June 28, 1949. H. H. BELCHER 2,474,717

PROCESS AND APPARATUS FOR TENSIONLESS HANDLING OF RUNNING LENGTHS OF MATERIALS

Filed Feb. 10, 1948

Fig. 1

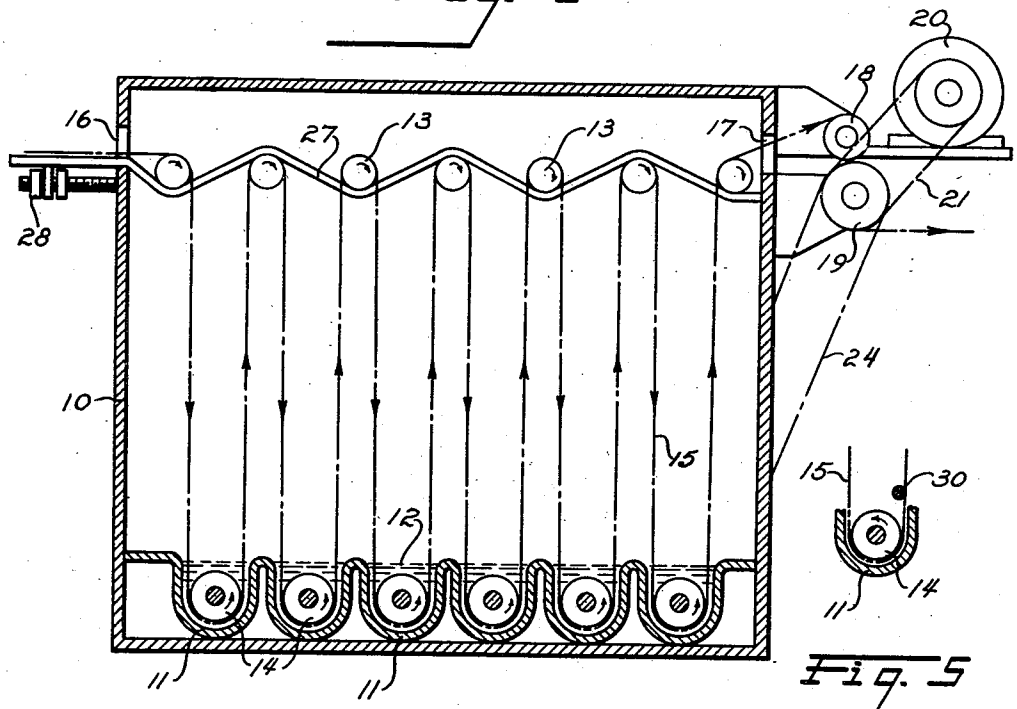


Fig. 5

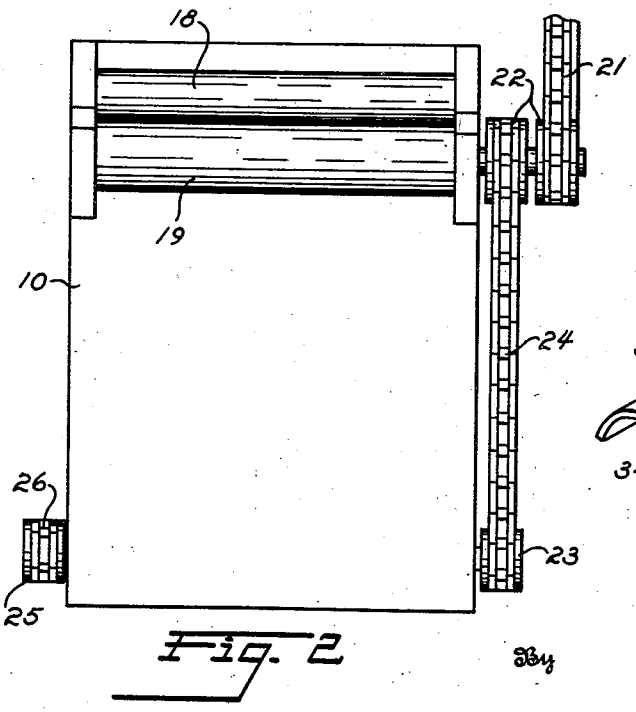


Fig. 2

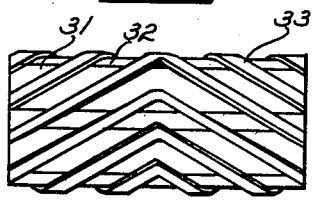


Fig. 3

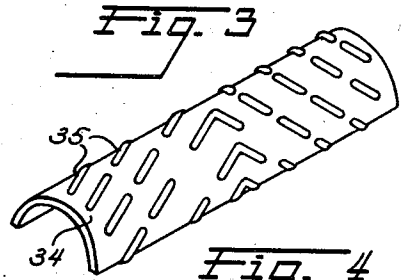


Fig. 4

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PROCESS AND APPARATUS FOR TENSIONLESS HANDLING OF RUNNING LENGTHS OF MATERIALS

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23 Claims. (Cl. 8—151)

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My invention relates to methods and apparatus for handling moving webs, especially webs of fabric and similar materials.

This application is a continuation-in-part of my copending applications Serial No. 624,871, filed October 26, 1945, entitled "Apparatus for fluid treatment of materials," and Serial No. 718,710, filed December 27, 1946, entitled "Method for fluid treatment of materials," both now abandoned.

Fabrics are made from a wide variety of materials and differ widely in texture, weave and strength, as from heavy canvas to sheer stocking material, and are usually subjected to a number of physical and chemical treatments while being processed for marketing. These treatments may include washing, bleaching, dyeing, drying, ageing and the like and during many of these treatments the fabric is subjected to forces and conditions tending to shrink or stretch it. In substantially all of these treatments, the fabric is moved as a continuous web to or through a treating vat or chamber wherein it usually is subjected to the action of a liquid or gas treating agent or reagent.

Fabrics generally are susceptible of physical distortion and permanent injury, especially under such conditions, and most fabrics may be much more easily distorted or torn when wet than when dry. In practice it has been found that many of the more delicate fabrics are so sensitive to mechanical stress during processing that it has heretofore been necessary to treat them by a relatively slow and antiquated batch process rather than a continuous process. Under modern production requirements it is highly desirable to treat fabrics continuously at high speeds. In some instances it is necessary to handle dry fabrics, in others wet fabrics in air or other gas and in still others to handle fabrics in a liquid.

Many processes and machines have been devised to meet these conditions, but to my knowledge none of these processes or machines has met with more than limited success, usually with a few particular fabrics for which they are specially designed. In general, in such prior processes and machines the fabric web is passed over a series of upper and lower rollers during its progress through the treatment vat or chamber and a pair of nip rollers is provided at the outlet end of the vat or chamber for pulling the fabric through. These prior processes and machines have been unsatisfactory or of limited application mainly because the tension and changing feed speeds necessary to advance fabric which may drag,

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stretch or shrink when wet, through the vat or chamber, are usually enough to distort or damage most fabrics unless proper provision is made to overcome this difficulty, and prior to my invention, this difficulty has not been overcome.

The injurious effects of such tension have long been recognized and some efforts have been made to reduce the tension to the point where it is no longer harmful. These efforts have involved driving the upper rollers, the lower rollers, or both at or about the same peripheral speed as the nip rollers; the use of movable rollers which yield and shift with changing tension and various other proposed systems for equalizing tension or compensating for excessive tension. These proposed systems have failed or have had only limited application for one or more of several reasons which I have recognized in solving this problem. They do not compensate for general shrinkage or stretching of the fabric, they do not compensate for local or sudden changes in the fabric, or they operate with longitudinal web tensions higher than many fabrics can withstand without permanent distortion or damage.

The major object of the present invention is therefore to provide a process and apparatus for continuously handling fabrics in which the fabric is nowhere subjected to tension substantially in excess of that necessary to move the fabric. Another object is to provide a process and apparatus for continuously handling fabrics in which inequalities of operating tension are immediately and continuously compensated.

A further object is to provide a process and apparatus for handling fabrics in which stretch or shrinkage of the fabric is compensated without affecting the operating tension moving the fabric.

Still another object is to provide a process and apparatus for handling fabrics in various states and under various conditions without distortion or injury due to excessive tension.

It is a further object of the invention to provide a novel process and apparatus for moving a fabric or like web through a fluid treatment bath or the like wherein changes in the length of the web during its passage through said bath or the like are ineffective to materially alter the operating tension on the web.

A further object of the invention is to provide a novel process and apparatus for progressing a roller supported web of fabric or the like through a fluid treatment bath or the like wherein changes in length of the web due to shrinkage, stretching or like causes are ineffective to materially alter the operating tension on the web.

These and other objects and advantages reside in certain novel features of construction, arrangement and relationship of parts and in novel steps and processes as will hereinafter be more fully set forth and pointed out in the appended claims.

Referring to the drawing:

Figure 1 is a vertical longitudinal section of an apparatus embodying my invention;

Figure 2 is an elevation of the outlet end of the apparatus;

Figure 3 is an elevation of one form of driven roller which may be used in the apparatus;

Figure 4 is a modified form of cleat for the roller illustrated in Figure 3; and

Figure 5 is another form of driven roller assembly which may be used in the apparatus.

While my invention is adapted to the handling of fabrics in various forms such as rope or open width and in various conditions, dry, wet or in a liquid as will hereinafter appear, for simplicity, I have illustrated the invention as applied to the handling of open width fabric in a liquid, as for example in dyeing.

In the drawing, 10 designates a dyeing vat having along its bottom a series of parallel troughs 11 for holding the dye liquor 12. The troughs 11 serve primarily to reduce the amount of dye liquor required. Within the vat 10 there are a plurality of upper guides such as freely rotatable upper rollers 13 and a plurality of lower rollers 14, each lower roller 14 being located in a trough 11. The fabric 15 enters the vat 10 through an opening 16 and is threaded over the upper rollers 13 and under the lower rollers 14 in succession through the vat 10.

The fabric 15 is finally withdrawn from the vat 10 through an opening 17 by nip rolls 18 and 19. For positive feeding, the fabric 15 may be passed over the upper idler nip roll 18, then between the nip rolls, then out under the driven nip roll 19.

Nip roll 19 is driven from any convenient source of power such as the motor 20 through a chain 21 and a sprocket wheel 22. The sprocket 22 is also connected by a drive chain 24 to a sprocket wheel 23 on one end of one of the rollers 14. In the embodiment illustrated, each of the rollers 14 is provided with a sprocket wheel 25 on the side opposite sprocket wheel 23, and all of the sprocket wheels 25 are connected by a chain 26 so that all of the rollers 14 rotate together and are driven from the nip roll 19.

The principal feature of my invention resides in the relation between the surface speeds of the nip roll 19 and that of the rollers 14. I have found that when the rollers 14 are rotated at a speed such that their peripheral surface speed is greater than the linear speed of the fabric, excessive tension is eliminated throughout the apparatus.

The linear speed of the fabric through the apparatus is a function of two factors, the linear speed imparted by the nip rolls 18 and 19 and the amount that the fabric shrinks or stretches in the vat. For example, if the fabric shrinks 10% in length while in the vat 10, that means that 10% less length of fabric is withdrawn through opening 17 than enters through opening 16. If this shrinkage is not accompanied by stretching at any point in the apparatus, the maximum linear speed of the fabric would therefore be approximately 11% greater than the speed of the nip rolls 18 and 19. A fabric may shrink at some points in the apparatus and stretch at others so that the fabric will be traveling at different linear speeds at different points and these speeds may exceed either the input or output speeds or both. I have found that when the surface speed of each roller 14 exceeds the maximum linear speed of the fabric at that roller, the fabric is moved through the apparatus without appreciable tension. The amount by which the surface speed of the rollers 14 should exceed the linear speed of the fabric is not critical but may be limited by other factors in certain processes as will hereinafter be described.

In ordinary operation the loops of fabric containing the rollers 14 are relatively loose, and the rollers 14 slip forwardly relative to the adjacent portion of the fabric, imparting a forwardly directed driving force to the fabric by friction. As indicated in Figure 1, actual physical contact between the rollers 14 and the fabric may not always be present, particularly when the rollers are immersed in a liquid, since a film of liquid will tend to adhere to and rotate with the rollers and this film will transmit the required driving force from the rollers to the fabric. If slack develops in a particular loop due to elongation of the fabric or from some other cause, the loop will lengthen, the frictional driving force will be reduced, and the speed of the fabric in that loop will decrease slightly until the slack is taken up. If tension starts to develop in a particular loop, the loop will shorten, the frictional driving force will be increased, and the speed of the fabric in that loop will instantly increase to avoid any excess tension. Since the peripheral speed of each roller 14 is always greater than the linear speed of the adjacent fabric, the driving forces of these rollers are thus made more effective or less effective by the slightest increase or decrease in tension, so that these forces are instantly applied at the proper points whenever tension begins to increase. Since the amount of driving force applied by a particular roller 14 depends upon the tightness or looseness of the fabric traveling beneath that roller, and the amount of forward slip of the roller relative to the adjacent fabric in turn depends upon the driving force, the driving force imparted will always be just enough to prevent undue tension and not enough to introduce appreciable slack.

In the description of my invention it must be borne in mind that the tensions referred to are so slight as to be practically negligible. Throughout the apparatus, the fabric is in a loose, relaxed condition and the most minute changes in tension are instantly and locally relieved and equalized.

It can be seen that between any two rolls 14 there are two balanced lengths of the fabric 15 passing over a freely rotatable roller 13. The only tension any roller 14 need impart therefore is that necessary to overcome the friction of the roller 13. This tension is so slight as to be practically negligible.

My apparatus is so free from tension that with some fabrics and in some operations it has been found to be sometimes desirable to provide means for introducing outside tension to prevent overrunning or tangling. This tension may be applied by a friction member 27 secured at one end to the wall of the vat 10 and at its other end to an adjusting mechanism 28. The member 27 frictionally engages the rollers 13 and the amount of friction may be varied by the adjusting mechanism 28.

While the principle of my invention is ap-

plicable to a wide variety of conditions, I have found that for certain treatments, operation is improved by particular designs and shapes for the rollers 14.

Dry fabric may be handled in air or other gas with rollers of practically any shape. Cylindrical rollers are simple to make and operate entirely satisfactorily with dry fabrics.

The handling of wet fabrics, or the handling of fabrics in liquids, involves other problems. Wet fabrics sometimes tend to adhere to or wrap around the rollers and, when the rollers and fabric are covered by a liquid as shown in Figure 1, this tendency to adhere and wrap around is increased due to the fact that the liquid immediately adjacent the roller rotates with the roller. There is so little tension in the system that this rotating liquid tends to move the fabric around over the top of the roller 14. This tendency of the fabric to adhere to and wrap around the roller may be reduced or eliminated in a number of ways and several examples of means for eliminating or reducing this tendency are illustrated in Figures 3, 4 and 5.

As illustrated in Figure 5, any tendency of the fabric to adhere to or wrap around the roller 14 may be eliminated by providing a fixed stripping bar or rod 30 adjacent the roller 14. This stripping bar or rod 30 may be rigidly fixed to the wall of the vat 10 and the fabric engages this bar or rod 30 as it leaves the roller 14 and is thus positively prevented from wrapping around the roller.

I have also found that the tendency of the fabric to adhere to or wrap around the roller is diminished as the surface contact between the fabric and the roller is reduced and also when the surface contact between the fabric and the roller is not continuous.

A roller embodying these principles is illustrated in Figure 3, this roller consisting of a cylindrical body 31 having a plurality of parallel spaced rods or cleats 32 fixed thereto. These rods or cleats 32 hold the fabric away from the surface of the cylindrical body 31 and eliminate or minimize any tendency of the fabric to wrap around the roller. In the handling of open width fabrics, some outward smoothing may be desired and wires 33 in herringbone form, may be secured over the rods or cleats 32 to provide this outward smoothing effect. These wires 33 are inclined outwardly from the center to the ends of the cleats 32 and rearwardly with respect to the direction of rotation of the roller.

The cleat shown in Figure 4 may be substituted for the cleats 32 and wires 33 on the roller shown in Figure 3. This cleat consists of a semi-cylindrical body portion 34 having raised, spaced knobs 35 which may be inclined rearwardly and outwardly with respect to the direction of rotation of the roller in herringbone form to give some outward smoothing effect if desired. The body portion 34 is suitably secured to the cylindrical body 31 by welding or the like.

The roller illustrated in Figure 3 is merely an example and various other forms may be used. I have used square rollers, elliptical rollers, rollers with corrugated surfaces and rollers of other shapes with satisfactory results.

As pointed out above, when the rollers 14 are operating in a liquid as shown in Figure 1, the liquid tends to rotate with the roller and increases the tendency of the fabric to wrap around the roller. This effect increases as the speed of rotation of the liquid increases and, since the speed

of rotation of the liquid depends upon the speed of rotation of the rollers, it is sometimes preferable to keep the speed of the rollers 14 as low as possible so long as the surface speed of the rollers exceeds the maximum linear speed of the fabric.

In certain liquid treatments, such as washing, where a large amount of turbulence is desired, the rollers 14 may be rotated at high speed to increase the turbulence.

From the foregoing it will be apparent that I am able to attain the objects of my invention and provide novel processes and apparatus for handling fabrics continuously and at high speeds without subjecting the fabrics to substantial or injurious tension.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description.

I claim:

1. Apparatus for handling a moving length of material from a source of supply comprising means for pulling said material, said material having a depending loop between said source of supply and the pulling means, material advancing means positioned in said loop and means for operating said material advancing means at a surface speed in excess of the linear speed of said material in the curved portion of said loop.

2. Apparatus for handling a moving length of material comprising two spaced substantially horizontal upper guides over which said material is passed, said material being positioned with a depending loop between said upper guides, means for withdrawing said material from said apparatus, material advancing means positioned within said loop and means for operating said material advancing means at a surface speed greater than the linear speed of said material at the bottom of said loop.

3. Apparatus for handling a moving length of material comprising a plurality of spaced freely rotatable upper rollers, said material being positioned with a depending loop between adjacent upper rollers, means for withdrawing said material from said apparatus, material advancing means positioned within each of said loops, and means for operating said material advancing means at a surface speed in excess of the linear speed of said material at the bottom of said loop.

4. Apparatus for handling a moving length of material comprising a plurality of spaced upper guides over which said material is passed, said material being positioned with a depending loop between adjacent upper guides, means for withdrawing said material from said apparatus, a roller within each loop and means for rotating each roller at a speed such that the surface speed of the roller exceeds the speed of the material in the curved portion of said loop.

5. Apparatus as defined in claim 4 in which the upper guides consist of freely rotatable rollers.

6. Apparatus for handling a moving length of material which may change in length during handling, comprising a plurality of spaced freely rotatable upper rollers and a plurality of spaced lower rollers spaced from said upper rollers, said material passing over each upper roller and under each lower roller in succession, means for

withdrawing said material from said apparatus, and means for driving said lower rollers at a speed such that the surface speed of the lower rollers is greater than the surface speed of the withdrawing means by an amount exceeding the maximum variation in speed of the material resulting from change of length of said material.

7. Apparatus for fluid treatment of an elongated web of material comprising an enclosure, means to support a portion of the web within the enclosure in the form of a depending loop, means for delivering the web from the enclosure at a predetermined speed, web-advancing means located within the lower portion of the loop and arranged to advance the web solely by frictional engagement therewith, and means to drive the web-advancing means at a surface speed appreciably exceeding the speed of web delivery and thereby cause the web-advancing means to slip forwardly relative to the adjacent portion of the web regardless of shrinkage or elongation of the web.

8. Apparatus for fluid treatment of an elongated web of material comprising an enclosure, means to support a portion of the web within the enclosure in the form of a depending loop, means for delivering the web from the enclosure at a predetermined speed, a substantially horizontal rotatable roll located within the lower portion of the loop and arranged to advance the web solely by frictional engagement therewith, and means to drive the roll at a surface speed appreciably exceeding the speed of web delivery and thereby cause the roll to slip forwardly relative to the adjacent portion of the web regardless of shrinkage or elongation of the web.

9. Apparatus for fluid treatment of an elongated web of material comprising an enclosure, means to support a portion of the web within the enclosure in the form of an open width depending loop, means for delivering the web from the enclosure at a predetermined speed, a substantially horizontal rotatable roll located within the lower portion of the loop and arranged to advance the web solely by frictional engagement therewith, the peripheral surface of the roll including projections which are inclined in directions outwardly from the central portion of the roll toward the ends thereof and rearwardly with respect to the direction of rotation thereof, and means to drive the roll at a surface speed appreciably exceeding the speed of web delivery and thereby cause the roll to slip forwardly relative to the adjacent portion of the web regardless of shrinkage or elongation of the web, the said projections imparting a continuous outward smoothing action to the web.

10. Apparatus for fluid treatment of an elongated web of material comprising an enclosure, a series of guides to support a portion of the web within the enclosure in the form of a series of depending loops, means to deliver the web from the enclosure at a predetermined speed, a substantially horizontal rotatable roll located within the lower portion of each loop and arranged to advance the web solely by frictional engagement therewith, and means to drive the rolls at surface speeds appreciably exceeding the speed of web delivery and thereby cause the rolls to slip forwardly relative to the adjacent portions of the web regardless of shrinkage or elongation of the web.

11. Apparatus for fluid treatment of an elongated web of material comprising an enclosure, a series of substantially horizontal idler upper rolls to support a portion of the web within the enclosure in the form of a series of depending loops, means to deliver the web from the enclosure at a predetermined speed, a substantially horizontal lower rotatable roll located within the lower portion of each loop and arranged to advance the web solely by frictional engagement therewith, and means to drive the lower rolls at surface speeds appreciably exceeding the speed of web delivery and thereby cause the lower rolls to slip forwardly relative to the adjacent portions of the web regardless of shrinkage or elongation of the web.

12. Apparatus as set forth in claim 11, in which adjustable friction braking means is provided in connection with the upper idler rolls to resist the rotation thereof.

13. A method for fluid treatment of running lengths of flexible materials such as textiles and the like which are subject to shrinkage comprising the steps of supporting the material in a depending loop, allowing the material to enter the loop and to leave the loop freely without appreciable tension, withdrawing the material from the loop at a predetermined speed, and applying a force to the inner surface of the loop by friction tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof.

14. A method for fluid treatment of running lengths of flexible materials such as textiles and the like which are subject to shrinkage comprising the steps of supporting the material in a depending loop, allowing the material to enter the loop and to leave the loop freely without appreciable tension, withdrawing the material from the loop at a predetermined speed, and applying a rotary force to the inner surface of the loop by friction tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof.

15. A method for fluid treatment of running lengths of flexible materials such as textiles and the like which are subject to shrinkage comprising the steps of supporting the material in a series of depending loops, allowing the material to travel freely from each loop to the next without appreciable tension, withdrawing the material from the loops at a predetermined speed, and applying a rotary force to the inner surface of each loop by friction tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof.

16. A method for fluid treatment of open width running lengths of flexible materials such as textiles and the like which are subject to shrinkage comprising the steps of supporting the material in a depending loop with the lower portion thereof shaped as an upwardly concave arc, allowing the material to enter the loop and to leave the loop freely without appreciable tension, withdrawing the material from the loop at a predetermined speed, and applying a rotary force to the inner concave surface of the loop by friction tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof.

17. A method for fluid treatment of open width running lengths of flexible materials such as textiles and the like which are subject to shrinkage

comprising the steps of supporting the material in a depending loop with the lower portion thereof shaped as an upwardly concave arc, allowing the material to enter the loop and to leave the loop freely without appreciable tension, withdrawing the material from the loop at a predetermined speed, and applying a rotary force to the inner concave surface of the loop by friction with a component tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof, the said rotary force also having oppositely directed lateral components tending to smooth the material from its center toward its edges.

18. Apparatus for feeding a web from a source of supply comprising means for pulling said web, guide means for supporting said web between said source and the pulling means, said web being supported in the form of a depending loop, a web advancing member rotatably mounted within and adjacent the bottom of said loop, means for rotating said web advancing member at a speed such that the surface speed of the web advancing member is greater than the linear speed of said web at the bottom of said loop, and means for breaking the adhesion between said web and said member.

19. Apparatus for feeding a web from a source of supply comprising means for pulling said web, guide means for supporting said web between said source and the pulling means in the form of a depending loop, a web advancing member rotatably mounted within and adjacent the bottom of said loop, means for rotating said web advancing member at a speed such that the surface speed of the web advancing member is greater than the linear speed of said web at the bottom of said loop, and guide means positioned within said loop adjacent said web advancing member for guiding the material away from the advancing member at the desired point to prevent said material from wrapping around said advancing member.

20. Apparatus for handling a moving elongated web of material comprising guide means, said material being positioned on said guide means with a plurality of depending loops, means for pulling said material from said guide means, substantially horizontal roller means positioned within each loop adjacent the curved bottom portion thereof and means for rotating the roller means in each loop at a surface speed greater than the linear speed of the material in the curved bottom portion of such loop, the excess speed of said roller means causing said roller means to slip forwardly with respect to said material.

21. Apparatus for handling a moving elongated web of material comprising guide means, said material being positioned on said guide means with a plurality of depending loops, means for

pulling said material from said guide means, substantially horizontal roller means positioned within each loop adjacent the curved bottom portion thereof, means for rotating the roller means in each loop at a surface speed greater than the linear speed of the material in the curved bottom portion of such loop, the excess speed of said roller means causing said roller means to slip forwardly with respect to said material, and means for breaking adhesion between said material and said roller means.

22. Apparatus for handling a moving elongated web of material comprising guide means, said material being positioned on said guide means with a plurality of depending loops, means for pulling said material from said guide means, substantially horizontal roller means positioned within each loop adjacent the curved bottom portion thereof, means for rotating the roller means in each loop at a surface speed greater than the linear speed of the material in the curved bottom portion of such loop, the excess speed of said roller means causing said roller means to slip forwardly with respect to said material, and means within such loop and adjacent such roller means for stripping the material from the roller means.

23. A method for fluid treatment of running lengths of flexible materials such as textiles and the like which are subject to shrinkage comprising the steps of supporting the material in a depending loop, allowing the material to enter the loop and to leave the loop freely without appreciable tension, withdrawing the material from the loop at a predetermined speed, applying a rotary force to the inner surface of the loop by friction tending to advance the material at a speed appreciably exceeding the speed of withdrawal and thus avoiding excess tension in the material regardless of shrinkage thereof and guiding said material away from said rotary force as the material leaves the curved bottom portion of said loop to prevent the material from wrapping on itself in the loop.

HAROLD H. BELCHER.

REFERENCES CITED

The following references are of record in the file of this patent:

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644,498	Cook	Feb. 27, 1900
1,058,459	Petzold	Apr. 9, 1913
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2,239,636	Weiss	Apr. 22, 1941
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2,276,605	Andrews	Mar. 17, 1942
2,321,635	Taylor	June 15, 1943

Certificate of Correction

Patent No. 2,474,717. June 28, 1949.

HAROLD H. BELCHER

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 10, list of references cited, following line 61, add the following:

1,158,560	Rutherford	November 2, 1915
1,260,595	Thompson	March 26, 1918
1,679,096	Pourfillet	July 31, 1928
1,803,664	Cohoe	May 5, 1931
2,066,168	Witte	December 29, 1936
2,123,445	Van Leuven	July 12, 1938

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.