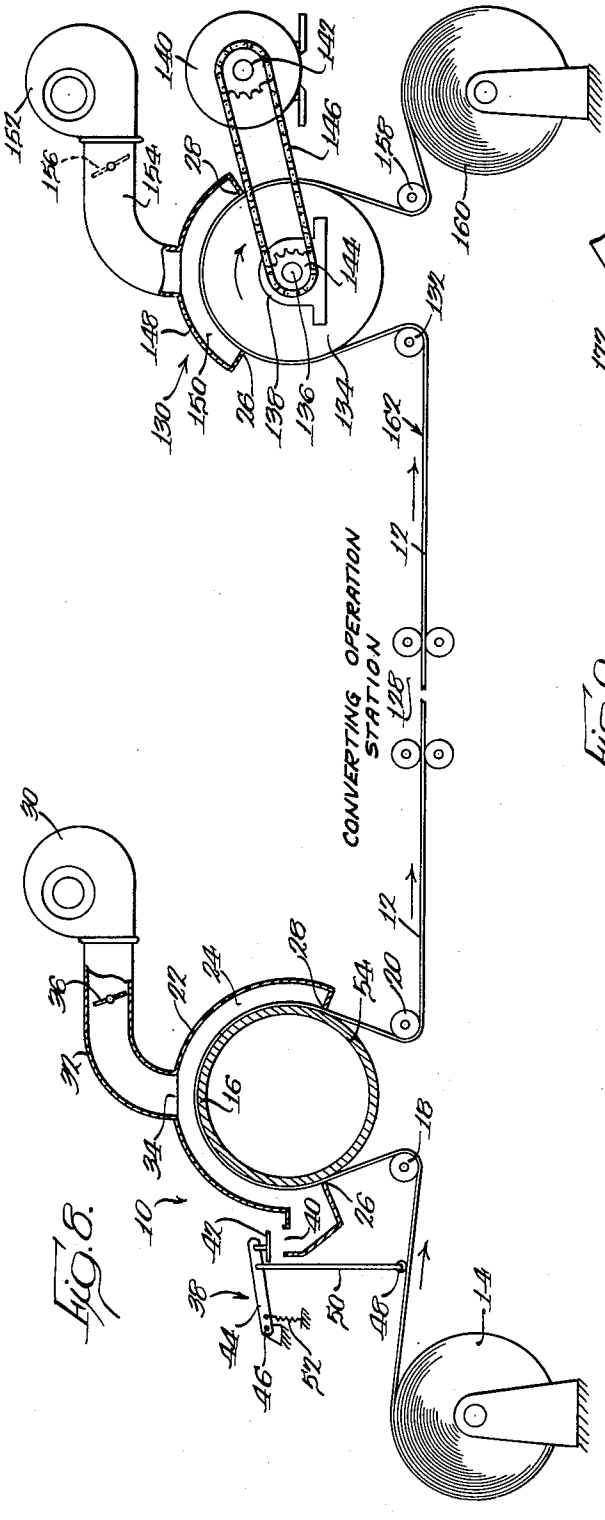


Fig. 6.

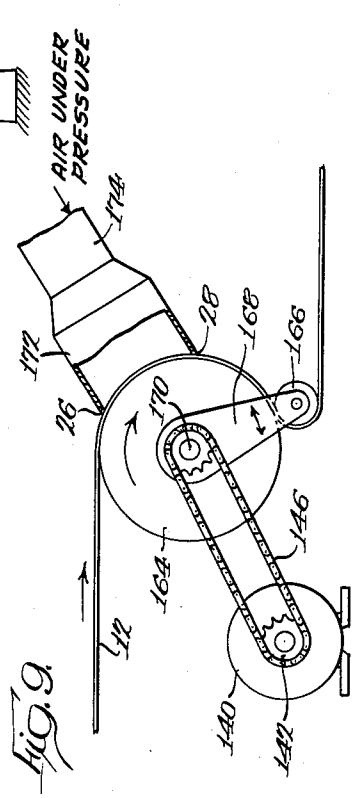


Fig. 9.

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3,061,159

AIR ACTUATED SELF-ENERGIZING TENSIONING SYSTEM

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Filed Sept. 15, 1958, Ser. No. 760,952
12 Claims. (Cl. 226—39)

The present invention relates to a novel system and apparatus for regulating the tension on a moving web of sheet material such as paper, plastic, and the like, which is being converted or processed by printing, dyeing, cutting, forming, and the like. More particularly, the present invention relates to such system and apparatus which is air actuated and self-energizing to give a nicety of tension control that was not heretofore possible, and it relates to the regulation of the back tension and the pull tension.

It is known that the web tension can be regulated by zigzagging the web across a plurality of spaced and parallel bars in such fashion that first one face of the web and then the other is pulled over the surfaces of the bars. Since both faces of the sheet or web contact the bars, this arrangement is impractical to use where one face of the web is wet and thus could be smeared. A second disadvantage of this system is that for back tension control it is almost impossible to use a festooned feed to the first bar in the series. Third, close regulation of the tension in the web as it leaves the last bar in the series is very difficult to obtain.

Mechanical brakes on the web do not permit of a fine adjustment in the tension and the result may be too little or too much tension. Tension regulation by dancing rolls alone is too uneven except under conditions where the tension need only be approximately some predetermined amount.

The use of an air blast or stream frictionally to hold the web against a flat surface has been proposed as an improvement over the arrangements previously mentioned. With such system the only regulation is by varying the pressure of the air blast, and there are therefore practical limits on the variations obtainable.

The system and apparatus of the present invention overcome all of the known disadvantages of the prior art and combine their best aspects in an entirely new arrangement and approach to the problems controlling tension in a moving web.

It is, therefore, a principal object of the present invention to provide a new and improved system and apparatus for controlling tension in a moving web of material which provides for a very fine control over the tension to an extent heretofore not possible.

Another object is to provide a new and improved web tension control system and apparatus which is air actuated and wherein the tension creating friction means is at least partially self-energizing.

Another object is to provide a new and improved web tension control system and apparatus in which the web is held against a curved surface which may be cylindrical, ellipsoidal, or a combination of the two.

Another object is to provide a new and improved web tension control system and apparatus in which the web is held by an adjustable differential air pressure against a cylindrical surface, an ellipsoidal surface, or a combination cylindrical-ellipsoidal surface.

Another object is to provide a new and improved web tension control system and apparatus wherein adjustable means are provided to direct the web into contact with a variable area of a cylindrical surface, an ellipsoidal surface, or a combination cylindrical-ellipsoidal surface.

Another object is to provide a new and improved web tension control system and apparatus having the foregoing described advantages, wherein superatmospheric air pressure is used at least initially to hold the web against the surface over which it passes.

Another object is to provide a new and improved web tension control system and apparatus having the foregoing described advantages, wherein suction means are utilized at least initially to hold the web against the surface over which it passes.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, wherein

FIG. 1 is a schematic view, partially in section, of a first form of the web tensioning apparatus of this invention for the control of back tension;

FIG. 2 is a fragmentary elevational view of the drum or cylinder over which the web is drawn;

FIG. 3 is a schematic sectional view of a modified form of the tensioning apparatus;

FIG. 4 is a perspective view of another modification of the tensioning apparatus;

FIG. 5 is a sectional view, taken along the line 5—5 of FIG. 3, looking in the direction of the arrows;

FIG. 6 is a view similar to FIG. 3, illustrating a combination cylindrical-ellipsoidal surface over which the web is drawn;

FIG. 7 is a schematic sectional view of still another modification of the tensioning apparatus;

FIG. 8 is a schematic view showing a pull tension regulating device used in some equipment as a back tension device; and

FIG. 9 is a schematic view showing one form of pull tension regulating device.

It has been found, in connection with the present invention, that the effective tension creating drag on a traveling web of sheet material can be augmented if the web is caused to move over or passes around a direction changing surface, such as a cylindrical, ellipsoidal, or combination cylindrical-ellipsoidal surface. Air under pressure, or a vacuum, is used at least initially to cause the web to hug the surface and the curvature of the surface makes it certain that the web travels across or around a predetermined surface area. By adjusting the position at which the web initially contacts the surface, which of course determines the curved area traversed, it is possible to regulate the tension applied to the web. However, it has been found that the amount of tension does not increase or decrease in direct arithmetic ratio to the surface area traversed, but in a more nearly geometric ratio. An increase or decrease in the initial pressure with which the web is caused to hug the surface appears to have a direct effect on the final tension.

In the following description and accompanying drawings, there are disclosed several typical systems and apparatus which utilize the foregoing phenomena.

Referring to the drawings, and more particularly to FIG. 1, the reference character **10** designates the tensioning device of the present invention as applied to a moving web of sheet material **12** which may be drawn from a source roll **14**, and, in this arrangement, regulates the back tension on the web. It should be understood that the tensioning system may be placed in any intermediate position in the processing apparatus through which the web is moving. Such processing apparatus may include printing presses, dyeing lines, spreaders, forming equipment, and the like. The sheet material might be completely impervious to the passage of a gaseous medium such as air, and in this respect it could be a plastic material such as sold under the trademark "Pliofilm," or it might be paper such as kraft paper, or it might be a woven fabric material.

In the equipment shown in FIGS. 1 and 2, the web **12** is drawn over a stationary cylindrical drum **16** having a

smooth or polished surface. Direction reversing idler rolls 18 and 20 guide the travel of the web onto and from the drum 16.

The drum 16, to the width of the web 12, is partially enclosed by a hood 22 providing an air pressure chamber 24 embracing the drum 16 to the extent of the travel of the web 12 across the surface thereof. The hood 22 is slightly spaced from the drum surface at 26 and 28 to permit the ingress and egress of the web 12 into the chamber 24. The openings 26 and 28 usually will be slightly greater than the thickness of the web, so that it does not contact the edge of the hood 22 thereby preventing scraping of the web against the hood edge, which might possibly mar the surface of the web.

Air under pressure is supplied to the chamber 24 within the hood 22 from a conventional blower 30 which has its outlet connected to a duct 32 which in turn is connected to the inlet 34 to the chamber. A manually operated damper 36 is positioned in the duct 32 and is adjustable to control the air flow into the chamber 24, and consequently the air pressure in the chamber 24. Air pressure is, of course, additionally adjustable by regulating the output characteristics of the blower 30.

Automatic adjustment for the pressure in the chamber 24 is obtained by means 38 sensitive to the tension in the web 12 prior to its passage over or upstream of the reversing roll 18 and into the chamber 24 about the stationary drum 16. The means 38 comprises an outlet 40 from the chamber 24 controlled by a valve member 42 mounted on the end of an operating arm 44, the opposite end of which is pivotally mounted at 46. The position of the valve member 42 is controlled by a tension sensitive roller 48 which rides lightly on the surface of the web 12 between the source roll 14 and the direction reversing roll 18. The roll 48 is connected to the arm 44 intermediate its ends by a link 50. Since the tension of the web 12 as it leaves the drum 16 is a function not only of the tension which has been created by the passage of the web over the drum 16, but also of the initial tension, the latter should be measured so that the tension which is added by passage over the drum 16 will produce a final tension downstream of the reversing roll 20 to the extent desired. When the tension of the web 12 upstream of the drum 16 is great, or nearly approaches that of the desired tension, the action of the sensing roll 48 and the linkage connected to the valve member 42 will operate to open the valve 42 against the effort of the spring 52, thereby bleeding a substantial portion of the pressure from the chamber 24. Thus, the air pressure causing the web to hug the cylinder 16 will be materially reduced and the additive effect of the tension creating mechanism 10 will be appreciably lessened to bring the final tension in the web 12 to the predetermined value.

It is clear that the mechanical arrangement for sensing the tension in the web 12 prior to its travel over the drum 16 can be replaced by other devices, such as a finger lightly riding on the web 12, which would operate electrical or electromagnetic means to control the valve 42. While there has been shown in the drawing a poppet type valve, it is also clear that this valve member may be replaced by one which has variable air flow control characteristics to it, which would change in accordance with the amount of valve opening.

It has been found that when the web 12 is a pervious, or a slightly pervious, material the air under pressure passes therethrough to provide a cushion of air between the drum 16 and the web 12, thereby destroying the frictional characteristics of the drum. To permit the air passing through the web to escape, it is preferred that the surface of the drum be provided with a plurality of circumferential grooves 54, as seen in FIG. 2. These grooves permit the web to hug closely and frictionally engage the smooth major circumferential surface of the drum 16 which is presented by the lands between the grooves 54.

In FIG. 1 the drum 16 is diagrammatically shown as being a hollow cylinder. This permits the introduction of a cooling medium into its interior 56 to dissipate any heat of friction which might be generated. It is possible that the generated heat will be so little that no cooling medium would be necessary, and it might even be possible to substitute a solid bar for the hollow cylinder. The particular factors underlying each installation dictate the particular structure which is to be used.

The hood 22 of the apparatus shown in FIG. 1 has its position fixed with respect to the drum 16. The web is shown as traveling about a substantial portion of the drum surface, about 225°. This may be increased by moving the outlet direction roller 20 in the direction indicated by the arrow 58, thereby increasing the area of the cylindrical surface traversed by the web 12, increasing the total friction between the web and the drum, and increasing the amount of tension created in the web with respect to any given air pressure existing in the chamber 24.

Somewhat more versatile equipment is shown diagrammatically in FIG. 3, wherein the same reference characters have been used to indicate the same or similar elements.

The web of sheetlike material 12 is drawn over a direction reversing nip roller 60 mounted on ears 62 carried at the opposite edges of a relatively short hood 64, that is, short from the standpoint of encompassing any great arcuate, as distinguished from longitudinal, area of the cylinder 16. The hood 64 is closely spaced at 26 and 28 from the surface of the cylinder 16, and has an inlet 66 connected to the pressurized air duct 32. The hood 64 is provided with a pair of supporting arms 68 at its opposite sides, which are pivotally mounted on trunnions 70 so that the position of the hood 64, and therefore of the nip roller 60, can be adjusted with respect to the cylinder or drum 16. The cylinder or drum 16 should, of course, be provided with grooves 54 for the purpose of permitting the escape of air passing through pervious or semipervious materials 12.

The hood 64 is shown in the position which permits maximum traverse of the web 12 over the cylindrical surface of the drum 16. The dotted or phantom line position indicates a hood position for a minimum traverse of the web over the drum, the difference being between 290° traverse as a maximum, and 145° traverse as a minimum. This hood adjustment allows a very considerable variation in the tension of the web 12 between the time it enters the controlling mechanism 10 and the time it leaves to be processed or converted in accordance with the dictates of the equipment with which the tension controlling mechanism is used.

In FIGS. 4 and 5 there is shown an apparatus which is similar to that shown in FIG. 3, except that it does not use the direction reversing entry nip roller 60. In this equipment a hood 71 is provided which embraces approximately one-half of the cylindrical surface of the drum 16. The hood 71 is mounted for adjustment on the drum 16 by a pair of stirrups or arms 72 which are pivoted on trunnions 74, the arms 72 being riveted or welded at 76 to the body of the hood. The conduit 32 from the air blower 30 has its outlet connected to the inlet 78 of the hood. The traveling web 12 is prevented from scraping against or contacting the hood 71 at its inlet edge by virtue of the air which escapes through the slit opening 26 thereat. If desired, this opening 26 can be slightly enlarged so as to make certain that there is a substantial air flow therethrough, or it can be shaped so as to give a defined air stream passing over the surface of the web 12 as it approaches the hood 71. In other respects the equipment operates in the same fashion as that shown in other forms of the invention.

It should be noted that with respect to the apparatus shown in FIG. 3 and that shown in FIGS. 4 and 5, the air blower 30 would probably be mounted in a fixed or stationary position and the communicating air duct 32 would

have a flexible section intermediate the outlet from the blower **30** and the inlet to the respective hoods **64** and **71**.

Still another form of the invention is shown in FIG. 6, which is similar in every respect to that shown in FIG. 2, except for the shape of the curved surface over which the web **12** is drawn.

In this modification the curved surface is defined on a member **80** having a first curved surface **82** formed as a substantial portion of a cylinder, and an extending ellipsoidal surface **84** which blends into the curved surface toward one end of the ellipse used in developing the ellipsoidal surface. The member **80**, therefore, has a projection tongue portion **86** from which the tensioned web **12** is withdrawn. The direction of the web is completely changed so that it leaves the tension controlling device **10** in the opposite direction from which it enters in a first position of the hood **64**. However, the hood is capable of being adjusted as indicated by the arrow surrounding a substantial portion of the figure at the lower left.

Longitudinal openings **88** are provided for the circulation of a cooling medium, such as air or water, should the member **80** become heated due to the friction between the web **12** and the member **80**.

It should be noted in FIGS. 3 to 6 that the web **12** upstream of the tension creating apparatus **10** is slack or without tension other than that created by its own weight. These figures illustrate how a festooned feed of the web is readily accommodated by this apparatus. It is obvious that a feed with some initial tension will act as shown in FIG. 1, and air pressure regulating means can also be used in these other modifications.

FIG. 7 shows an arrangement of the apparatus **10** wherein the pressure differential created is by means of suction applied to the undersurface of the web, rather than air pressure applied to the top surface. In this mechanism there is provided a stationary hollow drum **90** having its cylindrical wall formed with a multitude of slots or similar openings **92** through which air may be drawn to the interior of the drum. The drum **90** is wrapped with or enclosed in a coarse distribution screen **94** over which is wrapped a fine, close, mesh abrasion resistant screen, or closely perforated abrasive resistant sheet **96** on which the web **12** travels, and from which it obtains its friction for the controlled tensioning.

Within the drum **90** is a second hollow cylinder or drum **98** which is fixed thereto and has one of its ends closed and the other end open as at **100**, and connected to a source of suction, such as the blower **99** by a conduit **101**. The drum **98** has a longitudinal opening **102** therein, which extends substantially the length of the drum **98** so as to communicate the interior of the drum **98** with the interior of the perforated drum **90**. A radial baffle **104** at one edge of the opening **102** seals the drum **98** against the interior of the drum **90** to define an adjustably arcuate space **106** which is subject to the suction created at the opening **100**. The extent of the arcuate space may be adjusted by a slide plate **108** which extends radially in the space **106** and which has a foot portion **110** slidable on the outer surface of the drum **98**.

The position of the slide plate **108** is adjusted in accordance with the position of an entry nip roller **112** over which the web **12** is trained as it initially contacts the outer surface of the fine screen **96**. The roller **112** is journaled in a pair of arms **114** which in turn are journaled on trunnions **116** at the opposite ends of the drum **90**. The slide plate **108** has its ends secured to the arms **114** by the pins **118** which extend through an arcuate slot **120** in the end walls **122** of the drum **90**. Thus, as the position of the entry nip roller **112** is changed to increase or decrease the cylindrical area contacted by the web **12**, the position of the slide plate **108** is accordingly adjusted in order to subject the proper number of holes **92** in the drum **90** to the action of suction to hold the web **12** in frictional engagement with the screen **96**.

In the foregoing portion of this specification the tension created may be called "back tension" as it is created by holding back on the web or retarding its movement. It is created by moving the web over a stationary curved surface against which it is held at least at the initial point of contact by a pneumatic pressure different between the outer surface of the web and that in contact with the curved surface and with the higher pressure being applied to the outer surface.

This same phenomenon may be utilized for the creation of a "pull tension" of carefully regulated or controlled value. Such a tension is that which exists in a web being pulled through a processing station against a retarding force, and the control is in the pulling device rather than in the retarding device.

It is, of course, feasible and, under some circumstance, highly desirable to incorporate both devices in one piece of equipment. Such equipment is schematically shown in FIG. 8 wherein the left portion of the apparatus is similar to that shown in FIG. 1 and the right portion illustrates a pull tension device.

The back tension apparatus or device **10**, being like that of FIG. 1, will not be redescribed. After passing through the converting or processing operation (printing, dyeing, slitting, etc.) at the station, the web **12** enters pull tension apparatus or device **130** around a direction reversing and guiding roller **132**. The web is directed into contact with a rotating drum **134** which has an axle **136** journaled in bearings **138**. The drum is driven by a suitable motor **140** through a pair of gears or sprockets **142** and **144** and a chain **146**; of course these elements may be replaced by pulleys and a belt, or the motor may be connected to the axle more directly or through a gear box. Such drives are obvious substitutions for the one illustrated.

The web **12** is caused to hug the surface of the drum by air under pressure in hood **148** which defines an air chamber **150** enclosing an appreciable portion of the cylindrical surface of the drum **134**. Air under pressure may be supplied to the hood from any suitable source, such as the blower **152** having its outlet connected to the chamber by a conduit **154** in which there is a flow controlling valve **156**. The surface of the drum **134** may be grooved as described in connection with the drum **16** (FIG. 2) to facilitate use of the apparatus with pervious or semi-pervious materials.

At the outlet side of the drum **134** there may be another direction changing and guide roller **158** to guide the web to the next operation station or onto a take-up and storage roll **160**.

The pressure in the chamber **150** may be controlled by a valve arrangement similar to that previously described with reference to FIG. 1, the tension in the web being measured at about the point indicated at **162**, which would give an indication of the tension in the web and whether it should be increased or decreased.

The drum **134** is a driving drum and pulls the web **12** through at least a portion of the equipment. The pull on the web exerted by the drum is a function, not only of the rotational speed of the drum but also of the frictional forces developed between the web and the drum. The latter are determined by the area of contact of the web against the drum and by the air pressure exerted in the chamber **150**.

FIG. 9 shows a slight modification of the equipment shown in FIG. 8 and is similar to FIG. 3. In this arrangement, the area of contact between drum **164**, which may or may not be grooved, is determined by the position of exit roller **166** freely journaled on the outer ends of a pair of arms **168** which are adjustably mounted on axle **170** of the rotatable drum which is arranged to be driven by the motor **140**.

Air under pressure is directed against the outer surface of the web through a hood **172** which is held stationary, but may, if desired, have its position adjusted toward and

away from the drum to increase or decrease the air escape slots **26** and **28** or arcuately around the drum. The hood **172** is connected to a suitable source of air under pressure through conduit **174**.

If desired, the web may be held against the drum by suction, in which case apparatus similar to that shown in FIG. 7 would be used. The motive power would be connected to rotate the perforated drum or shell **90**.

It will be observed, therefore, that a pressure differential is always created between the drum and the web, whether it be subatmospheric or superatmospheric, to provide the initial force holding the web to the drum in the action of frictionally creating the back tension or the pull tension on the web.

It will be observed from the foregoing description that the objectives claimed for this invention at the outset of this specification are fully attained by this apparatus, and they will not be reviewed in detail.

While preferred embodiments of the air actuated, self-energizing tensioning system and apparatus constituting this invention have been shown and described, it will be apparent that further modifications and variations thereof may be made without departing from the underlying principles of the invention. It is therefore desired, by the following claims, to include within the scope of the invention all such variations and modifications by which substantially the results of this invention may be obtained through the use of the same or equivalent means.

What is new, and desired to be secured by United States Letters Patent, is:

1. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into substantial sliding frictional contact with a predetermined portion of the said surface to produce substantial tension in that portion of the web moving away from said surface, and means to direct a differential air pressure against at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface.

2. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex cylindrical surface over which the web is drawn, means guiding the web so as to direct the web into sliding frictional contact with said surface at a particular locus so that the web traverses a predetermined portion of said surface defining an angle not substantially less than 90° to produce substantial tension in that portion of the web moving away from said surface, and means to direct a differential air pressure against at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface.

3. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex cylindrical-ellipsoidal surface over which the web is drawn, means guiding the web so as to direct the web into sliding frictional contact with said surface at a particular locus so that the web traverses a predetermined portion of said cylindrical surface and substantially all of said ellipsoidal surface to produce substantial tension in that portion of the web moving away from said surface, and means to direct a differential air pressure against at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface.

4. A tensioning apparatus for a moving web of pervious sheet material comprising stationary means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, means to direct air under pressure against the upper side of at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface, and grooves in said surface extending in the direction of web movement to permit escape of air from the underside of the web.

5. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, hood means to conduct air under pressure against the upper side of at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface, adjustable means mounting said web guiding means and said hood means with respect to said surface so that the area of said surface traversed by said web may be varied, and a source of air under pressure connected to said hood means to supply pressurized air thereto.

6. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, hood means having an open mouth closely adjacent said surface and of a width at least equal to the width of the web to conduct air under pressure against the upper side of at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface, adjustable means mounting said web guiding means and said hood means so as to permit adjustment of their positions with respect to said surface and thus to permit variation in the area of said surface traversed by the web and control of the tension in that portion of the web moving away from said surface, and a source of air under pressure connected to said hood means to supply pressurized air thereto.

7. A tensioning apparatus for a moving web of sheet material comprising means forming a drum over a portion of the convex surface of which the web passes, means guiding the web so as to direct the web into sliding frictional contact with a predetermined portion of said drum surface defining an angle not substantially less than 90° to produce substantial tension in that portion of the web moving away from said surface, and means to direct a differential air pressure on the web so that at least a portion of the web contacted with said drum surface will have its outer face subjected to a higher pressure than its inner face thereby to increase the force with which the web is held against said drum surface, thus to increase the tension in that portion of the moving web adjacent said surface.

8. A tensioning apparatus for a moving web of sheet material comprising means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, means to direct a differential air pressure against at least a portion of the web contacted with said surface to increase the force with which the web is held against said surface and thus the tension of that portion of the web moving in the vicinity adjacent said surface, and means regulating the amount of differential air pressure in accordance with the tension in that portion of the web moving toward said surface.

9. A tensioning apparatus for a moving web of sheet material comprising stationary means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, hood means to

direct air under pressure against at least a portion of the web contacted with said surface to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface, and means bleeding a portion of the air under pressure from said hood means in accordance with the tension in that portion of the web moving toward said surface.

10. A tensioning apparatus for a moving web of sheet material comprising stationary hollow means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into contact with a predetermined portion of said surface, hood means enclosing at least a portion of said surface traversed by the web to direct air under pressure against the upper surface of the web to increase the pressure of the web against said surface and thus the tension of that portion of the web moving away from said surface, air bleed valve means in said hood means to release at least a portion of the air pressure therein, means for sensing the tension in the web moving toward said surface, and means connecting said tension sensing means with said valve means to bleed air pressure from said hood means in accordance with the tension in the web moving toward said surface.

11. A tensioning apparatus for a moving web of sheet material comprising stationary hollow means forming a convex curved surface over which the web is drawn, means guiding the web so as to direct the web into sliding frictional contact with a predetermined portion of said surface defining an angle not substantially less than 90° to produce substantial tension in that portion of the web moving away from said surface, a plurality of openings communicating said surface with the interior of said stationary hollow means over at least a portion of said surface traversed by the web, and suction means connected to said stationary hollow means to create a vacuum in said interior whereby the pressure of the web against said surface is increased and thus the tension of the web moving away from said surface is increased.

12. A tensioning apparatus for a moving web of sheet material comprising a stationary hollow cylinder forming a convex surface over which the web is drawn, adjustable means guiding the web so as to direct the web over a predetermined portion of said surface, a plurality of openings in the wall of said cylinder, a foraminous friction creating member enclosing said cylinder and against which the web is directed, a suction means connected to said cylinder to create a vacuum in the interior thereof, gate type valve means in said cylinder controlling the transmission of the vacuum to said openings, and means connecting said valve means and said guiding means together so that only those openings traversed by the web are subject to vacuum, whereby the pressure of the web against said foraminous member is increased and thus the tension of the web moving away from said cylinder is increased.

References Cited in the file of this patent

UNITED STATES PATENTS

545,674	Burns	Sept. 3, 1895
782,909	Jefferis	Feb. 21, 1905
1,629,154	Ybarrondo	May 17, 1927
1,957,148	Oehmichen	May 1, 1934
2,620,183	Kyle et al.	Dec. 2, 1952
2,778,634	Gams et al.	Jan. 22, 1957
2,796,223	Detweiler	June 18, 1957
2,955,732	Stobb	Oct. 11, 1960

FOREIGN PATENTS

330,788	France	July 8, 1903
84,308	Sweden	Sept. 11, 1935
770,969	Great Britain	Mar. 27, 1957