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Calamari, Jr. et al.

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[54] **CHAINLESS MERCERIZER SUITABLE FOR USE WITH LIQUID AMMONIA**

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[73] Assignee: **The United States of America as represented by the Secretary of Agriculture**

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[52] **U.S. Cl.** .....**68/244,** 26/63, 34/71, 68/19.1, 68/22 R

[51] **Int. Cl.**.....**B05c 3/132,** D06f 45/22, D06c 15/08

[58] **Field of Search**.....68/22 R, 43, 97, 19.1, 244; 100/161, 162 R, 162 B, 176; 34/95, 71, 116, 123, 159, 161; 26/1, 63

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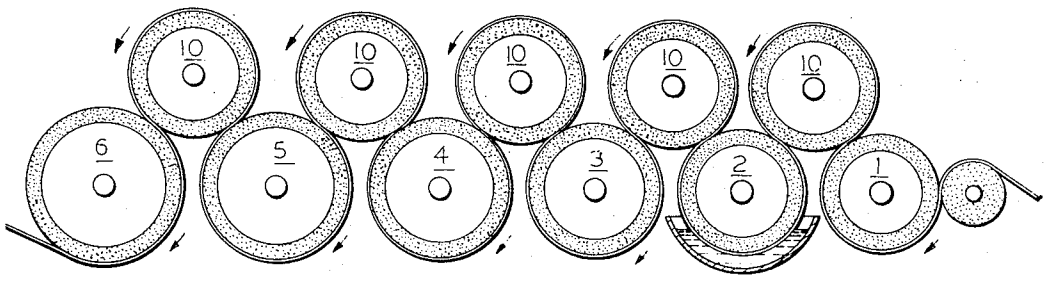
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[57] **ABSTRACT**

An improved chainless mercerizer utilizing a series of graduated rollers which increase the efficiency of a chainless mercerizer. Each driven roller is constructed incrementally larger in diameter than the previous driven roller in the direction of fabric travel through the mercerizer. The fabric being mercerized is stretched incrementally tighter as it is transferred from one driven roller to the next succeeding one, thereby increasing the forces opposing widthwise shrinkage. The idler rollers have a uniform diameter approximately that of any of the driven rollers.

1 Claim, 3 Drawing Figures



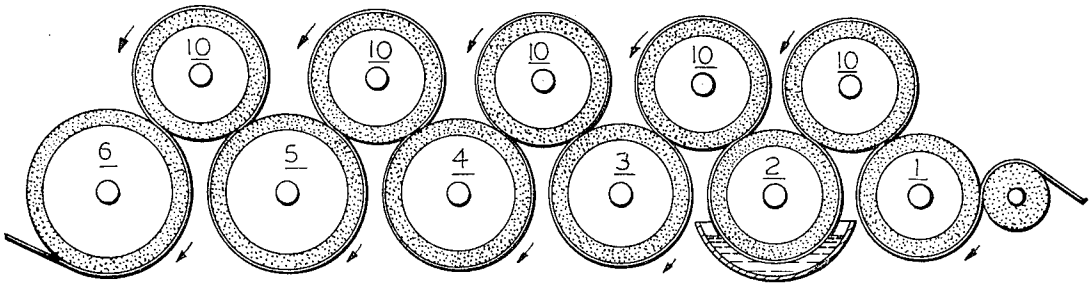


FIG.1

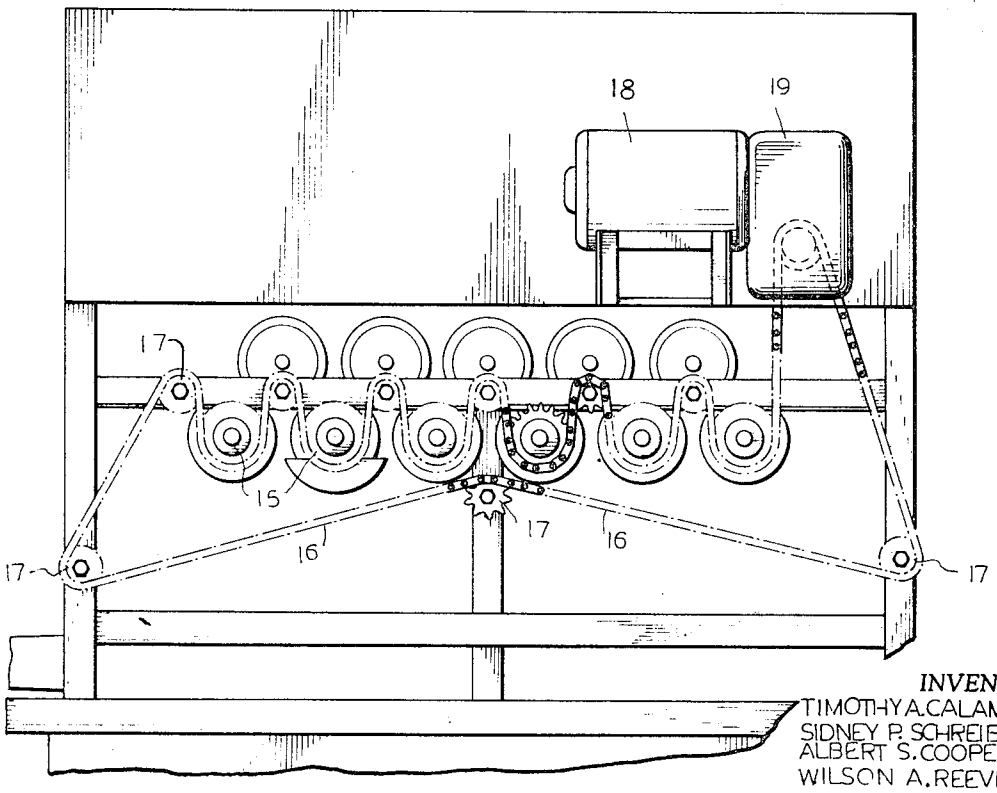


FIG.2

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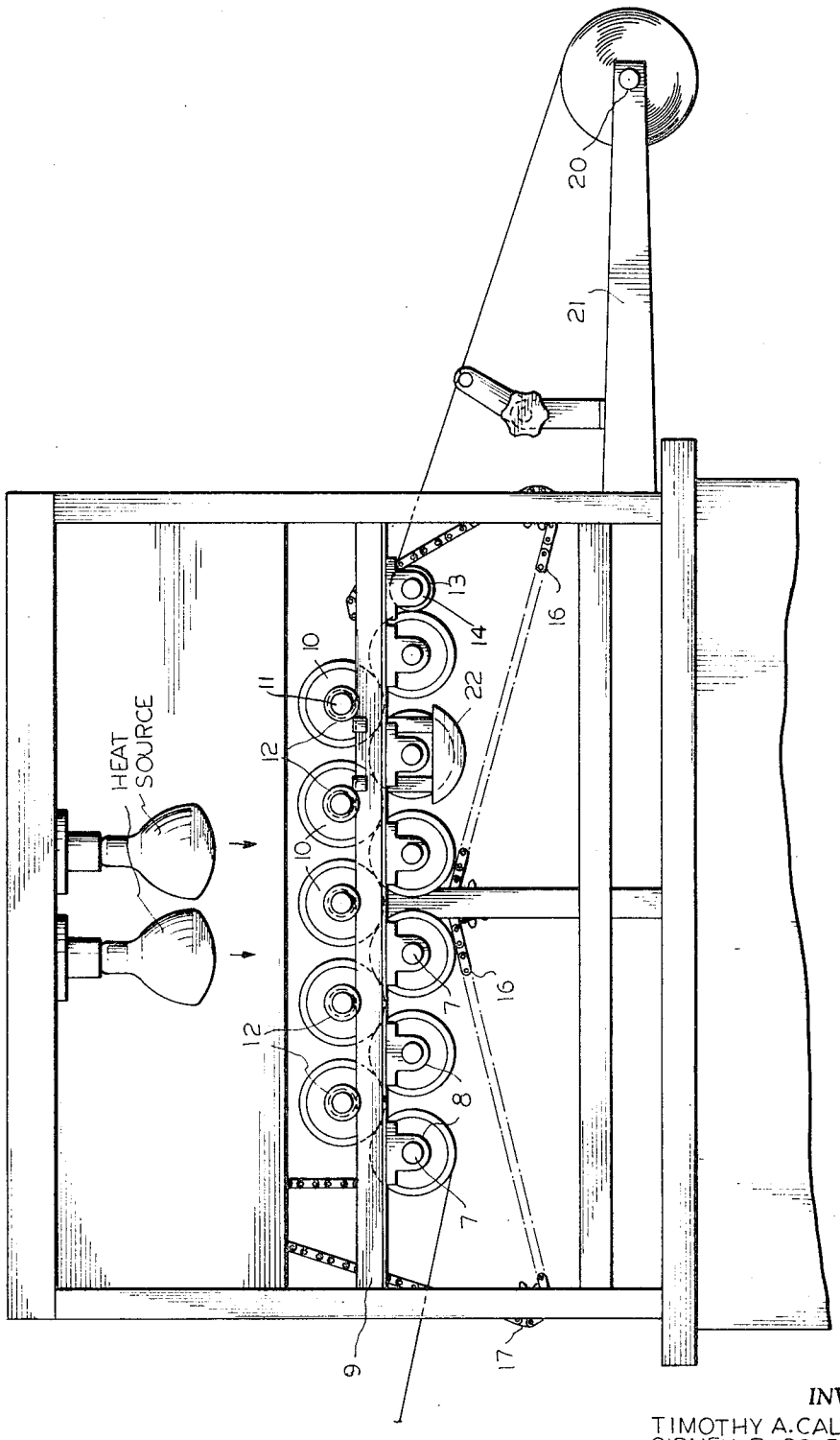


FIG. 3

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CHAINLESS MERCERIZER SUITABLE FOR USE WITH LIQUID AMMONIA

A non-exclusive, irrevocable, royalty-free license in the invention herein described, throughout the world for all purposes of the United States Government, with the power to grant sublicenses for such purposes, is hereby granted to the Government of the United States of America.

In copending application Ser. No. 141,360 filed of even date a process is disclosed for the continuous treatment of fabrics with liquid ammonia.

The chainless mercerizer for which the graduated rollers of this invention were developed is comprised of a series of driven rollers of uniform diameter mounted in tandem on some suitable frame. These driven rollers are mounted such that they do not touch, but are close enough to each other to permit the placing of a similar non-driven idler roller in the gap formed above and between each pair of driven rollers. These idler rollers are also uniform in diameter, and are either the same or nearly the same diameter as the driven rollers. Fabric to be mercerized is threaded under the bottom of the first driven roller, over the top of the first non-driven roller, under the bottom of the second driven roller, and so on until the fabric is either batched or removed for further finishing. Mercerizing agent is applied to the fabric at some convenient location after the fabric has been completely transferred from the first idler roller. Since the mercerizing agent causes the fabric to shrink, the fabric is pulled tight on the rollers thereby discouraging further shrinkage. One measure of the efficiency of the mercerizer is the amount of fabric shrinkage which occurs. This lateral shrinkage is in turn related to the degree of tightness with which the fabric is stretched over the rollers. The tighter the fabric is stretched, the less the lateral shrinkage. After passing over several driven and non-driven rollers, the mercerizing agent is removed from the fabric using some suitable technique. The fabric is then either drawn off for additional finishing or batched. It is clear, therefore, that the tightness of the fabric on the rollers of the prior art is governed primarily by the shrinking force of the fabric being mercerized.

It is the object of this invention to incorporate graduated driven rollers of increasing diameter into a device of the prior art such that each driven roller becomes incrementally larger than the previous one in the direction of fabric travel. The increase in diameter of the rollers will be governed by the type fabric being mercerized, the mercerizing agent, and the operating conditions; however, in no case should the incremental increase in diameter be more than 2 percent between adjacent driven rollers, or more than 5 percent between the smallest and largest driven rollers of the entire series. After removal of the mercerizing agent, the fabric is removed from the machine in a manner identical to that described above for the prior art.

In the accompanying drawing,

FIG. 1 is a plan view of the mercerizer rollers and shows the spacial arrangement of the driven rollers and the associated idler rollers. FIG. 1 also depicts the incremental increase in diameter of the driven rollers in the direction of fabric travel;

FIG. 2 is a side view of the mercerizer showing particularly the driving mechanism for the driven rollers; and

FIG. 3 is a side view of the mercerizer showing the side opposite the drive mechanism, and shows, particularly, the path of the fabric or the yarn through the mercerizer. FIG. 3 also depicts a heat source (two infrared lamps) the purpose of which is to evaporate ammonia from the fabric (as see Example 2, hereinafter).

Referring to FIG. 1, FIG. 2, and FIG. 3 of the drawing, the mercerizier consists of a series of graduated driven rollers 1 through 6 mounted by means of their central shafts 7 in self-centering bearings 8 which are in turn mounted to the bottom of the upper horizontal member of the rigid frame 9 and spaced such that the driven rollers do not touch, but are close enough to each other to permit the placing of similar non-driven idler rollers 10 in the gaps formed above and between each pair of driven rollers. Each driven roller becomes incrementally larger in diameter than the previous driven roller in the direction of fabric travel. The spacing of the driven rollers is further adjusted so that the idler roller shafts 11 just clear the top of the horizontal member of frame 9. The idler rollers 10 are fitted with alignment collars 12 mounted on the idler roller shafts 11 such that the collars straddle the vertical component of the upper horizontal member of the rigid frame 9 and thereby maintain proper alignment of the idler rollers during operation. A smaller feed roller 13 is mounted in self-centering bearings 14 which in turn are mounted to the bottom of the upper horizontal member of the frame 9 and spaced such that the feed roller 13 and the drive roller 1 touch and that the line of contact between these rollers forms a squeezing surface.

FIG. 2 shows the drive mechanism which consists of drive sprockets 15 mounted on the driven roller shafts 7. The drive chain 16 runs over the bottom half of each drive sprocket 15. Idler sprockets 17 are mounted on the rigid frame 9 and are spaced such that maximum contact between the chain 16 and the drive sprockets 15 is achieved. The drive train is powered by means of a variable speed motor 18 with speed reducer 19 and controlled by a silicon-controlled rectifier drive 20.

FIG. 3 shows the operation of the mercerizer. Fabric or yarn to be mercerized is batched on the feed assembly 21. The leading edge of the fabric or sheet of yarn is fed through the nip formed between feed roller 13 and driven roller 1 (the smallest of the graduated driven rollers), under roller 1, over the top of the first idler roller 7, under the larger driven roller 2, over the next idler roller and so on until the fabric is either batched or further processed after leaving the last and largest driven roller 6. Liquid ammonia or some other suitable mercerizing agent is applied to the fabric as it passes through treatment tray 22. It is then removed from the fabric or yarns at some convenient location before the fabric passes through the last squeezing surface formed between driven roller 6 and the last idler roller. Speed of travel of the fabric or sheet of yarns through the mercerizer is controlled through the use of the silicon-controlled rectifier drive 20.

EXAMPLE 1

This example illustrates the continuous tension mercerization of all cotton and blended cotton/polyester sheeting with liquid ammonia using the improved chainless mercerizer. The particular machine employed in this and in the following examples utilized a 2.3 percent overall diameter increase distributed

throughout six driven rolls (i.e., the first driven roll measured 4.40 inches in diameter, the sixth and last driven roll measured 4.50 inches in diameter). In this example mercerization is terminated by the quenching of the ammonia treated fabric with hot water.

The all-cotton sheeting sample had a thread count of 120×70. The blended sheeting had 50 percent cotton and 50 percent polyester in both the warp and filling direction and a thread count of 120×70. Eight inch widths of each fabric were batched on feed rolls. The batched rolls were then placed on a feed assembly which permitted the adjustment of back tension. The fabric was then run through the mercerizer. Liquid ammonia was applied to the fabric by means of a treatment tray located under the second driven roller of the mercerizer. Immersion time was estimated at 0.5 seconds. Mercerization was allowed to proceed for 8 seconds. Hot water was applied to the ammonia treated fabric near the top of the fourth driven roller. This quenching assured an abrupt termination of mercerization. The fabric was stretched progressively as it passed from one graduated driven roller to the next. The dimensions of both the all-cotton and the cotton/polyester blended sheeting both before and after mercerization are given in Table I below.

TABLE I

	Dimensions (in.) Before NH_3 Treatment Warp:Filling		After NH_3 Treatment Warp:Filling		% Change Warp:Filling:Area		
Cotton Sheeting	52.0	7.9	55.0	7.8	+5.8	−1.3	+4.4
Cotton/ Polyester Sheeting	52.0	8.0	54.2	7.9	+4.2	−1.3	+2.9

As can be seen from this data, filling shrinkage during ammonia mercerization was held to a minimum. Elongation of the warp resulted in an overall increase in fabric area.

After removal of the fabrics from the mercerizer, they were crosslinked with a solution containing 1 percent dimethylol-methoxyethyl carbamate and 0.8% $Zn(NO_3)_2 \cdot 6H_2O$ using a pad, dry, cure procedure. The physical properties of the all-cotton samples before and after crosslinking are compared in Table II below as are those for the blended cotton/polyester samples in Table III.

TABLE II

	Tearing Strength Filling (gms.)	Stoll Flex Abrasion Cycles (Warp)	Wrinkle Recovery Angle (W+F)° Conditioned)	(Wet)
Control (120×70 Cotton Sheeting	907	1016	209	176
Crosslinked Control	327	159	271	259
Liquid NH_3 for 8sec. 1/	913	2038	185	218
Liquid NH_3 for 8 sec. then crosslinked/	360	216	278	260

1/ Removed by water quenching

TABLE III

	Tearing Strength Filling (gms.)	Stoll Flex Abrasion Cycles (Warp)	Wrinkle Recovery Angle (W+F)° (Conditioned)	(Wet) Control
120×70 Blended Sheeting)	1733	3814	260	267
Crosslinked Control	733	2076	281	277
Liquid NH_3 for 8 sec. 1/	1913	3058	248	273
Liquid NH_3 for 8 sec. then Crosslinked 1/	827	2098	290	281

1/ Removed by water quenching

As can be seen from the data given above in Tables 1 and 3, ammonia mercerization causes significant improvement in the physical properties of the treated cotton and cotton/polyester sheeting both before and after crosslinking treatments.

EXAMPLE 2

This example is identical to Example 1 except that the ammonia was removed from the fabric through evaporation induced by means of two 150 watt infrared lamps as a heat source. Evaporation was begun 3 seconds after the fabric was immersed in the liquid ammonia, and was over 90 percent complete 10 seconds later. Some physical properties of the all-cotton and blended samples before and after mercerfzation and crosslinking are compared below in Tables IV and V.

TABLE IV

(gms.)	Tearing Strength Filling	Stoll Flex Abrasion Cycles (Warp)	Wrinkle Recovery Angle (W+F)° (Conditioned)	(Wet)
Control (120×70 Cotton Sheeting	907	1016	209	176
Crosslinked Control	327	159	271	259
Liquid NH_3 for 8 sec. 1/	960	1796	219	210
Liquid NH_3 for 8 sec. then Crosslinked 1/	527	330	282	252

1/ Removed by a heat induced Evaporation

TABLE V

	Tearing Strength Filling (gms.)	Stoll Flex Abrasion Cycles (Warp)	Wrinkle Recovery Angle (W+F)° (Conditioned)	(Wet)
Control (120×70 Blended Sheeting)	1733	3814	260	267
Crosslinked Control	733	2096	281	272
Liquid NH_3 for 8 sec. 1/	1783	5196	272	280
Liquid NH_3 for 8 sec. then crosslinked 1/	947	4373	294	284

1/ Removed by heat induced evaporation

EXAMPLE 3

The example illustrates the continuous tension mercerization of cotton yarn with liquid ammonia. The yarn used in this work was a loose twist greige 10/2 Deltapine cotton yarn having a T.M. of 2.21 (6.99 tpi) in the singles with a reverse ply T.M. of 3.11 (6.95 tpi). A sheet of three ends was batched on a skein winder

and fed into the chainless mercerizer in a manner similar to that used for fabric in Example 1. In this example mercerization was terminated by the induced evaporation of ammonia from the yarn by means of two 150 watt infrared lamps. Immersion time in the liquid ammonia was estimated at 0.4 seconds. Evaporation was induced beginning 2.5 seconds after the initial immersion, and was over 90 percent complete 5 seconds later. Some physical properties of the ammonia mercerized yarn are given below in Table VI.

TABLE VI

	Breaking Strength (g)	Tenacity (g/Tex)	Elongation To Break (%)
Control (10.2 yarn)	1274	10.8	7.7
Liquid NH_3 for 5 sec.	1524	12.6	8.2

As can be seen from the data given above, substantial increases in yarn breaking strength and tenacity can be obtained without a correspondingly large decrease in elongation. Yarn length was increased 18.6 percent by the treatment.

EXAMPLE 4

This example illustrates the continuous tension mercerization of a sample of cotton tubular knit fabric with liquid ammonia. The fabric used was a plain jersey knit from a greige 40/2 balanced yarn. It had 41 courses and 34 wales/in. and weighed 3.0 oz./yd^2. The flattened width of the tube was about 5 inches. A floating spreader bar was placed inside the tube so that it spread the knit jersey immediately before entering the nip formed between the first driven roller and the feed roller. The tube was then threaded through the machine in a manner similar to that outlined in Example 1. Ammonia was applied as indicated in Example 1 and removed using infrared lamps as in Examples 2 and 3. Over 90 percent of the ammonia was removed 12 seconds after the initial immersion. After mercerization, several samples were crosslinked with dimethylolmethoxyethyl carbamate for enhanced dimensional stability to washing. The data gathered on these samples is given below in Table VII.

TABLE VIII

	Mullen Bursting Strength (lbs/sq. in.)
Control (3.0 oz. plain Jersey)	86
Crosslinked Control[1/]	44
Liquid NH_3 for 12 sec.[2/]	86
Liquid NH_3 for 12 sec.[2/] then crosslinked	64

1/ Crosslinked with 10% dimethylolmethoxyethyl carbamate using a pad, dry, and cure procedure.
2/ Removed using heat induced evaporation.

As the data show the bursting strength of ammonia mercerized, then crosslinked jersey is greatly improved over that of a non-pretreated crosslinked control.

We claim:

1. In a chainless mercerizing machine comprising a first roll series consisting of a plurality of smooth surfaced, horizontally disposed, axially parallel, tandem and rotatably mounted rolls, radially spaced to provide nip space and rotational clearance between adjacent rolls, said first roll series being provided with a driving means adapted to revolve the rolls severally at constant and equal rate; a second roll series less by one in number and similar to said first roll series, said second roll series consisting of a plurality of uniform, smooth surfaced, radially spaced, horizontally disposed, axially parallel rolls, tandem mounted and freely rotatable, said second roll series being positioned immediately above said first roll series, each individual roll member of said second roll series being positioned within the nip space formed by a pair of rolls of said first roll series immediately beneath, and being driven by both members of said pair via roll surface contact; the improvement which consists of an incremental increase in roll diameter from the first driven roll relative to fabric travel to the last driven roll, the diametric increase being at least 1 percent and not more than 5 percent distributed throughout all of the driven rolls.

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