March 1, 1938. S. COHN ET AL 2,109,469

SYSTEM FOR TREATING FABRICS

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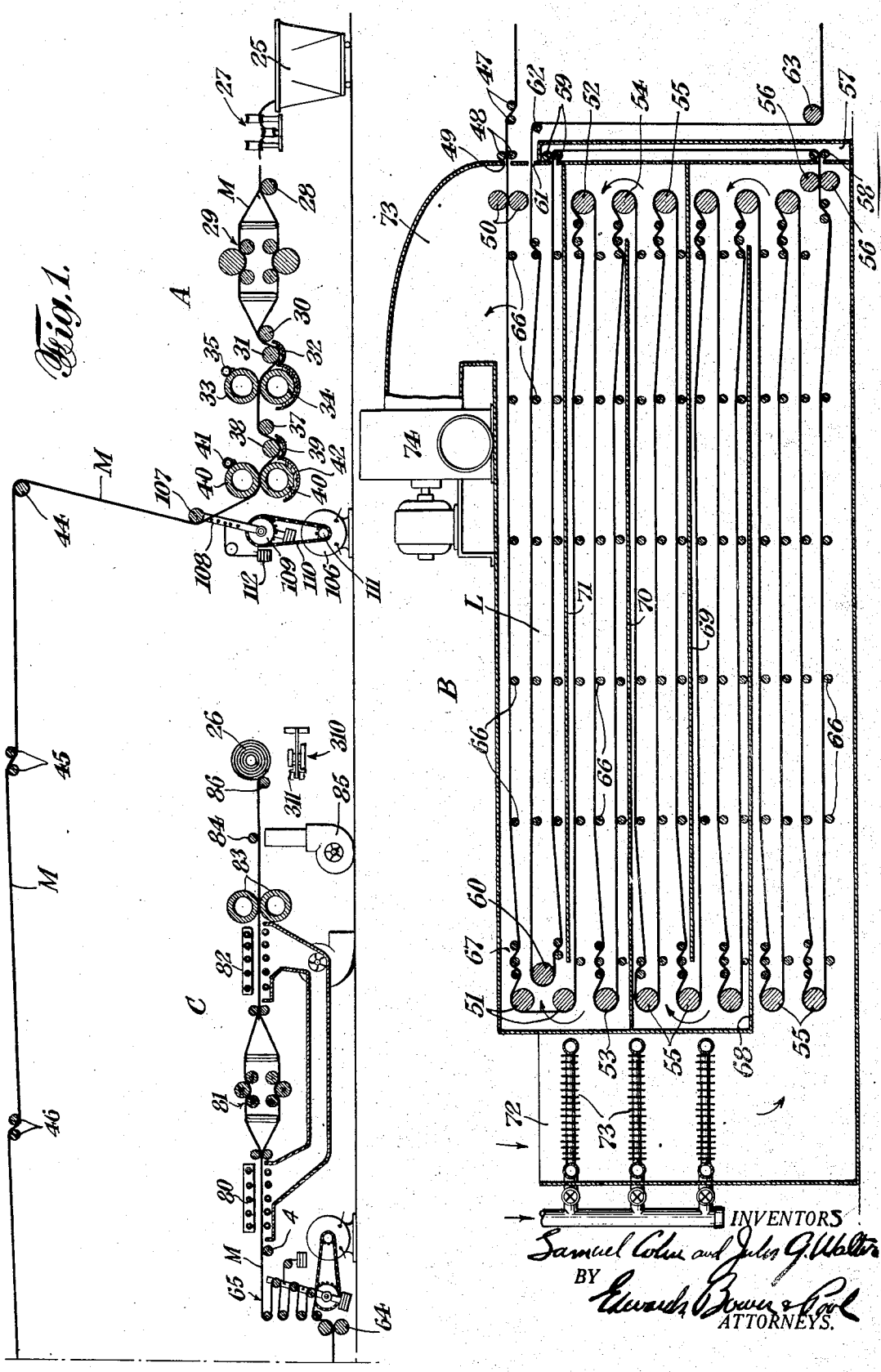

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SYSTEM FOR TREATING FABRICS

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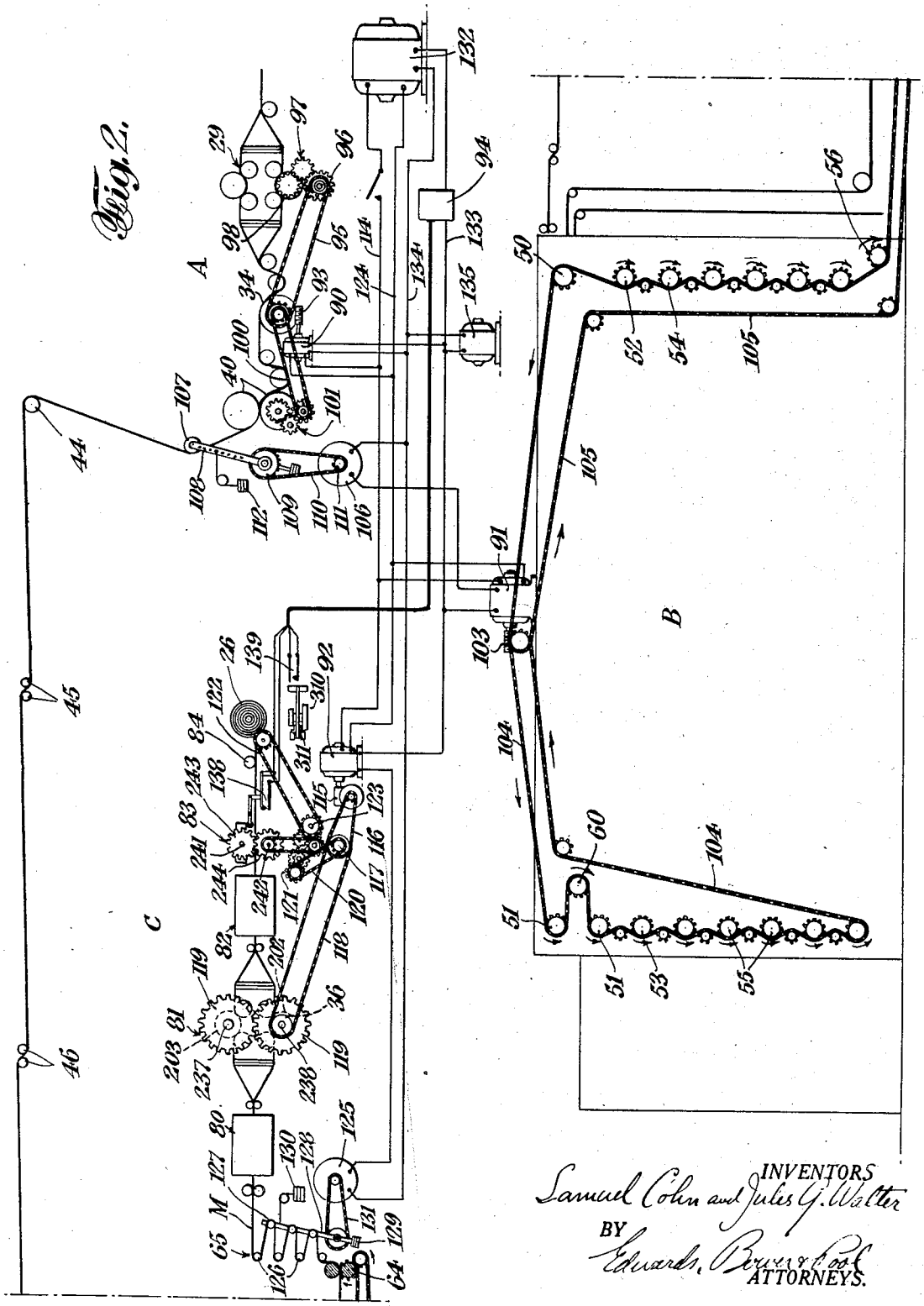
Fig. 2.



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SYSTEM FOR TREATING FABRICS

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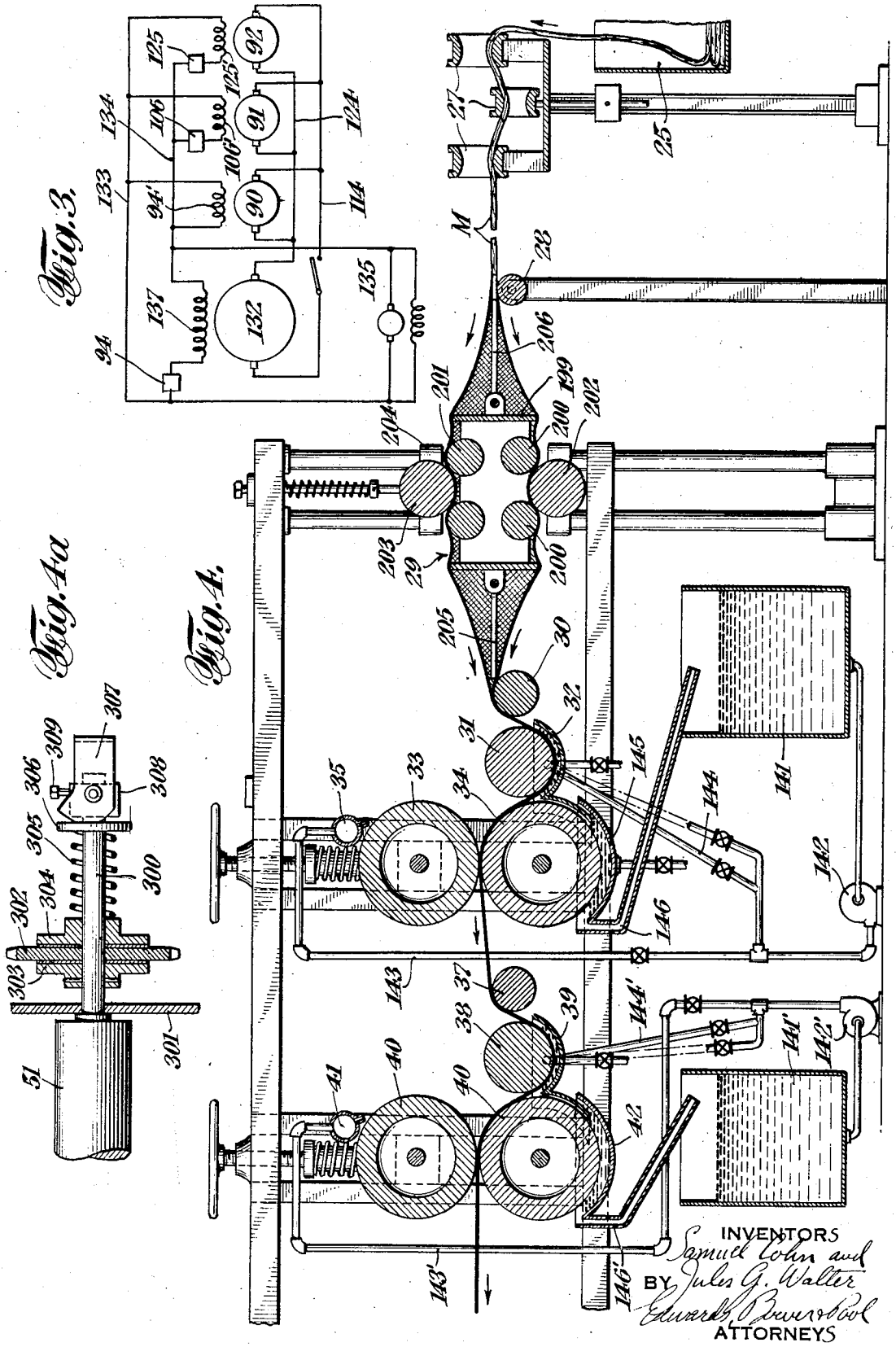

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SYSTEM FOR TREATING FABRICS

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Fig. 5.

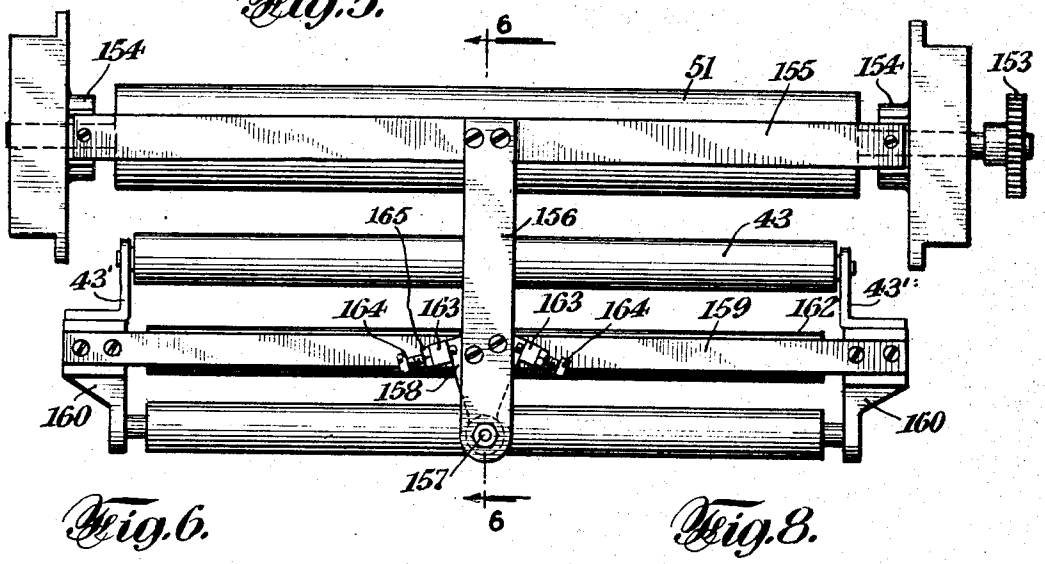


Fig. 6.

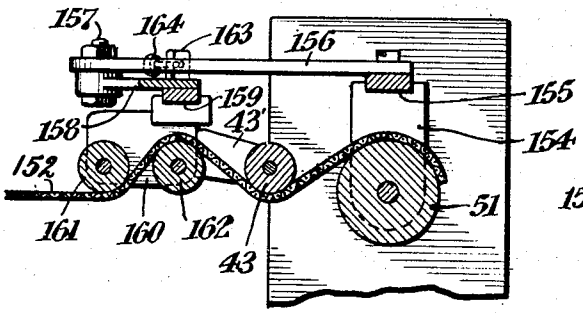


Fig. 8.

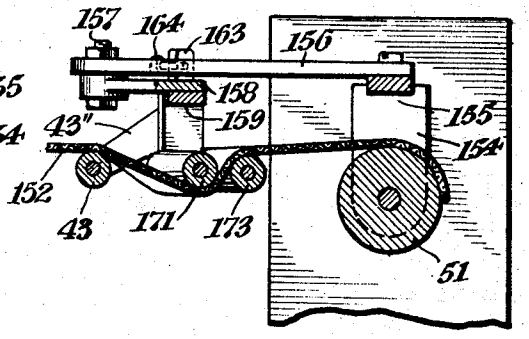


Fig. 7.

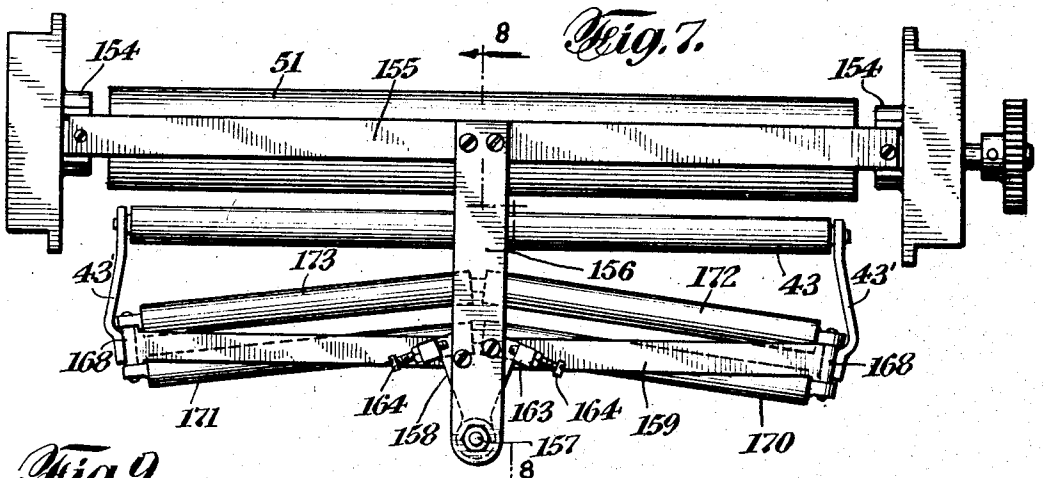
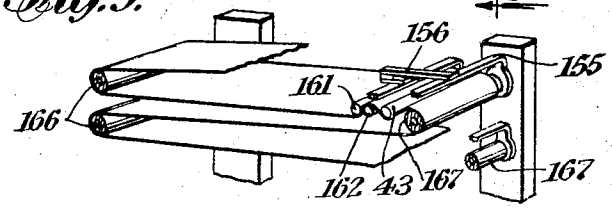


Fig. 9.



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SYSTEM FOR TREATING FABRICS

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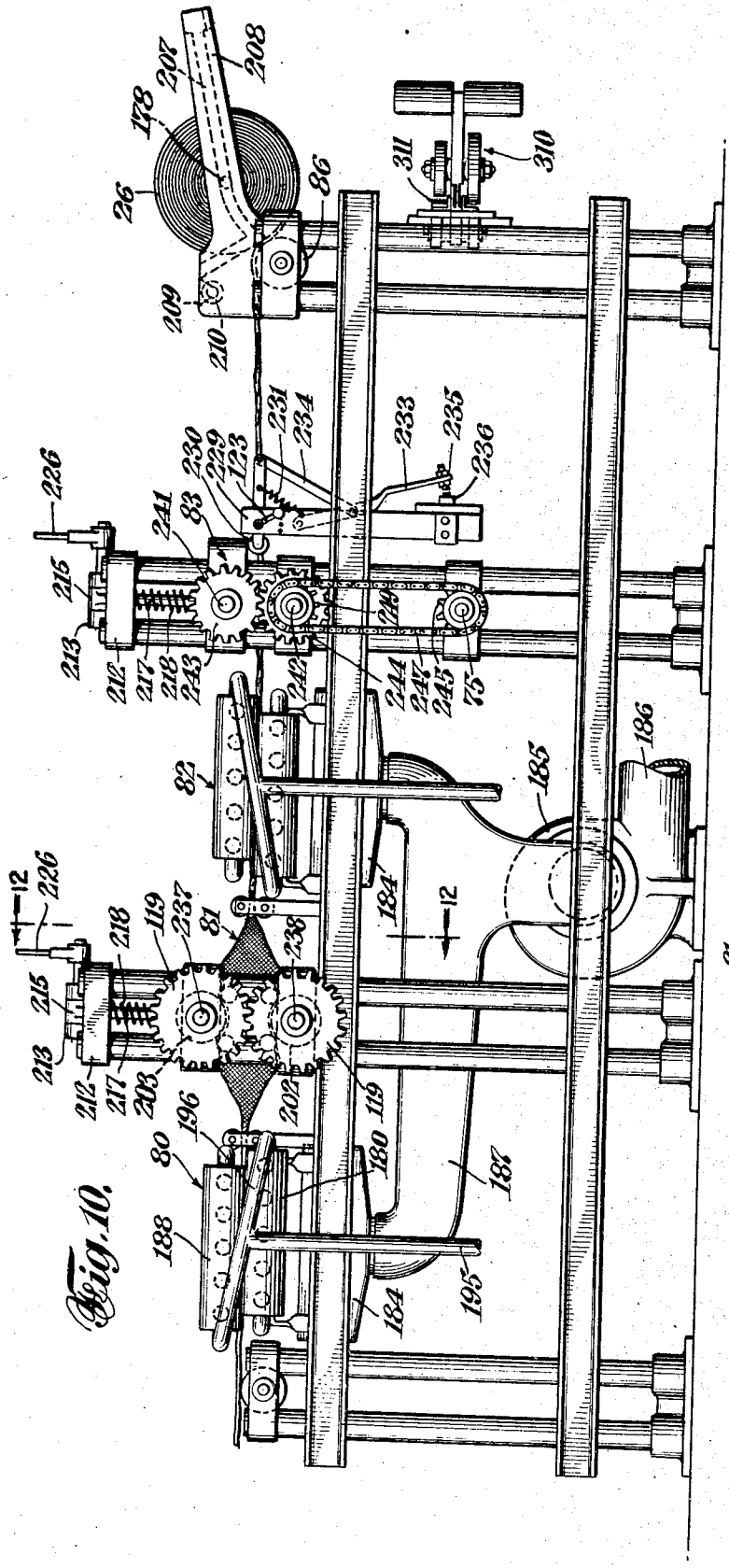

Fig. 10.

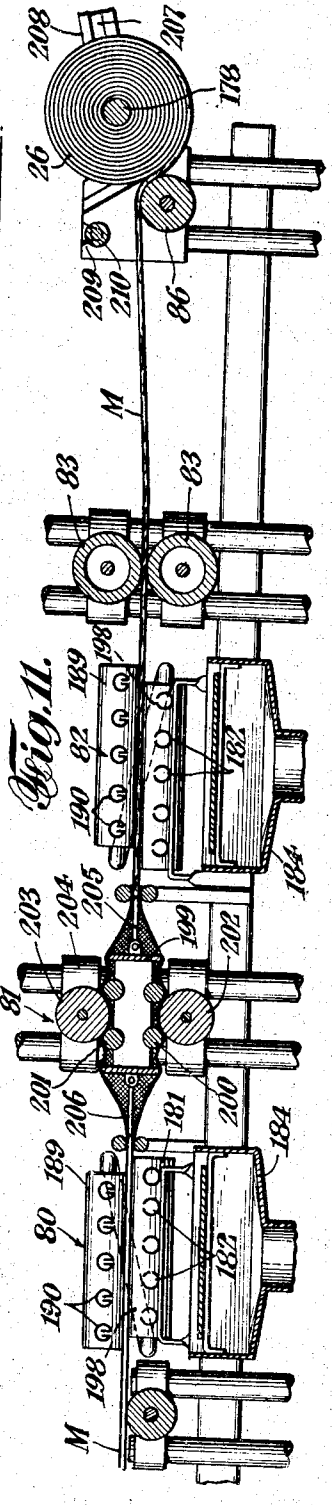

Fig. 11.

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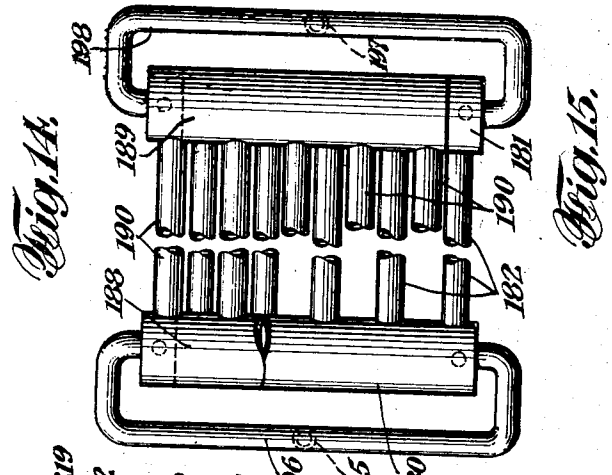

Fig. 14.

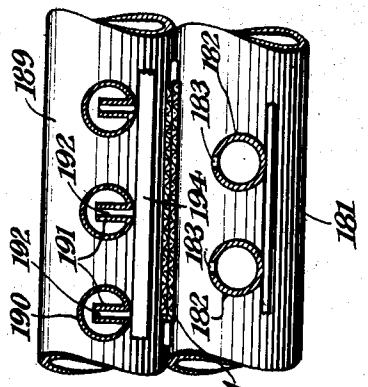

Fig. 15.

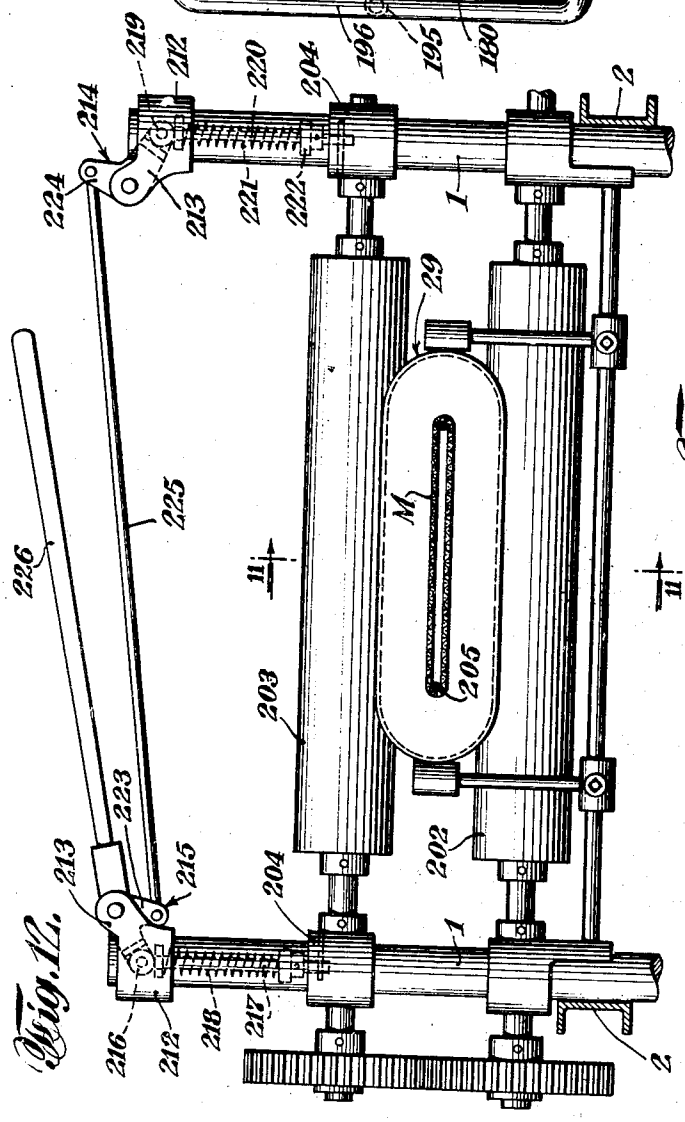

Fig. 12.

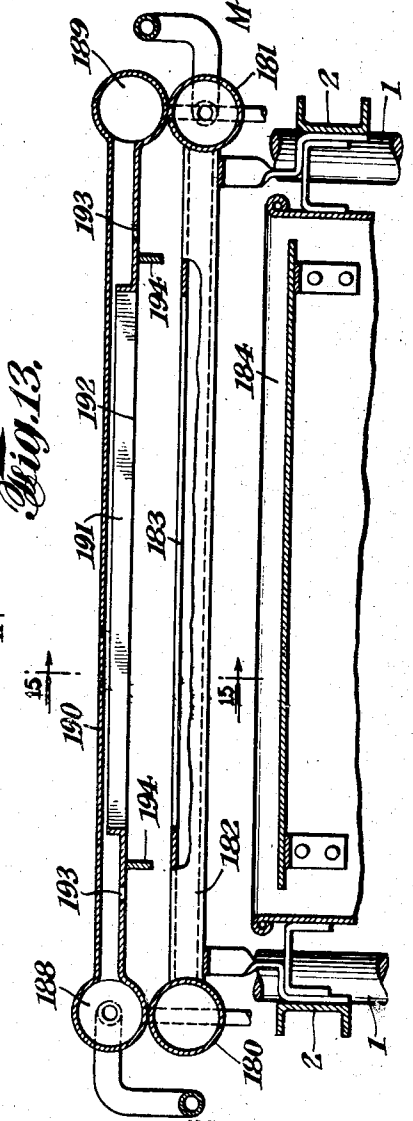

Fig. 13.

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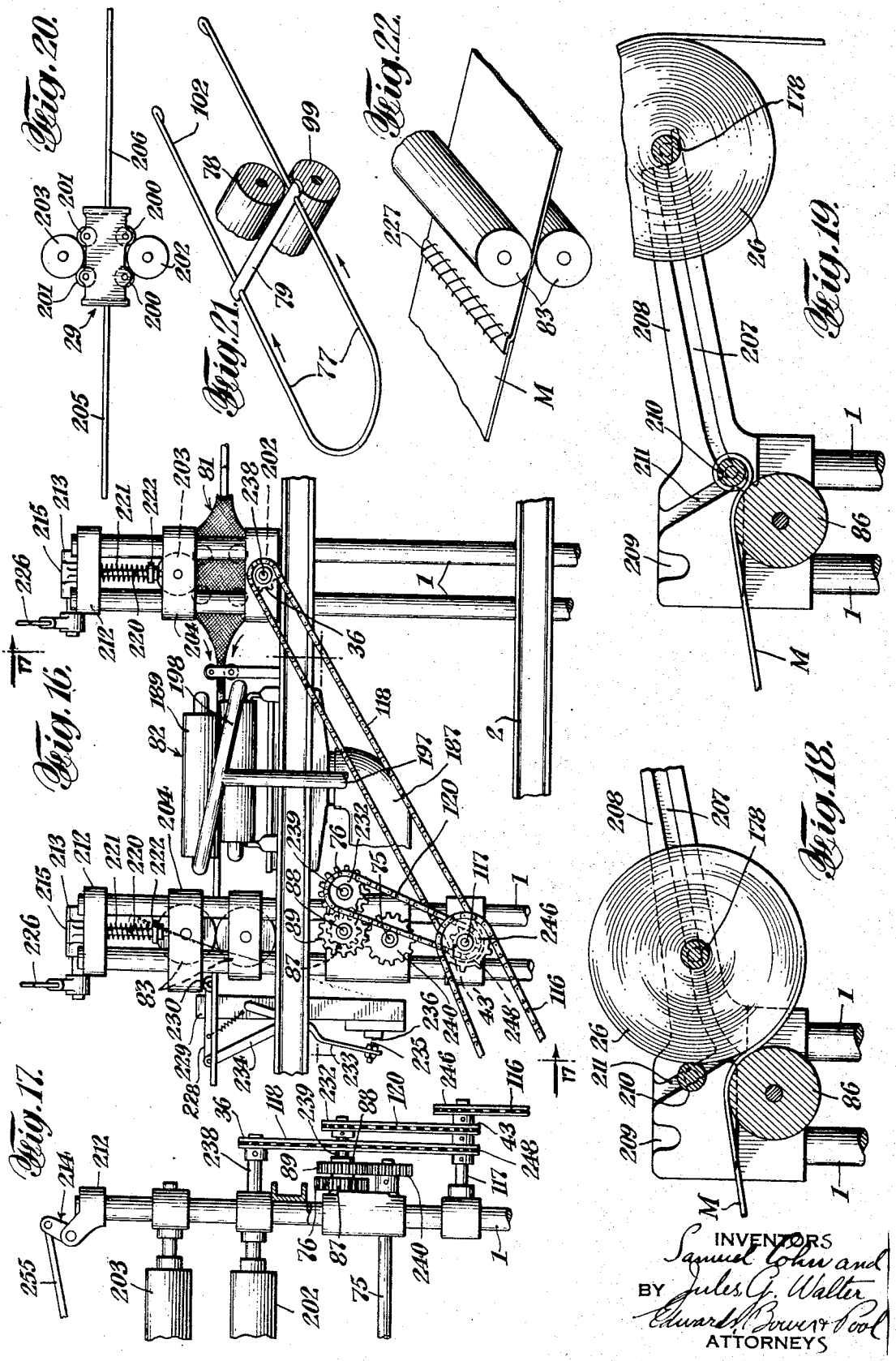

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SYSTEM FOR TREATING FABRICS

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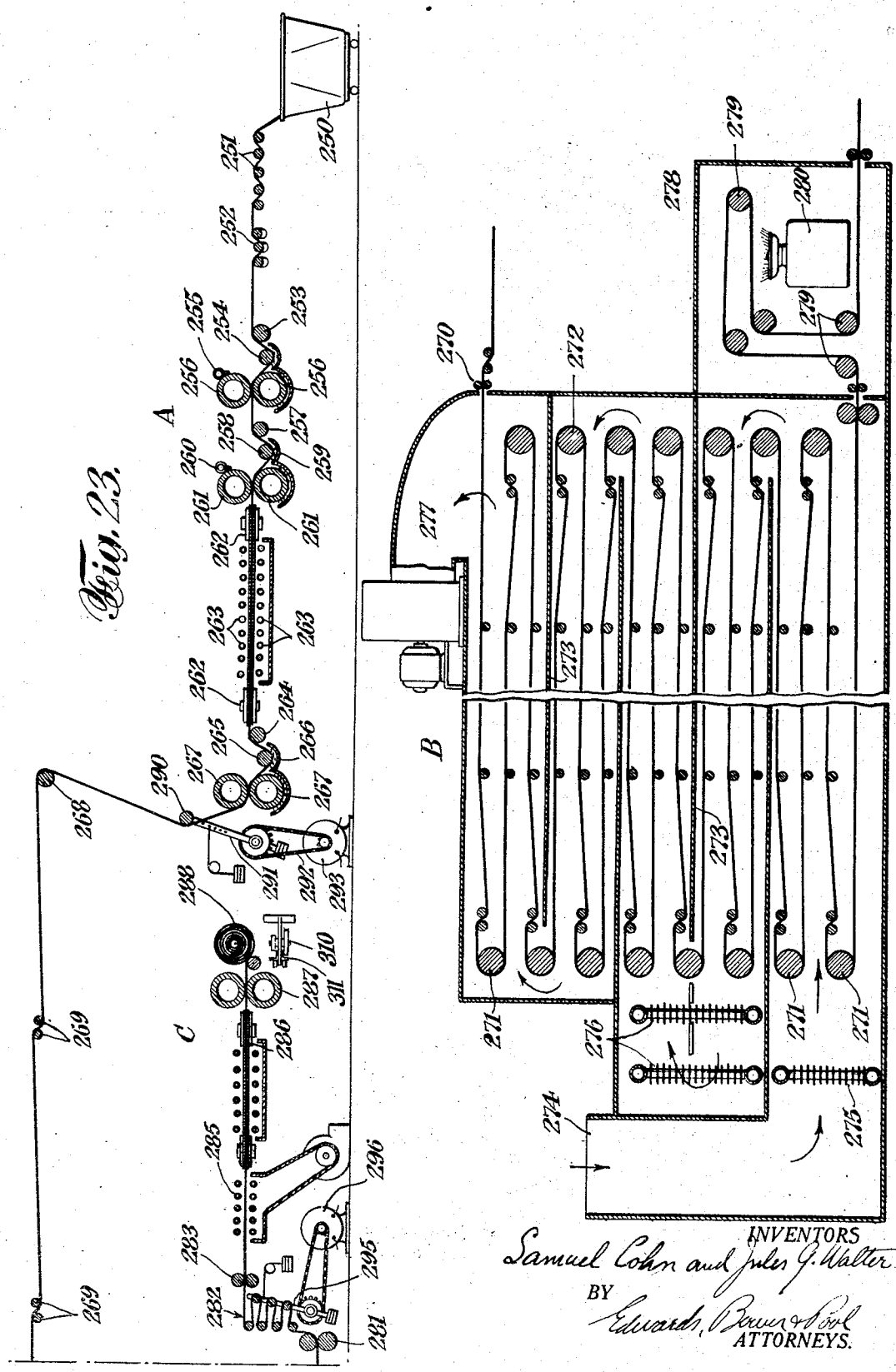
Fig. 23.



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Patented Mar. 1, 1938 2,109,469

UNITED STATES PATENT OFFICE

2,109,469

SYSTEM FOR TREATING FABRICS

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Application September 29, 1933, Serial No. 691,522

12 Claims. (Cl. 26—56)

This invention relates to the treatment of fabrics and particularly the treatment of the fabric strip in a series of related operations.

The main object of the invention is to provide a method and apparatus for preliminarily treating the fabric, then drying it, then finishing the dried goods, all in continuous sequence and definitely predetermining and accurately maintaining the conditions of each treatment, while at the same time preserving the desired cooperation between the successive steps.

Further objects of the invention particularly the details of the successive apparatuses and controls therefor in the treatment to handle the fabric will appear from the following specification taken in connection with the accompanying drawings in which

Fig. 1 is a diagrammatic view in elevation showing the successive treatments of the material designated generally A, B and C;

Fig. 2 is a schematic view showing the relation of the drives for the various parts of the apparatus and the controls therefor;

Fig. 3 is a diagram showing the electrical connections for the driving means;

Fig. 4 is an enlarged cross-section of the preliminary treating apparatus designated generally by A in Figs. 1 and 2;

Fig. 4a is a sectional view illustrating a detail of the friction clutch drives for the rolls of the drying mechanism;

Fig. 5 is a plan view of a rectifying device in which there is shown a driven roller over which the fabric travels and in relation to which the rectifier is adapted to maintain the fabric centralized;

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 5;

Fig. 7 is a view similar to Fig. 5 but showing our invention in a modified form;

Fig. 8 is a cross sectional view taken on the line 8—8 of Fig. 7, but illustrating a further modification;

Fig. 9 is a perspective view showing how the rectifier may be employed in a drying apparatus having the fabric engaging over a plurality of propelling rollers, so that it travels in a series of horizontal planes;

Fig. 10 is a side elevation of a finishing machine in preferred form and illustrating the steaming device operating in advance of and after the propelling device in addition to the finishing rollers;

Fig. 11 is a longitudinal sectional view taken on the line 11—11 of Fig. 12;

Fig. 12 is a sectional view taken on the line 12—12 of Fig. 10;

Fig. 13 is a cross sectional view showing the principal parts of one of the steaming devices;

Fig. 14 is a plan view of one of the steaming devices;

Fig. 15 is a sectional view thereof taken on the line 15—15 of Fig. 13;

Fig. 16 is a side elevation of a part of the machine showing the change gear device for adjusting the longitudinal tension in the fabric;

Fig. 17 is a sectional view thereof, taken on the line 17—17 of Fig. 16;

Fig. 18 is an enlarged sectional view of the wind-up and arbor changing devices;

Fig. 19 is a similar view showing how the wound-up fabric is shifted and a new mandrel placed in position to receive the newly created end of the fabric;

Fig. 20 is a side elevation illustrating the propeller and the spreaders carried thereby.

Fig. 21 is a perspective view of one of the spreaders;

Fig. 22 is a perspective view showing the approach of one of the seams to the finishing rollers; and

Fig. 23 is a diagrammatic view of a modified form of apparatus adapted to treat flat material.

In the fabric treating system of this invention the material is continuously subjected to a series of operations in certain sequence and at predetermined rate, each operation succeeding the previous one in definite timed relation and with the maintenance of identical conditions so that all portions of the fabric are similarly treated, dried and finished without any intermediate handling and without the interposition of any variable operation likely to cause a difference in different parts of the material. Successive lengths of fabric are seamed together so that each leading strip will carry the following strip with it, and then at the end of the finishing operation these successive strips are again cut apart without stopping the mechanism, which is thus kept in continuous operation so long as there are successive strips to be operated on. Not only each individual strip is thus subjected to identical operations from end to end, but also successive strips are similarly treated unless there is an intentional intermediate adjustment of parts of the machine to definitely treat the successive strips. In any case material of one kind is identically treated throughout on both sides, along the edges and in the middle, the successive operations following each other in precisely de-

termined sequence so as to entirely avoid any possibility of variation.

The system has been shown applied to tubular fabrics and in the specific embodiment of the invention shown in Fig. 1 the mechanism is in three parts designated generally A, B and C, A corresponding to the preliminary treatment, B to the drying and C to the finishing. The strip of fabric is continuous through the three operations, feeding from the basket or container 25 and being wound up in finished form on the roll 26. The material in the container 25 is usually in soft, wet form fresh from the dye kettle and may be centrifugally extracted or may have the extraction performed during the preliminary step A of the present mechanism. The material M feeds first through the guides 27 tending to aline it in generally flattened form and then over the guide roll 28 to the feeding propeller and spreader designated generally at 29. This propeller 29 is of well known construction to be described in detail later and acts to accurately spread and expand the material without imposing any drag or stretching, simply moving the material while positioning it in tubular form around the guide surfaces of the interior parts. From this spreading action the material is delivered at the end of the propeller 29 over the roll 30 to pass under the roll 31 where it may be subjected to treatment with any desired treating liquid. If the first operation is an initial cleansing and extracting, the fluid in the trough 32 of roll 31 will be water which will soak into the material which then passes between the squeeze or wringer rolls 33, 34 pressed together under a predetermined force applying the proper compression to the material to give the desired wringing or extracting action. Water is supplied by the spray means 35 at the upper front surface of the upper roll 33 so that both sides of the material are supplied with the liquid in advance of the squeezing or wringing action.

The material thus cleansed then passes into the secondary treatment of the preliminary stage and runs over roll 37 and under the submerging roll 38, passing the material through the liquid in the second trough 39 in advance of the second set of squeeze rolls 40. This second treatment is usually a chemical treatment in a liquid supplied to the upper spray means 41 and to the trough or pan 39, the surplus passing over into overflow trough 42 underneath the lower roll 40. In this way the upper and lower surfaces of the material passing are thoroughly impregnated from below and from above after which there is an immediate wringing or extracting action under the pressure of the rolls 40 which pressure is predetermined to give the proper action to cooperate with the other factors, mainly the hardness of the surface of the rolls 40 and the consistency and other characteristics of the treating liquid, such as its concentration.

The material delivered from this first stage A is thus cleansed and chemically treated in any desired manner while at the same time the tubular fabric itself has been accurately expanded into tubular form with its loops precisely arranged and then again flattened and pressed while being maintained in this accurately flattened form. The material in the container 25 is in a rope form without any accurate relative positioning of the loops with relation to each other or any predetermination of the relation between the length and width of the fabric strip. This first stage of preliminary treatments in spreading and propelling the material is so adjusted as to accurately control and predetermine the width of the fabric so as to have it in proper condition for the subsequent treatments and in a condition favorable to the production of the final width.

This adjustment of the structure of the fabric in the preliminary treatment A determines the speed of progress of the material over the propeller and into the treating rolls and this speed will vary with the various treatments and is fixed for a given strip according to the condition of the strip of the material itself. Preferably, as hereinafter explained, the material will be fed slightly slower through the propeller 29 so that there will be a predetermined and controlled tension between the propeller and the subsequent rolls. In general practice whatever tension is established between the propeller and the first treating rolls 33, 34 will be maintained between these rolls and the subsequent rolls 40.

After the preliminary treatment the material is passed to the drying operation designated generally at B. As shown in Fig. 1 the strip passes upward around the upper guide roll 44 and through the successive series of alining or rectifying rolls 45, 46 and 47 which rolls act as hereinafter explained to keep the strip properly flattened and centered. Then the material passes through the entrance idler rolls 48 at the edges of the slot 49 of the drier casing. These rolls 48 act mainly to close the opening 49 and reduce the air leakage into the drier.

In the drier the material passes over a long series of driven rolls carrying the material around and back many times while subjecting it to a current of drying air under less than atmospheric pressure. This material passes from the first rolls 50 around the end roll 51 of the first length, then around the second roll 51 to lead back horizontally toward the entrance end, passing around roll 52 and back horizontally around roll 53, thence back and forth from the rolls 54 and 55 in a number of sequences giving repeated horizontal lengths travelling in opposite directions to the end rolls 56 from which the material is carried to the outer chamber 57 between the rolls 58 and up to the re-entrance rolls 59 where the material is again introduced to the upper or outlet part of the drying chamber where the air has a higher content of moisture. It has two lengths of travel in this upper chamber. After passing around roll 60 it is carried backward to the entrance end of the casing out through the slot 61, around the guide rolls 62 and 63 to the rolls 64 and thence through the feeler mechanism designated generally at 65 to the finishing operation at C.

In the drying chamber the horizontal lengths of the material are supported by the guides 66, arranged as designed, and preferably each length of the material in the drying chamber also passes through a rectifier 67 to maintain the corresponding length flattened and alined with respect to the driving rollers. The drying chamber itself is preferably divided into a series of lengths by baffles or partitions in the general manner shown in Fig. 1 where the lower partition 68 is above the four lower lengths of the material and each of the succeeding partitions 69, 70 and 71 is spaced to contain three lengths between them. The air entering the inlet 72 passes over the heating aerofins 73 and then in succession to the lower chamber below partition 68 and succes-

sively through the subsequent chambers under the partition 69, 70, 71, and then through the uppermost chamber and out through the exhaust passage 73 to the exhausting blower 74.

With this arrangement the material travels generally counter to the current of the drying air although certain lengths in each subcompartment move in the direction of the passing air. In general the material being dried is subjected to drier air and the wetter material to wetter air but as a controlling modification of this countercurrent drying effect the auxiliary loop designated L passing around the roll 60 is the driest material and is subject to an atmosphere of air of the highest moisture content. In this way the material is first reduced to a minimum moisture content and then has some moisture returned to it so that the final content of moisture at the delivery end of the drier will be somewhat in excess of the moisture content of the material as it leaves the lowermost chamber. This provides automatic control of the moisture content tending to take care of varying widths, weights and materials so that the drying operation will have the desired effect with these various materials in removing the moisture and delivering the material with the proper amount of moisture to cooperate with the subsequent steps in the finishing operation at C.

In the drying operation the material will change mainly by shrinking and narrowing as it progresses, the shrinkage tending to require a slowing down of the successive driving rolls and the narrowing having a contrary effect tending to require the successive rolls to travel at a slightly higher speed. As between these two effects there is great variability in the successive convolutions through the drier and with the various materials and widths so that the driving rolls within the drier are made automatically adjustable to these changeable conditions and for this purpose are frictionally driven with an automatic slip between the roll and its driver whenever the material exerts a predetermined resistance. Within the drier therefore the speed conditions continually change from point to point and between intake and output and these conditions also change in relation to the proper speed of drying for the preliminary operations at A.

As the material proceeds from the drier to the finishing operation only a relatively very light tension is desired and the material under this tension is delivered directly through the double steam operation indicated at 80 to the propeller 81 and then to the second steaming operation at 82 just in advance of the final pressing or finishing rolls 83, after which the material running under the guide roll 84 is cooled or sprayed and cooled under the action of air blast from the blower 85. It is then wound up on the final roll 26 over the driven delivery roll 86.

The spreading action of the propeller 81 is adjustable and is carefully predetermined to give the proper expansion to the material so that after the final steaming, finishing and cooling the desired final width will be attained. As the material is spread in width it tends to shorten in length and consequently the speed of the propeller drive has to be accurately adjusted to the material to avoid excessive tension and similarly the tension between the propeller 81 and the final finishing rolls 83 is carefully adjusted to give the proper relation between width and length as desired in the final product. Additionally a final control is exerted between the speed of the finished rolls 83 and the wind up at 26, the general operation of the finishing apparatus being to receive the material relatively narrow in width, to steam and soften this under slight tension and to then expand this on the propeller 81 to a total transverse periphery corresponding to a width in predetermined relation to the finally desired width. Then there is a slight narrowing under the tension between the propeller and the finishing rolls 83 and a further slight narrowing between the finishing rolls and the wind up rolls due to the tension and to the cooling.

In order to drive the entire apparatus with its successive stages A, B and C (Fig. 2) in continuous operation and maintain the proper relative velocity conditions, a unitary control is used which utilizes three separate motors one for each stage, motor 90 for stage A, motor 91 for stage B and motor 92 for stage C. The motor 90 through the worm drive 93 drives the lower wringer roll 34 at a predetermined speed as set by the rheostat 94 of the main control. The propeller drive is taken from shaft of roll 34 by sprocket and chain drive 95 rotating a gear 96 of the variable gears designated generally at 97 connected to the lower roll 98 of the propeller 29. These gears 97 may be changed to vary the speed ratio between the propeller 29 and the wring roll 34.

Similarly a chain 100 of sprocket on shaft of roll 34 drives the changed speed gearing 101 rotating the lower roll 40 of the second set of wringer rolls and this changed speed gearing 101 permits the speed ratio between the two sets of wringer rolls to be varied as desired. In the preliminary apparatus for cleansing and treating the fabric the successive steps are thus variable as to their relative speeds but in turn all vary together by the speed of the motor 90 predetermined by the setting of the rheostat 94.

In the drier unit designated generally at B the motor 91 through the worm drive 103 drives the chains 104 and 105 threaded over sprockets connected through slip friction grip devices to the shafts of the driven rolls 50, 51, 52, 53, 55, 56, 60 within the drive and the extension of the chain 105 extends outside of the drive to a sprocket similarly connected through a friction clutch to the shaft of the drive roll 64. As previously explained the friction clutches between the sprockets and the roll shafts permit relative slipping between the drive and the rolls so that some of the rolls will automatically have a peripheral velocity less than the peripheral velocity of such rolls as are rotated at the full speed of the chain drive. Superposed upon these variations is the variation in the speed of the motor 91 automatically controlled through rheostat 106 actuated from the dancer roll 107 between the preliminary treatment stage A and the drier B. As shown in Fig. 1 the dancer roll 107 is adjustably carried by the arm 108 of sprocket 109 connected by a chain 110 and sprocket 111 on the contact arm of the rheostat 106. The arm 108 is held toward the left by the adjustable weights 112 and toward the right by the tension exerted by the material M as it passes from the final wringer rolls 40 to the upper guide roll 44. As the speed of the drier drive increases with relation to the initial drive of stage A the tendency of the material is to increase in tension at the dancer roll 107 so as to press this roll to the right and turn the arm of rheostat 106 in a direction to reduce the speed of the motor 91. This reduction in speed correspondingly releases the tension on the material between stage A and stage B so that the dancer

roll 107 tends to move toward the left by the weights 112 to cause an increase in the speed of motor 91. By properly adjusting the length of the arm 108 and the weights 112 the desired tension in the material between stage A and stage B can be maintained within very close limits so that the speeds of these two stages will be automatically kept in proper relation to each other according to the setting of the initial speed of motor 90.

This desired initial speed will vary with the material being handled and with the treatment applied to the goods, for instance, with heavy materials the initial speed of stage A as determined by rheostat 94 will usually be set relatively slower than for lighter materials.

In the final finishing operation a relatively light tension is used so that the material from the drive is subjected to substantially no stretching. The final feed rolls 64 deliver the material to the dancer roll mechanism 65 from which it is drawn by the drive rolls of the propeller 81, from which the material is drawn by the finishing rolls 83 from which the material passes to the final wind-up roll 26.

These finishing drives are all operated from the motor 92 which through the arm and worm wheel 115 drives the chain 116 rotating shaft 117 and through chain 118 driving the propeller rolls 202, 203. A chain 120 driven from shaft 117 through the change speed gears 121 drives the finishing rolls 83 as shown, these rolls being geared together as shown. The drive for the final wind-up roll 26 is taken from the finishing rolls through chain 122 and change gears 123 (Fig. 2) so that each of these drives, the propeller, the finishing rolls and the wind-up roll may be relatively varied as desired to maintain the desired relative speeds and the tensions on the passing material. When these relative speeds have been set by proper choice of the change speed gearing, the speed of the entire unit will vary with the speed of the single drive motor 92.

The speed of this motor 92 is controlled by rheostat 125, the regulating arm of which is actuated from the feeler or dancer roll mechanism 65. This mechanism comprises a series of idler rolls 126 on a stationary frame and a second series of idler rolls 127 mounted on the arm 128 counterweighted at 129 and normally held toward the right by the adjustable weights 130. The material M is looped around the idlers 126 and 127 in succession as shown so that there is a multiplication of the tension of the material on the arm 128 tending to tip the arm toward the left and lift the weigh 130 which through sprockets and chain 131 controls the position of the contact arm of rheostat 125. As the speeds of the drier and the finisher vary with relation to each other, the tension on the material will increase when the finisher is running too fast for the drier and similarly will decrease when the speed of the finisher lags. The resultant variations in tension on the material between the finisher and the drier will tip the arm 128 to the left to lower the speed of the motor 92 and to the right to increase said speed. By proper adjustment of the idlers 126, 127 and weights 129, 130 the tension on the material between the drier and the finisher can be kept within very close limits and regulate the speed of the finisher to follow variations in the rate of supply from the drier and to control variations occurring in the rate of feed through the finishing apparatus itself.

As shown in the electrical circuit diagram of Fig. 3, the armatures of the three motors 90, 91 and 92 are connected in parallel across the leads 114, 124 from the variable voltage D. C. generator 132. Similarly the fields 94', 106' and 125' of these motors are supplied with leads 133 and 134 from a direct current exciter 135, the fields being arranged in parallel. Rheostat 106 automatically operated as above described, controls the speed of the drier motor 91 through field 106' and rheostat 125 of the finishing operation varies the field 125' with the finisher motor 92 to automatically regulate the speed of the final finishing operation according to the tension between the drier and the finisher. The speed of the entire apparatus as a whole is controlled through the main rheostat 94 in series with the field 137 of the variable voltage generator 132 so that adjustment of this rheostat 94 will slow down or speed up the entire apparatus to give the desired rate of travel of the material while at the same time maintaining the properly and automatically adjusted relative speeds of each individual part. As hereinafter explained automatic means is provided for operating this rheostat to slow down the speed when a seam between two lengths of material passes through the finishing rolls 83.

The armatures of all the motors being connected in parallel with the generator armature, they will vary in speed as the generator voltage is varied. Consequently by providing a limit switch 138 to control the arm of rheostat 94 the closing of the switch will move the rheostat arm to automatically lower the generator voltage and correspondingly decrease the speeds of the driving motors from the normal speed to any desired lower speed. This limit switch 138 is arranged to be operated by the raising of the final ironing or finishing roll 83 so that as the seam between successive strips reaches these rolls the entire apparatus will automatically slow down to permit the operator to separate the successive strips by cutting them apart and another limit switch 139 preferably engaged at the end of this cutting operation will act to return the arm of rheostat 94 to normal position to restore the motor speeds to normal. In Figs. 1 and 10 a cut off device is indicated at 310 of the type for instance disclosed in U. S. Letters Patent No. 1,745,476 of February 4, 1930, the device being adapted to operate along the cut off bar 311. Upon the slowing down of the machine by the arrival of the seam between the final finishing rolls, the operator disconnects the drive for the wind up roll 26 and moves this roll outward on its supporting bracket 208 and replaces its mandrel 178 with another mandrel 210. In the meantime the slack in the material between the wind up roll and the guide roll 86 accumulates and drops downward until finally it lies over the cutter bar 311, and when the seam between the strips is about to pass over this cutter bar, the operator moves the cutter 310 across the cutter bar to separate the strips along the line of the seam, then throwing the end of the following strip of fabric over the new mandrel 210 so that this will immediately begin to wind up the following strip.

In this way the continuity of the movement of the strips through the machine is preserved and there is no stoppage of the machine at any point of the operation; all moving surfaces are kept in relative motion and there is only a slight temporary slowing down of the mechanism just sufficient to provide for the cutting apart of the successive strips.

The operating functions of the entire machine

thus provide for acceleration to a predetermined speed as set on the rheostat **94** of the generator feed and deceleration to a fixed low speed which is always the same. The operating speed range may be, for instance, six to thirty-two yards per minute for the wringer unit A and 50% above or below any speed between these limits for either the drier or finishing units B or C.

This apparatus with its combined drive and speed control takes care of all of the operations from the moment the fabric is taken from the dye kettle and fed into the machine. The moisture is extracted, the fabric treated, dried, steamed, finished and rolled up with the proper yardage. All movements of the fabric are automatically correctly co-ordinated. Preparatory to its entry into the machine the fabric is in loose rope form. After it passes through the wringer it is spread out to flat width to any dimensions desired.

While the drive and control of the relative speeds of the successive units of this system have been described in connection with a drive by inter-related electric motors, other forms of driving means may be used giving the desired automatic speed variation of the successive stages and of the machine as a whole.

Since the fabric is of knitted construction and subject to varying dimensions, it would tend to get narrow and longer at some times and wider and shorter at others. To compensate for the varying dimensions which the fabric assumes and to maintain the desired tensions and conditions of the fabric at each part of each operation, the drive units are subject to relative variations within each stage and to automatic variation of each stage with relation to the other and within the drier to the automatic slippage provided by the friction clutch drive on each roll.

There are three main variations in the dimensions of the fabric. Initially the fabric is spread to predetermined width over the wringer propeller and thereafter in its flat wet form is subject to change of dimensions through decreased width and increased length through the tension exerted thereon preparatory to its entry into the drier B. Similarly the fabric tends to decrease in width and increase in length in its passage through the drier from its wet to dry form due firstly to the natural shrinkage taking place as the fabric dries and secondly to the tension exerted on the fabric to maintain its proper passage therethrough. As the fabric emerges from the drier in flat dry form its width must be co-ordinated with the final desired width after finishing, and it is, therefore, subject to varying dimensions on the propeller of the finishing unit C. Within the drier box, both width and length dimensions vary from layer to layer as the fabric passes into various stages of drying in the drying chamber B, and similarly in its passage through the finishing machine after passing over the propeller. Prior to its passage through the finishing rolls and subsequent thereto the fabric assumes varying dimensions due to the factors of steam application, natural shrinkage and cooling forces, all of which affect the fabric. The automatic control of the tensions both in the drier box through the friction clutches and the change gear units on the finishing machine before and after its passage through the finishing rolls give the automatic control necessary to the proper co-ordination of dimensions to obtain the proper finished width.

With the apparatus of this invention all of these variations are accurately and precisely accommodated and maintained in proper relation to each other without stretching or straining the fabric and with a continuous progress of the fabric from end to end of the successive treatments. This is accomplished by prearranging the relative speeds of the successive treatments within the stages A and C, preadjusting the spring tensions on the various friction clutches of the drier rolls and permitting the material to automatically adjust itself within the convolutions of the intermediate drier stage, while at the same time driving the drier and finishing units B and C in constantly adjusted speed relation to each other and to the speed of the material as it is fed from the initial cleansing and treating operations at stage A. As a definite example any frictionally clutch driven roller in the drier has several settings of spring pressure within the limits of which the speed of the roll is automatically controlled by the passage of the fabric thereover.

The entire operation under the unified control of the successive treatments makes it possible to automatically handle the material from raw form to the finished form on the wind-up roll **26**. The mechanism is readily adjusted to fabrics of different weights and sizes involving wide differences in elasticity and in the behavior of the fabric in the reaction to the successive stages of the treatment. Having pre-set the relative speeds within each stage and the relative frictions on the driving clutches of the drier roll, the remaining action of the apparatus in accommodating itself to the peculiarities of each part of each different strip of material is entirely automatic.

The apparatus of stage A is specially adapted to give a very thorough cleansing and/or treatment of the material as it passes. As illustrated in greater detail in Fig. **4** the propeller **29** due to the operation of the upper and lower propeller rolls and the action of the spreading frame expands the tubular material in very smooth and accurate manner avoiding all undue strains or stretching of the material in the formation of wrinkles or other irregularities. This controlled expansion of the material also accurately adjusts and positions the individual loops of the material from point to point so that the subsequent tension of the material between the propeller and the squeeze rolls draws these loops longitudinally and transversely together in very even formation, while the fabric is guided into its flat form over the guide roller **30**.

The material so rearranged and maintained in its flat condition with the upper and lower layers positioned together and mutually self-supporting is carried around under roll **31** beneath the surface of the treating liquid in the trough **32**. Immediately thereafter the movement of the material exposes its upper surfaces to the flow of the treating liquid passing down over the front surface of the roll **33** and on to the surface of the fabric as it passes upward around with the rotation of the lower roll **34**. Both sides of the fabric strip are thus substantially simultaneously exposed to a bath of the treating liquid which flows down from above and is supplied at constant depth in the trough **32**.

The reservoir of this liquid is indicated at **141**, the supply being put under pressure by pump **142**, passed upward through pipes **143**, **144** leading respectively to the upper distributor **35** and the trough **32**. The surplus flow from the distributor **35** passes down into the trough **32** of roll **31** or trough **145** under roll **34**, and the overflow from

trough 32 passes down into the trough 145 and out through the overflow drain 146 back to the reservoir 141. The material passing around the rolls 31 and 34 is thus subjected on both of its surfaces to a bath of the treating liquid, and while thus tensioned and saturated, it is passed into the bite of the rolls 33, 34 preferably hard surfaced and with the compression between them adjusted to remove the surplus liquid to desired degree, depending upon the material and the character of the treatment.

After this preliminary treatment, which may be either cleansing or some chemical treatment, such as loading, applying pigment for dyeing, sizing, or the like, the fabric strip is carried over the guide roll 37 to the dipping roll 38 carrying the material down into the liquid in the second trough 39 and then passing the strip up around the surface of the lower roll 40, preferably surfaced with softer material than the rolls 33, 34. The upper liquid supply 41 maintains a constant flow of the second treating liquid over the upper surface of the strip on the roll 40 so that the fabric is again bathed on both its surfaces and then squeezed in the bite of the second wringer rolls 40 and compressed together to remove the desired amount of surplus liquid from the fabric as it passes, and leaving within the fabric a predetermined amount of the treating chemical. The supply of liquid as in the previous step is drawn from a reservoir 141' sucked up by pump 142' through pipes 143', 144' to the distributor 41 and trough 39 from which the overflow is passed to the trough 42 and back to the reservoir through the overflow drain 146'.

The second step of this treatment will depend on the character of the first treatment. Following the cleansing a dyeing, loading or sizing step may be used, or following an original pigmentation a second fixing step may be applied, for instance. In any double chemical treatment the material supplied to the container 25 will, of course, be centrifuged or otherwise extracted or dried.

The material thus cleansed and treated is still in wet condition, and in the system of this invention passes immediately to the drier where it is carried in tortuous passage over the driven rollers 51, 52, 53, 54 and 55 at each end of the drier chamber and through the successive subcompartments to driest condition in the lowermost portion of the chamber. The number of sub-compartments is optional and may be made more or less dependent upon the requirements. There may also be more or less lengths of fabric in each compartment.

The small idler rollers 66 hold the fabric suspended in each layer between the driven rollers, and the fabric in each layer passes over five such idlers. The guides or rectifiers 67 are set directly in front of most of the driven rollers 51, 52, 53, 54 and 55 so that the fabric is kept in spread condition, and at the same time properly centered in its tortuous progression through the machine. These rectifiers 67 must be set in front of the driven rollers at the end of each chamber where the air turns from one chamber to the next, at which point the air blows directly against the fabric and would disturb and wrinkle it if it were not for the rectifiers.

A suction blower 74 draws the air from the drier chamber creating a suction throughout the entire five subcompartments so that the air progresses through the drying box in a course of travel as indicated by the arrows, the entire interior being under less than atmospheric pressure. When the dissipated air discharged by the blower 74 is not completely saturated with water to its capacity, it is feasible to recirculate a part of this air so that a definite portion of it will be supplied with the fresh air entering the aerofin units at 72. This tends to reduce the steam consumption as the recirculated air still retains some of its original heat. Without recirculation the normal temperature drop from 220° to 100° for instance, indicates efficient drying with no waste of steam. The temperature of the initial air depends upon the amount of steam pressure used, which may vary from five to one hundred twenty-five pounds, which in most cases is boiler pressure. Where the temperature of the air at the inlet is 140°, it emerges at a temperature of approximately 80°. Where the air enters at a temperature of 260°, it emerges at a temperature of about 140°.

In this system of drying the hottest air comes into contact with the driest goods, thereafter passing through the various chambers picking up moisture from the wet fabric, which moisture upon entering into the air current decreases the temperature. A temperature drop from 220° to 100° indicates efficient drying and practically all of the drying is done in the four upper compartments so that the fabric is quite dry when it enters the lowermost compartment, which is mainly an extra precaution to allow for varying conditions in the drier, such as changes in boiler pressure, different time elements of the fabric in the drier due to the slowing down of the machine, varying widths of fabric and varying weights of fabric, as well as the different types of yarn composing the fabric. The excess drying taking place in the lowermost chamber 5 can be eliminated by the use of instruments for humidity control, or denoting the moisture content in the fabric at the drying box outlet. In addition as shown in Fig. 1 the dried material may be carried back again into one of the earlier compartments to pick up some additional moisture and correct any tendency to overdrying that may have occurred. Additional moisture treatment may also be provided between the drier and the finishing step as indicated for instance in Fig. 23.

The blower 74 may be varied in capacity depending upon the temperatures and the condition of the material being dried. It may for instance pass about 5,000 cubic feet of air per minute for a speed of the fabric corresponding approximately to thirty yards per minute. If the number of drying chambers and layers of fabric is increased, a lower temperature of the air is necessary for drying as the time element of the fabric in the drying box increases. With sufficient drying chambers it is possible to dry the fabric with air at much lower temperatures. It is proportionally much cheaper to heat air to a relatively slight degree so that in each installation a most economical balance may be reached between the length of the drying chambers and the temperature of the air.

With the single draft drier of this invention the conditions of installation and the control of the drying are completely flexible for adaptation to local conditions of heat supply and space available and under all conditions efficiently apply the drying air to the material as it passes. Without departing from the spirit of the invention the flow of air to the drier may be initiated either by blowing or suction at either end of the drier. This method of drying as shown in the drawings

directs a single preheated air flow to the fabric in one continuous passage through the drying chambers.

During this drying of the long length of fabric looped back and forth between the driving rolls and subject to air currents of considerable velocity, there are wide variations in the condition of the fabric not only as to its moisture content from end to end of the drying chamber, but also as between successive convolutions of the fabric. Some of the fabric lengths between the rollers at each end will tend to sag while others will tend to tighten. It is vital to the operation of the apparatus that the relative tensions between the successive convolutions be controlled and maintained within quite definite limits, as otherwise excess of tension would develop at some point tending to injure the fabric and too much slack at other points tending to drop down and interrupt the proper feeding of the material through the machine, or tend to under dry those sagging portions. Any such irregularities will result in a corresponding irregularity in the width, texture and appearance of the final product.

To automatically control and even the tensions of the successive convolutions each of the driving rollers **51**, **52**, **53**, **54** and **55** is provided with a special drive by means of a friction clutch (Fig. 4*a*) to maintain a predetermined tension on the fabric passing over the corresponding roller. These tensions are adjustable so that each roller will be initially set for each class of goods with the appropriate attention to maintain proper operation, and during operation these tensions may be varied and readjusted as desired to maintain the most desirable operating conditions. In Fig. 4*a* the roller **51** is shown with a typical friction clutch drive on the shaft **300** passing through the side partition **301** of the drier. On the shaft **300** the sprocket **302** is rotatably mounted between the friction disks **303** and **304** contacting with the sprocket by facings of fibrous material such as asbestos. The disk **303** is rigid with the shaft of roller **51** and turns with it. The disk **304** is rotatable on the shaft and is pressed by the spring **305** between disk **304** and slidable collar **306**, which in turn is held by a yoke member **307** mounted on a ring **308** set in place on the shaft **300** by the set bolt **309**. The yoke **307** is pivotally mounted on the ring **308** and has three positions of adjustment corresponding to three different positions of the collar **306**, which thus acts to adjust the pressure of the spring **305** holding the disks **303**, **304** against the sides of the driving sprocket **302**. This yoke adjustment is superposed upon the primary adjustment made by the setting of the ring **308** so that there is a large range of adjustment of each friction clutch, and as between the different rolls there may be wide variances in the spring pressures and the resulting frictional engagement.

The driving chains **104**, **105** pass over all the sprockets **302** to drive the rollers at the intended maximum speed of the drier, which is for instance, thirty yards per minute. The predetermined tension on any fabric layer between two driven rollers is greater than the set friction of the hubs or disks **303**, **304** against the sprocket **302** so that the rollers will normally move at the same speed as the fabric passing thereover. Assuming, however, that the cloth tends to move at a slower speed than the set speed at which the chains and sprockets move, then the tension on the goods between two driven rollers will create a drag on the shaft of the second roller, and the disk **303** will tend to lag with respect to the corresponding sprocket **302**, and when this tendency exists the set friction between the sprocket and the disks will permit the sprocket to continue to revolve but the corresponding disk **303** and its roller will slip in the sprocket and rotate at a lower speed conforming with the speed of the fabric. If it is assumed that while the driven rollers are moving at the rate of twenty yards per minute the fabric is moving faster and therefore tending to accumulate slightly, there will be no or very little tension on the fabric between the two driven rollers, and, therefore, no resistance or insufficient tension to overcome the light frictional contact of the disk **303** against the sprocket **302**. In such case the shaft **300** and the connected driven roller will tend to increase in speed approaching the maximum speed of the sprocket **302** to the point where the predetermined tension on the fabric between the driven rollers is re-established, and thereafter the rate of travel of the rollers will be controlled by the fabric passing thereover. It is clear that while the sprockets **302** actually turn the driven rollers, the rate of speed of the driven rollers is controlled by the rate of travel of the fabric itself as it passes thereover. If the fabric tends to tighten in tension or move slower than the driven rollers a drag will be created on the rollers which reflects itself on the shaft **300**, which will decrease in speed to the point where the predetermined tension on the fabric is re-established.

In this way a variable speed is obtained for each driven roller **51**, **52**, **53**, **54** and **55** whereby a definite and predetermined tension is established and maintained on each increment of the fabric as it passes over the successive rollers, and any variation from this predetermined fabric tension, either greater or lesser, will tend to decrease or increase the speed of the rollers and re-establish the predetermined fabric tension. This same relation exists between any two given layers of the fabric.

Under actual working conditions the variations in speed of the fabric between running tight and loose exist only between quite fixed limits because when a difinite spring tension against the disk **303** is used there will not be any violent fluctuations in fabric tension except that the influencing tendency exists to maintain the uniform and predetermined fabric tension. Where violent changes in the fabric tension tend to occur, they are overcome by adjustment of the spring tension against the disk **303** to increase or decrease the speed of the driven rollers in operation to the maximum set speed of the sprocket **302**.

In this way the driving means passing the material through the drier is continually kept in condition to automatically and immediately anticipate any fluctuations in the tension of the strip as it passes, the proper corrective movement of the individual rollers being immediately affected. This variable response is very noticeable in the operation of the machine. The relative speeds of the rollers are continually changing as the material develops irregularities and lags in its progress through the successive convolutions. All of the interior strains on the material are thus reduced to a minimum and even tension within very close limits from end to end of the drier as a unit is maintained.

The efficiency as well as the eveness of the drying and its effect on the fabric are greatly improved by the maintenance of the proper tension

on the material so that each increment of the strip as it passes receives exactly the same drying treatment corresponding to maximum effectiveness.

Cooperating with this automatic self-adjustment of the driving rollers **51**, **52**, **53**, **54** and **55** are the guides or rectifiers **67** positioned preferably in advance of each of the driving rollers.

A belt, band or strip of material running over rolls or pulleys has a tendency to run off one side or other of the roll or pulley unless there is something to hold the material properly centered and alined. It is especially difficult to control the travel of material, such as textiles, over rollers and pulleys because the material is soft or non-rigid and this is specially true of knitted fabrics due to their loose or limp construction, and in tubular fabrics of this character there are superimposed layers, which, especially if in wet condition, are difficult to handle in the flat form so as to maintain them centralized on pulleys or rollers and to move them without shift laterally.

The problem is even more difficult where the fabric is looped back and forth reversely over a plurality of rollers so that the fabric travels in a succession of horizontal runs because it tends to accumulate creases wherever it is reversed in direction and also to run off toward one side or other of the pulleys or rollers.

In the present invention a simple, inexpensive and efficient means herein referred to as a rectifier is provided shown at **67** in Fig. 1 which automatically rectifies the course of travel of the fabric to counteract its tendency to run off the rollers or pulleys and when the tendency to do so arises, to guide the fabric back into central position. The present rectifier gently and gradually guides the fabric back to a centralized position or into its intended path as soon as the tendency to travel laterally on the rollers or pulleys develops, and the device automatically rectifies the fabric or returns it to its intended course, regardless of whether it has developed a tendency to move off to the right or to the left on the rollers or pulleys. Providing flanges on the rollers or pu'leys will not suffice to accomplish this result, especially where the strip of material is textile fabric, but the equalizer operates substantially throughout the width of the strip.

First describing the form of the guide or rectifier illustrated in Figs. 5 and 6 there is shown a roller **51** around or partly around which a travelling strip of fabric **152** is adapted to be propelled, and while this roller may be an idler, it is indicated as being driven by any means engaging the gear **153** on the outer end of the shaft of the roller.

One purpose of the present rectifier is to guide the fabric and to equalize it so that it remains centered in relation to the roller **51**; or, in other words, it prevents the fabric from moving laterally in either direction off the surface of the roller **51**.

Two supporting members **154** are shown at opposite sides of the device, and which are adapted to be mounted say on the interior of the walls of a drying chamber in which the fabric is to be dried. There is a cross bar **155** stationarily mounted in these brackets at opposite ends, the bar **155** being disposed crosswise of the machine or parallel with the axis of the roller **51**. Any other form of support may be employed. A bar **156** rigidly mounted on the bar **155** and projecting forwardly from above the roller **51** to form a supporting member for the pivoted part of the rectifying device is shown. In the forward end of this last mentioned bar there is a stud or bolt **157** and pivotally mounted therein and below the bar **156** is shown a bracket **158**. The bracket **158** is rigidly connected with the cross bar **159** which forms part of the rectifier, so that by the construction just described the rectifier is pivotally mounted on the bolt **157** which is supported by the bars **156**, **155**; and preferably the axis of the bar **159** is in the center line of the correct path of travel of the fabric or in line with the middle of the roller **51**. On opposite ends of the rectifier bar **159** are shown brackets **160** rigidly connected to the bar and forming bearings for the axles of two rollers **161**, **162**. As shown in Fig. 6, these rollers are so disposed that the strip of fabric in approaching the roller **51** engages under the first roller **161** of the rectifying device and thence over the second roller **162**, so that there will be sufficient surface contact of the fabric with these two rollers to cause them to revolve as the fabric travels partly around them. It is to be understood that the rollers **161**, **162** are freely revolvable and their axles may be mounted in ball bearings if desired, in order that these rollers will turn very easily under the traction of the moving fabric.

To limit the extreme diagonal swing of the rectifier on the pivot **157** are shown ears **163** extending upwardly from the opposite sides of the bracket **160** and stop screws **164** are threaded through these ears and they are adapted to engage opposite side edges of the stationary bar **156** for the purpose of limiting the swing of the rectifier on the pivot **157**. These stop screws are adjustable to vary the permissible swing of the pivotal part of the rectifier and they may be secured after adjustment by tightening the lock nuts **165** against the ears **163**.

The pivotal part of the rectifier carries the roll **43** by brackets **43'** on each side fastened to the brackets **160**. This roll **43** cooperates with the rolls **160** and **162** to provide the proper hug contact under sufficient tension to give the required sensitivity to the action of the rectifier, the fabric (Fig. 6) flexing and passing around these rolls as shown. The brackets **43'** may be adjustable as to length and/or angularity to variably position the roll **43** with relation to the rolls **161**, **162** and the roll **51**. With this combination of rolls the tension on the material as it passes through the pivotally carried rolls of the rectifier is rendered largely independent of the tension beyond the rectifier, and the tension on the material through the driving and idler rollers may be considerably less than the tension on the material between the rolls **161** and **51**, for instance. The roll **43** instead of being positioned between the rolls **161**, **162** and the roll **51** may be mounted at the other side of the rectifier and in advance of the roll **161**.

The operation of this form of the invention is as follows: The fabric **152**, in flat form, whether of a single thickness or a flattened tube, having superimposed layers, will travel in a horizontal plane and will reach the rectifier from some previous roller or guiding means, or from any other source such as drive rolls **50** of Fig. 1. The fabric travels under the first roller **161** of the rectifier, and thence over the second roller **162** and there will be sufficient area of contact between the fabric and these rollers, so that the fabric may revolve the two rollers. After the fabric leaves the second roller **162** of the rectifier, it passes onto and partly around the roller **43** and thence to roller **51**. The function of the rectifier, as stated above, is to keep the traveling strip of

fabric centralized in relation to the roller 51. If while the fabric is traveling through the rectifier it for any reason develops a tendency to lead toward the right of the roller 51, as viewed in Fig. 5, the fabric will travel on the rectifying rollers 161, 162 toward the right, and when this action takes place there will be more fabric engaging the rectifier rollers to the right of the pivotal point 157 in Fig. 5 and this will cause the rectifier to turn diagonally toward the left in Fig. 5 or to swing anti-clockwise in this view, and the rectifier will thereupon immediately develop a left lead in the traveling fabric. This left lead will overcome the previously developed right lead of the fabric, or, in other words, the rectifier will equalize the fabric by leading it back towards the correct position. When this counter-lead starts to bring the fabric back to its correct position, the rectifier will also move from its diagonal position back to its central position, as shown in Fig. 5, so that by the time the fabric has been corrected in relation to the roller 51 the equalizer itself will have been brought back to the neutral or straight position at right angles to the correct line of travel of the fabric, as indicated in Fig. 5. The lateral lead caused by the equalizer is therefore brought to an end when the fabric has been brought back to its correct path. There is sufficient traction of the fabric on the rollers of the rectifier to revolve these rollers. The rectifying action is not sudden but takes place gradually as is necessary with a wide, soft fabric. If the pivotal screw 157 is arranged directly over the bar 159 of the rectifier, the rectifying action will be much slower and more gradual, whereas, with this pivotal point arranged ahead of the bar as shown in Figs. 5 and 6, there is a greater swing to the rectifier and, therefore, the rectifying action is quicker. For rectifying knitted fabric of soft material, the arrangement as shown in Figs. 5 and 6 has proven very satisfactory in its operation.

In Fig. 9 there is shown in perspective how the fabric may traverse a plurality of horizontal planes passing over idler rollers 166 at one end of the drying chamber and over propelling rollers 167 similar to rolls 51. In this case it is preferable to provide one of the rectifiers in advance of each of the propelling rollers 167 in order that the fabric will be rectified as it approaches the propelling rollers. As the rectifier requires no operating force other than the traction of the fabric and as these devices are simple and inexpensive, they may be arranged adjacent each propelling roller.

In Figs. 7 and 8 is shown a preferred form of the rectifier which not only rectifies the fabric as it feeds to the propelling roller 51 but it also serves to roll out any wrinkles in the fabric before it travels onto the propelling roller. In this form of the invention the same kind of support is used for the rectifier as in the first form, consisting of the brackets 154, the cross-bar 155, and the forward extending bar 156 which carries the pivot screw 157 on which the bracket 158 of the rectifier is pivotally mounted. The bracket 158 is fixed to the cross-bar 159 of the rectifier as in the previous construction, and the stop screws 164 co-operate with the bar 156 to limit the swing of the rectifier on its pivot 157. On the outer ends of the bar 159 there are mounted brackets 168 in which one end of the rollers are journaled, the opposite ends of the several rollers being journaled in the brackets 168 carried by the bar 159.

In this construction there is a pair of rollers 170, 171 each engaging about half the width of the fabric from the center line and on opposite sides. These rollers are divergent in relation to each other, so that their outer ends lie slightly in advance of the opposite ends of the rollers, as shown in Fig. 7. A second pair of rollers, consisting of the members 172 and 173 are also arranged in divergent relation to each other and parallel with the rollers 170, 171. The fabric passes under the first pair of rollers 170, 171, thence over the second pair of rollers 172, 173 and then around tension roll 43 and onto the propelling roller 51. If the fabric develops a tendency to lead to the right or left, this rectifier will act in the same manner as the one first described. That is to say, if the fabric develops a tendency to lead to the right in Fig. 7, there will be more fabric engaging the rollers 170, 172 on one side of the central line of the fabric, and this will swing the rectifier on the pivot 157 to the left or counter-clockwise in Fig. 7, and the rectifier will therefore develop a counter-lead to the left until the fabric has been brought back to its central position or the correct line of travel. If the fabric develops a tendency to lead to the left in Fig. 7, there will be more fabric engaging the rollers 171, 173 than the rollers 170, 172 and the rectifier will induce a right hand lead to offset the previously developed left lead, and the fabric will be brought back into its correct line of travel. At all times the rollers 170, 172 are in divergent relation to the rollers 171, 173 and the two pairs of rollers, acting on both sides of the center line of the fabric, roll the wrinkles from the center towards the opposite sides of the fabric, so that the wrinkles disappear or are smoothed out by the time the fabric reaches the propelled roller 51. Both the rectifying and smoothing actions are automatic in this form of the invention. In Fig. 7 the roll 43 is shown between the rolls 170, 172 and the drive roll 51, but as shown in the sectional view (Fig. 8) this roll 43 may be mounted in advance of the rolls 171, 173 being supported from the pivoted carrier 158 by the brackets 43''. When the roll 43 is positioned in front of the rolls 171, 173 or 160, 162, that is to the left as shown in Fig. 8, this roll instead of being carried by the pivoted part of the rectifier may be supported with its axis permanently at right angles to the line of travel of the fabric. Roll 43 when in advance or to the left (Fig. 8) of the other rectifier rolls may be mounted on the fixed axis instead of one moving around the vertical pivot 157.

It will be seen from the above that there is provided a very simple and automatically operating rectifier for maintaining the fabric or strip of whatever nature, in its correct path of travel. The rectifier operates on substantially the full width of the fabric or strip rather than locally, so that rather than creating wrinkles in the strip, it irons and smooths them out.

Preferably, the rectifier if used to guide a strip of fabric, is placed to act on the strip before it passes into a drying chamber, so as to insure uniform directional entry of the fabric into the drying chamber. Other rectifiers, all independent of each other, but all automatic in their operation, are preferably used within the drying chamber as shown to insure uniform directional progress of the fabric and preferably there is a

rectifier arranged close to each driven roller over which the fabric engages.

By placing a rectifier close to each driven roller over which the fabric engages, the sensitivity and accuracy of the rectifier is increased. Also, with the rectifier in close proximity to the driven rollers, the rectifier induces rapid rectification of the course of travel of the fabric. However, the present rectifier is operative even if placed at a distance from the propelling rollers.

The speed at which the rectifier leads the fabric back to its intended course may be accelerated by disposing the rectifier rollers ahead of the pivotal point of the rectifier, or in other words, by having the pivotal point of the rectifier more or less in advance of the rollers. This arrangement causes a greater lateral swing of the rectifier rollers than if the pivotal point were directly over the rollers. For slow rectifying action, therefore, the pivotal point of the rectifier may be placed over or near the axes of the rectifying rollers, whereas for more rapid rectification the pivotal point may be placed in advance of the rectifying rollers.

With the material thus centered and flattened during the entire drying operation the output of the drier is smooth and unwrinkled and in ideal form for the finishing operation. What is known as the conventional finishing operation of fabrics consists of removing distortions and wrinkles, and establishing the fabric in a predetermined, uniform width. The finishing rollers pull the fabric off from the flat spreader, by which latter the fabric is held distended laterally, and steam is applied to the fabric while on the spreader from below the plane of the fabric.

In such methods there has been no driving control of the longitudinal tension on the fabric, and the fabric is taut at all times while on the spreader.

Under this present method of finishing the fabric is advanced first in flat form and then in oval or circular form; after which it converges into flat form again, being always distended laterally. Steam is applied to the fabric after it has been distended in tubular form, and preferably before and after; after which the fabric is fed to a pair of finishing rollers while the tube is in flattened condition. Steam is applied to the fabric from both above and below, so that both sides of the flattened tube of fabric are uniformly steamed.

Under the present method and apparatus the fabric is propelled at the point of its tubular distension, and also in the flattened condition by the finishing rollers, and the speed of travel of the finishing rollers can either be decreased or increased in relation to the speed of propulsion when the fabric is distended in oval or circular shape, so that the longitudinal tension on the fabric can be controlled during the finishing operation.

Preferably the finishing rollers are operated somewhat more slowly than the propelling means which act on the fabric in advance of the finishing rollers, so that the shrinkage which takes place in the fabric during the steaming operation may be compensated for by an excess delivery of fabric at the place of initial propulsion. This can also be compensated for by propelling the fabric faster at the initial point of propulsion.

The fabric is therefore distended laterally and at the location where it is distended steam is applied to the fabric between the propelling means and the finishing rollers and the longitudinal tension on the fabric is controllable where the steam is being applied. It is not absolutely necessary that the fabric be steamed before it reaches the propelling means, but it is a decided advantage to steam the fabric before it passes through the propeller because the initial steaming operation allows the fabric to be immediately opened or distended laterally beyond the final width desired, so that after the fabric travels over the propelling means the desired lateral distension and longitudinal tension can be established for the fabric and after it has passed the finishing rollers and is wound up, it attains and retains the final and permanent width and length.

Generally the fabric in dry form and preparatory to the finishing operation is narrower than the ultimate width because the fabric in the dyeing and scouring operations revolves in a dyeing tub for several hours in rope form, and it becomes attenuated, which decreases its width. Thereafter the treating and drying operations while removing wrinkles do not necessarily expand the material to its full width. Consequently, the fabric after the preliminary treatments and drying operation is usually narrower than the ultimate width when it is finished. Heretofore, when the fabric has been placed over a spreader to undergo the finishing operation, it was stretched laterally but there was no control of the longitudinal tension and therefore when the desired width was attained the fabric was not in what might be called its natural condition, and the tendency to shrink still existed to a greater or lesser degree, depending upon how near to the ultimate width the fabric was when in its dry condition prior to the finishing operation. This system, for example, has taken fabric which under the old methods have been finished to a given width and which ran say four yards to the pound, and which could not be finished with fewer yards to the pound due to the tension on the fabric as the finishing roliers pulled it off the spreader, the same fabric was finished in the present machine at the same width but it ran three and one-half yards to the pound, which was a more desirable condition and which caused the cloth, when made up in a garment, to maintain its width and length. This was due to the fact that when the fabric was intermediately propelled and spread to a certain width, the longitudinal tension was decreased by decreasing the tension lengthwise of the fabric and preventing the latter from being drawn too taut.

By initially distending the fabric into flat form and then propelling it either in flat or extended form and then laterally distending the fabric again and passing it through the finishing rollers and steaming it at one or two points of lateral distension the dimensions of the fabric are completely controllable and especially if there is a double steaming operation, the fabric is uniformly finished to a width and length which it will persistently hold to when made up into garments.

Under the old method referred to above, the fabric is finished for the purpose of removing the wrinkles and to establish a width by making several runs on finishing machines but the longitudinal and lateral proportions of the fabric were not so controlled as to cause the fabric to retain its final width and length. To offset this the garment manufacturer generally cuts his garments so as to allow for substantial

shrinkage before the garment reaches the consumer and also after it is washed by the consumer. Knit goods finished according to the old method tended to shrink considerably after washing, whereas fabric finished under the present method is initially distended and is subjected to tension to remove the wrinkles, it is open to its full tubular proportions, the flattened portion of the fabric is wider than the ultimate or final width, and the light longitudinal tension regulated and controlled causes the fabric to converge from its tubular shape to the flattened shape loosely, both in width and length, and in that condition the fabric is steamed. The fabric is thus enabled to shrink and establish what may be called its natural proportion in width and length and while in that condition it passes through the finishing or pressing rollers. Fabric thus treated will hold its dimensions and when manufactured into garments it can be cut into exact fitting garments which will hold their shape after washing.

As has been said above, most fabrics prior to the finishing operation, are narrower than the ultimate or finished width desired, so that in the previous method described above, when the fabric was spread to width on the flat spreader, the tension in the fabric was greatest in the center so that when it passed through the finishing rollers the wales at the sides of the fabric were much closer than in the center.

Where the fabric is passed over a propeller as shown, it is uniformly spread to tubular form and width and it is then allowed to assume its flat form naturally and uniformly and not forcibly as with the ordinary flat spreader. In the present case the flat spreading member is not held in the bight of the finishing rollers. As a result, the wales of the fabric are uniform throughout its width.

Another object of the present finishing method is a saving in labor in the operation of the machine because by proper manipulation and steaming of the fabric, such fabric as rayons can be efficiently finished on the present machine by one passage through the machine at approximately twice the speed of each single finishing operation in previous machines. The reason rayon fabrics have heretofore been finished slowly and in two separate runs was due to the fact that after the initial or first run through the machine the width was necessarily narrower than the desired ultimate width, as otherwise the fabric would tear. In the present machine and under the present method the initial steaming operation, followed by a gentle expansion of the fabric to its proper tubular proportions, followed by propulsion, permits the handling of this type of fabric much faster than heretofore, and to perform a double steaming operation in one run of the fabric through the machine.

In the present machine the fabric dimensions are controllable during the steaming operation and therefore the machine is adapted to handle all types of tubular knit fabrics which may vary greatly in their elasticities. Two pieces of knitted fabrics, however, both made from the same type of yarn but knitted on different cylinders and intended to be knitted to the same final width, may vary greatly in their elasticities.

Variations in elasticity are also present in different types of yarn so that it is necessary to adjust the tension in various fabrics in the finishing operation to attain the desired results.

Any type of frame structure may be used for mounting the working parts of the machine and in the drawings there is shown a simple form of frame composed of several tubular uprights 1 connected by angle metal beams 2 near the top and bottom to form a rigid support for the several parts of the machine. The fabric coming from the drum is carried upwardly and passes first over an idler roller 4 which is arranged crosswise of the machine with its top in the plane in which the fabric travels through the machine.

A primary or first steaming device 80 is arranged to receive the fabric after it passes over the roller 4 and this steaming device is adapted, preferably, to apply steam to the top and bottom of the fabric while distended laterally in flat form. After passing through this initial steaming device, the fabric then passes over a part of the propelling device 81 which opens the fabric or distends it into oval or circular form and also propels the fabric. The fabric then passes through a second steaming device 82 which preferably also applies steam to the fabric above and below its plane, similar to the first steaming device, the fabric being flattened as it leaves the propelling device and while passing through the second steaming device. After passing through the second steaming device, the fabric in flattened condition, passes through the bight of the finishing rollers 83, 83 and in this flattened condition it passes over the roller 86 and winds upon a mandrel 178 to form a roll 26 in final or finished condition.

As stated above, the initial steaming device 80 may or may not be used according to the character of the work. It is preferred to subject the fabric to the steaming operation both before and after the passage of the fabric over the spreader and propeller and the machine will be described as so constructed and operated without intending to limit the invention thereto, except insofar as some of the claims may be definitely limited thereto.

The steaming devices are preferably similar to each other except for the position of the steam inlets and a description of one steaming device will suffice for both.

The steaming device, in the preferred construction, includes means for delivering steam to the fabric below its plane or to the under layer of the fabric, and in addition, means for delivering steam above the plane of the fabric or against the top layer. Two headers or steam boxes 180, 181 are arranged at opposite sides of the machine, which are fed by the feed pipe as will be hereinafter explained. These headers are shown as elongated and cylindrical in shape and disposed parallel to but outside the path of the fabric. The headers are connected by a plurality of cross tubes 182 of any desired number, five such tubes being illustrated in the drawings. The bores of these tubes are in open communication, each at one end with the header 180 and at the other end with the header 181 so that steam from the headers travels through the tubes and against the fabric. The tubes 182 of the lower steaming device are provided at the top with slots 183 to allow the steam to discharge from the tubes against the under side or lower layer of the fabric. Below the steaming device there is a collecting hopper 184 to receive any precipitated moisture, and excess steam.

There is a blower 185 disposed under the machine and operated by any suitable motor or any source of power; which blower discharges through a pipe 186 to the exterior of the building or wherever the used steam is to be discharged. This

blower creates a suction in the pipe 187 which is connected with the bottom of the hopper for the purpose of conveying away steam after it has served its purpose by acting upon the travelling fabric.

Above the plane of the fabric I have shown another pair of headers 188, 189 also disposed outside of and parallel with the plane of the fabric. The tubes 190 extending across between these headers each have one end in open communication with one of the headers and their other ends in open communication with the opposite header so that steam may flow from the headers into the tubes, the major portion of the steam being consumed in the manner hereinafter described. These tubes 190 are disposed in a plane just above the plane of the fabric and are adapted to discharge steam downwardly against the top layer of the fabric.

Means associated with the tubes 190 prevent any precipitated liquid from dripping from the tubes onto the fabric as it is desired to apply only the steam and not precipitated moisture against the fabric. For this purpose is shown strips of metal 191 extending upwardly within the tubes 190 and surrounding the steam discharge slots 192 of the tubes. These strips form dams so that steam can pass downwardly through the opening or slots 192 between the vertical walls 191 but any moisture precipitated within the tubes will be dammed by the walls 191 and will be prevented from passing out through the discharge slots 192 of the tubes. Steam entering the tubes 190 from the headers 188, 189 travels through the bores of the tubes, passes over the dams or strips 191 and then flows downwardly through the slots 192 onto or through the fabric.

Any of the steam which is condensed into liquid within the tubes will be prevented from flowing through the slots 192 by the walls 191. Apertures 193 are arranged in the tubes 190 beyond the discharge slot 192 at each side of the tubes for discharging any precipitated liquid from the tubes, this liquid being discharged beyond the side margins of the fabric into the hopper 184 in order that the liquid shall not come into contact with the fabric. There are guards 194 projecting downwardly from the several tubes and arranged between the slots 192 and the discharge apertures 193 which serve to prevent liquid which passes through the apertures 193 from running along the tubes and getting onto the fabric.

The blower 185, in addition to removing the used steam, tends to create a definite path of travel of the steam.

In looking down upon the upper and lower steaming devices, as in Fig. 14, it will be noted that the cross tubes 190, 182 of the upper and lower steaming devices are staggered in relation to each other. That is to say, the tubes of the lower steaming device are arranged in vertical planes which are disposed between the vertical planes in which the tubes of the upper steaming devices are arranged. This is for the purpose of having a more even distribution of the steam while acting on the fabric.

Steam is supplied to the headers as follows: The pipe 195 leading from any source of supply, connects with an inclined pipe 196, one end of which is connected with the upper header 188 at the left end in Figure 10 and its opposite end is connected with the header 180 of the lower steam device at the right side in Figure 10. At the other side of the machine there is a feed pipe 197 which connects with an inclined pipe 198.

One end of the latter is connected with one end of the upper header 189 and the other end is connected with the oppositely disposed end of the lower header 181 on the same side of the machine. Steam is thus supplied to the upper headers at ends oppositely disposed and likewise to the lower headers. This causes an equal distribution of the steam to the several tubes connected between the headers.

The next branch of the machine which operates on the fabric is the spreader and propeller.

The spreader is adapted to lie inside the tubular fabric which travels over and around it, the spreader being supported and the fabric propelled by exterior rollers. The spreader includes a frame 199 having cross rollers 200, 201 arranged in lower and upper pairs. There is a lower roller 202 mounted in the frame of the machine, to lie outside the fabric and adapted to press against the fabric and against the two lower rollers 200 of the spreader. There is also an upper roller 203 journaled in vertically sliding bearing blocks 204, and this roller presses downwardly on the fabric and against the two upper rollers 201 of the spreader. These exterior rollers propel the fabric by rolling contact in co-operation with the rollers on the spreader inside the fabric and they also support the spreader. The spreader cannot follow the fabric because it is held stationary while the fabric travels thereover, by co-operation of the exterior and interior rollers.

There is a rod 205 bent in U shape and attached to the frame of the spreader, with the loop of the bow projected toward the front end of the machine.

This bow also lies inside the tubular fabric and it extends from the spreader, through the steaming device 80 and to a point in advance thereof. This bow opens the fabric and holds it distended in the form of a flattened tube, as shown in Figure 12, while the fabric is passing into and through the first steaming device 80.

After the fabric passes through the primary steaming device it gradually opens up to an oval or circular form as it passes onto and over the spreading device described above, where it is also propelled.

There is another wire member 206 and this is also attached to the frame 199 of the spreader but it extends toward the rear of the machine or in the opposite direction to the member 205. The bow of this member extends to a point near the bight of the finishing rollers but it is not pressed into the bight of these rollers. As the fabric passes over the spreader it passes onto this wire member and gradually assumes the flat form preparatory to passing through the second steaming device and the finishing rollers.

The second steaming device 82 follows the spreading and propelling device and, as stated above, it may be a duplicate of the one described above. The pipes for delivering the steam to the headers, on the second steaming device are preferably disposed in reverse positions to those of the first device, as shown in Figure 10 in order that all portions of the fabric may be treated alike.

As the fabric passes through the second steaming device it will be subjected to steam above and below so that all portions will be steamed the same as in the first steaming device.

From the second steaming device the fabric, in the form of a flattened tube, will pass through

the bight of the finishing rollers 83, 83 which latter also serve to propel the fabric.

The finishing rollers may or may not be heated by interior means. The upper roller is pressed downwardly by means to be hereinafter described so the rollers press the fabric between them.

After the fabric leaves the finishing rollers it passes, in flattened condition, partly around a roller 86 which is driven, and it is then wound on a mandrel 178. The latter has pintles engaging in the opposite grooves 207 of an extension bracket 208 of the frame. While the fabric is being wound on the mandrel the latter is in the position shown in Figure 18, so that the propelled roller 86 acts on the body of fabric and revolves it and the mandrel. As the body of fabric increases in size the pintles of the mandrel move along the grooves 207 and away from the roller 86.

There are recesses 209 in the top of the bracket 208 to receive the pintles of an unfilled mandrel 210 ready for this mandrel to be placed in position to receive the fabric when the mandrel 178 is to be removed with the fabric wound thereon. There are downwardly extending grooves 211 in the brackets 208 which at the bottom communicate with the grooves 207. When the mandrel 178 has been filled by the roll or when a seam formed by the attachment of the ends of the strips of fabric require that the fabric be cut, then the mandrel 178 is moved out along the brackets 208 to the outer ends of the grooves 207 to move this mandrel and its roll of fabric away from receiving position. The new mandrel 210 is then lifted from the notches 209 and its pintles are presented into the upper ends of the grooves 211 so that the new mandrel moves down into engagement with the roller 86 ready to receive the severed end of the fabric.

While this is being done a loop is formed in the fabric by reason of the fact that the fabric continues to move and the fabric is cut crosswise, and the end coming from the finishing machine is started on the new mandrel 210 so that the fabric coming from the machine will now wind on the new mandrel and the mandrel 178 with its roll of fabric may be lifted out of the brackets.

Preferably, the upper rollers of the propeller and the finishing rollers are pressed downwardly by resilient pressure and I have shown similar devices for both these upper rollers. The bearing blocks 204 in which the shaft of the roller 203 is journaled, are slidable vertically on one of the standards 1. Above these bearing blocks there are collars 212 adjustably fixed on the standards 1; and these collars have brackets 213 in which are pivotally supported the angle levers 214, 215. At the left in Figure 12, one arm 216 of the angle lever 215 has pivotally connected with it a rod 217 around which is a coiled spring 218 and the other end of this spring acts on and is connected with a part of one of the bearing blocks. This spring is under compression and exerts a downward pressure on the bearing block to force one end of the roller 203 toward the roller 202. The lever 214 at the right of Figure 12 has an arm 219 to which the rod 220 is pivoted, and the spring 221 surrounding this rod has one end pressing upwardly on the collar 222 fixed to the rod, and therefore pressing upwardly on the lever arm 219 and downwardly on one of the bearing blocks 204.

The arm 223 forming part of the lever 215 extends below the pivot of this lever; and a short arm 224 of the lever 214 extends above the pivot of this lever. The arms 223, 224 are connected with each other by a pitman 225 so that the levers on opposite sides move in unison.

There is a hand lever 226 connected with an arm of the lever 215 and this hand lever, when swung downwardly serves to rock both levers 214, 215 and release the pressure of the springs upon the bearing blocks 204 and thus release the pressure of the feed rollers on the fabric. This is desirable when the fabric is being first threaded through the machine. This device acts as an equalizer and applies the same amount of downward pressure to both ends of the roller. The same kind of device is provided for the upper finishing roller and the parts are designated by the same numerals.

When a seam 227 by which the ends of two pieces of fabric are joined, approaches the bight of the finishing roller as shown in Figure 22, the seam being thicker than the plain portion of the fabric, will, as it enters the bight of these rollers, cause the upper finishing roller to be moved upwardly away from the lower roller or higher than when the smooth portion of the fabric is passing through the bight. There is a lever 228 pivoted on the bracket 229 and it has a roller 230 on one end which is held pressed upwardly against the bearing block 204 of the upper roller 83 by the action of the spring 231 which has one end connected with the lever 228 and the other with the bracket. As the upper roller 83 is lifted by the action of the seam 227 the roller 230 follows the bearing block 204 and the lever 228 rocks the lever arm 233 through a link 234 until the electrical contact member 235 carried by the lever arm 233 makes contact with the stationary contact member 236. The electric circuit controlled by these contacts includes any means such as the electric control shown or the known Reeves drive for reducing the speed of the various rollers of the machine down to a comparatively low speed but not to a dead stop. While the machine is running at low speed the fabric is cut near or through the seam 227 and the shifting of the filled mandrel and the placing of the new one in position takes place. The machine may then be returned to fast speed by a suitable hand operated switch 123 closed, for instance, by the movement of the cutter at the end of the cutting stroke.

The shafts 237, 238 of the upper and lower propelling rollers have fixed thereon the gears 119, 119 which cause these rollers to revolve in unison. The shafts 241, 242 of the finishing rollers also have gears 243, 244 which mesh with each other and cause these rollers to revolve in unison.

The chain 116 is driven from any source of power and it engages over and drives the sprocket 246 fixed to a short shaft 117 journaled in the frame of the machine. On this shaft there is fixed another sprocket 248 around which engages an endless chain 118, and the latter engages around a sprocket 36 fixed on the shaft 238 of the lower propeller roller. The power is thus transmitted from the shaft 117 to operate both propeller rollers.

There is another sprocket 43' on the shaft 117 and this drives the endless chain 120 which also engages around the sprocket 232 on the shaft 239. Between the shaft 239 and the shaft 75 which is driven from the former, there are change speed gears for altering the speed of the finishing rollers in relation to the propelling rollers to vary the longitudinal tension on the fabric. The gear 76 on the shaft 239 drives the gear 87

on the shaft 88. The gear 89 on the shaft 88 in turn meshes with and drives the gear 240 on the shaft 75. On the opposite end of the shaft 75 (as shown in Figure 10) there is a sprocket 245 around which engages the endless chain 247. The latter also engages around the sprocket 249 fixed on the shaft 242 of the lower finishing roller. Through the chain of gears, sprockets and chains just described, power is transmitted from the shaft 117 to drive the finishing rollers. By changing the intermediate gears 87, 89 for others having different numbers of teeth the speed ratio of the finishing rollers to the propelling rollers may be varied for the purpose, as above stated, of varying the longitudinal tension on the fabric.

Where it is not desired to distend the fabric into an oval or circle, the device shown in Figure 21 may be used for distending the fabric laterally and for propelling. This device may, therefore, replace the propelling device 81 shown in Figure 10. The rollers 78, 99 arranged one above the other in parallel relation, are separated enough to allow the bow 77 to pass through the bight of these rollers. This bow is connected to a cross bar 79 which is too large to pass between the rollers 78, 99. The wire forming the bow 77 passes through the bar 79 and projects on the opposite side in the form of two arms 102. The tubular fabric is passed entirely over the spreader consisting of the cross bar 79, the bow 77 and the arms 102, and the bow is passed between the rollers 78, 99 so that the bar 79 lies adjacent these rollers as shown in Fig. 21. As these two rollers are propelled, they act on the fabric against the bar 79 to propel it.

The fabric passes onto the bow 77 and over the complete spreader which holds it in the form of a flattened tube while passing over the primary and secondary steaming device.

Operation: The fabric is threaded through the machine by the previous strip or by attaching a dummy piece to the leading end of the tubular fabric which is to be treated. The fabric (or the dummy piece) will extend over the roller 4 thence horizontally through the first steaming device 80, thence over the spreader and between the latter and the propelling rollers; thence through the second steaming device 82, thence between the finishing rollers and over the roller 86. If a dummy piece is attached to the fabric to be treated then when the rear end of the dummy appears beyond the finishing rollers it is cut from the regular fabric and the leading end of the latter is directed onto the mandrel.

The levers 226 may be thrown down while the fabric is being threaded into the machine to raise the propelling and finishing rollers and then the levers 226 are released to allow these rollers to be pressed down by their springs.

The machine may now be set into operation and steam is fed through the pipes 195, 199 to be distributed through the steaming devices.

Where a primary steaming device such as 80 is employed in the machine the fabric, while passing as a flattened tube over the bowed member 205 in a horizontal plane, is subjected to a current of steam projected from the tubes 182 against the under side or the lower layer of the fabric. At the same time, steam from the upper tubes 190 is projected downwardly against the upper layer of fabric, so that both layers are at the same time subjected to the steam action.

After leaving the first steaming device, the fabric travels over the spreader 81 which opens the fabric up to oval or circular shape, thus distending it and removing wrinkles and separating the layers. The fabric is propelled at the spreader by the rollers 202, 203.

The fabric then passes onto the wire 206 and gradually returns to the form of a flattened tube. It then passes in this form over the wire 206 and through the second steaming device 82 where it is again subjected to the flow of steam from above and below against both layers thereof.

After passing through the second steaming device and over the wire 206 as a flattened tube, it passes between the finishing rollers and thence onto the wind-up device.

If through the selection of the correct intermediate gears 87, 89 the finishing rollers are operated at slightly slower surface speed than the propelling rollers then a definite and controlled longitudinal tension will be exerted on the fabric and allowance made for shrinkage; and this tension will be uniform with any given speed ratio between the propelling and finishing rollers. If a fabric of different character is to be run through the machine it may be necessary to change the intermediate gears 87, 89 to vary the speed ratio between the finishing and propelling rollers.

When the fabric has passed through the machine all wrinkles will have been removed, the width of the fabric will be uniform, there will be a definite, controlled and uniform number of yards of fabric per pound; the upper and lower layers of the tube will be uniform and the wales of the fabric will be uniform around the tube.

In Fig. 23 apparatus is outlined showing the successive steps in the treatment of fabric in flat form in successive stages A, B and C, where A involves a cleaning treatment placing the material under longitudinal and transverse tension and acting to apply a chemical treatment with successive squeezing or wringing actions on the strip of woven material as it passes. In stage B the strip is dried while carried at great length through successive convolutions extending the drying to a lower point within the drier and subsequently adding moisture before the material is passed on to the final finishing operation indicated generally at C. In this finishing operation the flat material is first stretched longitudinally, then steamed, then tensioned transversely while being permitted to contract longitudinally and then in this condition is immediately ironed before final finishing rolls and delivered to the wind-up roll.

In each of these operations the condition of the material is being changed from point to point involving the adjustment of the fabric structure and these successive treatments and readjustments provide a complete finishing of the material automatically carrying it from the raw state at the entrance to the final form at delivery.

The fabric strip as supplied in the container 250 is usually fresh from the dye kettle and wet and shapeless. It is first carried over the expanders or flattening and tensioning rolls 251 and 252 of special formation tending to smooth out the wrinkles and creases in the material and deliver it in flat form to the guide roll 253 of the first cleaner. The material is then carried under roll 254 through a trough of cleansing or treating liquid which liquid is also applied to the upper surface of the material through a spray nozzle 255 after which the strip is immediately subjected to the squeezing pressure of the wringer rolls 256. The material is then passed over guide roll 257 to a second treatment, passing under

roll 258 and in contact with a chemical treating liquid in the trough 259 which liquid is also applied to the upper surface of the material through the spray means 260 so that both surfaces of the material are simultaneously bathed in this liquid just prior to the squeezing action in the bite of the final wringer rolls 261.

A predetermined lengthwise tension may be applied to the strip between the wringer rolls 256 and the final rolls 261 tending to adjust it and partially fix the structural texture of the fabric threads with relation to each other and the advance of the action of the tenter mechanism immediately following. This tenter mechanism is indicated generally at 262 and comprises two diverging lines of tenter jaws or clamps gripping the side edges of the strip and exerting a predetermined lateral tension while the material is drawn forward between the upper and lower steaming nozzles 263. During this transverse tensioning and steaming the material is preferably left to readjust itself longitudinally by shrinkage, for instance, and the jaws of the tenter frame are so mounted as to permit slight relative longitudinal shifts between them to accommodate any lengthwise shortening of the fabric as it passes through the tenter frame apparatus.

The material leaving this tenter treatment passes over the guide roll 264 under the treating roll 265 and then moistening the strip in a treating or cleansing liquid, trough 266 after which it is pressed between the final wringer rolls 267 and passed on to the drying operation indicated generally at B. The material passes up over the guide roll 268, over the liners or rectifiers 269, maintaining the material in flat properly centered condition to pass into the drier through the entrance rolls 270.

In the drier the material is looped back and forth upon successive rolls 271 at one end and 272 at the other providing a number of convolutions in vertical sequence and with the partitions 273 separating these convolutions in successive chambers for the back and forth circulation of the drying air. The air entering at the inlet 274 passes over the heater 275 to the chamber under the lowermost partition 273. Then the air circulates back and forth along and through the successive partition compartments as indicated by the arrows and in general progresses opposite to the direction of progress of the fabric material being dried. Between the second and third compartments thin aerofins 276 for the air are provided and the entire air circulation is caused by the suction fan drawing the air out through the top exhaust opening 277.

The drying of the material is preferably carried to a relatively low point considerably below the moisture content desired in the final material. Part of the moisture to be added is applied immediately after the drying and in the auxiliary compartment 278 the material is carried over the guide rolls 279, providing a horizontal length beneath which is positioned a cooling and spraying means 280 comprising an air blower having a spray device spraying droplets of moisture into the current of air passing upward into the fabric as it passes. The strip of material is then fed into the final feed rolls 281 delivering it to the finishing operation C.

Between the drying and finishing the strip is looped and passed through the feed roll apparatus 282 to the driving rolls 283 arranged to establish a longitudinal tension on the fabric as it passes to the steam mechanism indicated at 285, moistening and softening the fabric as it passes to the tenter frame 286. In this tenter the material is tensioned transversely while substantially free longitudinally to readjust or shrink slightly from point to point after which it is subjected to the ironing pressure between finishing rolls 287. The strip is then wound up by the final wind-up roll 288.

In the preliminary cleansing and treating operation indicated at A the relative speeds of the wringer rolls 256, 261 and 267 may be relatively different as desired to produce the proper longitudinal stretching effect during the first and second sets of wringer rolls 256 and 261 and to allow for the longitudinal readjustment or stretching during the transverse tension exerted while the material is passing through the tenter frame. In the drier the driving rolls 271, 272 will preferably be driven by friction clutches permitting relative slipping between these rolls so as to automatically accommodate the drier to variations in the material as it passes through the drier.

In the final finishing operation the driving rolls 283 will preferably have a peripheral speed providing a definite longitudinal tension on the material between the rolls and the tenter 286 and similarly the final finishing rolls 287 will have a different peripheral speed depending upon the desired cooperation with the material as it is passing through tenter 286. All these relative speed variations are pre-arranged by proper changes in change speed gearing interposed in the drive.

Superposed on these individual speed variations within the individual rolls are the speed variations in the separate motors provided for each stage A, B and C. The speed of the motor driving the mechanism of stage A is set by the main rheostat controlling all of the motor drives but the speeds of the motors driving the drier and the finishing apparatus are independently and automatically varied according to the tension on the fabric strip as it passes from the preliminary treatment to the drier and from the drier to the finishing operation. At the delivery from the preliminary stage A the fabric strip contacts with the idler rolls 290 mounted on the arm 291 connected by a chain 292 to a sprocket on the shaft 293 of the contact arm of a rheostat controlling the field current in the field of the drier motor, the parts being so arranged that an increase in tension will lower the speed of said motor and a decrease in tension on the roll 290 will increase the speed of the motor for the drier. Similarly as the fabric passes from the drier to the finishing operation this tension will automatically control the inclination of the feeder arm 295 and correspondingly adjust the contact arm of the rheostat 296 of the motor for the finishing mechanism speeding this motor up when the tension is reduced and slowing down the motor when the tension on the arm 295 increases.

By this mechanism and control fabric in raw, fresh, dry condition is fed in at the entrance end of the machine and completely treated, dried and finished and rolled up on the wind-up roll 288. Within each stage the individual drives are pre-set according to the material and treatment desired and from there on the re-adjustment of the parts to maintain their desired condition is entirely automatic, the speeds of each succeeding stage being adjusted to maintain throughout the machine the proper conditions of cooperation be-

tween each successive stage in the handling of the material.

In this treatment of the fabric strip the material is first cleansed, then wrung to the desired content of moisture, and then placed under longitudinal tension and, if desired, further treated chemically and then again wrung and immediately placed under the transverse tension of the tenter while it is being steamed and softened and permitted to readjust itself longitudinally as required by transverse stresses, this step being followed by a further chemical treatment and squeezing before the final delivery to the drying means. Then during the drying accurate tension is maintained on the material which is kept in flat aligned condition by the rectifiers **269**, the drying being carried to a relative low point below the final moisture content. After this an additional amount of moisture is added and then the material is tensioned while in this relatively dry condition and then slightly moistened and transversely stretched in the tenter **286** which is so constructed and operated as to permit longitudinal adjustment of the fabric as required by the lateral stresses. Immediately thereafter the material is finished and wound up between the rolls **287** and delivered to the final wind up roll.

This repeated longitudinal and transverse stretching before and after the drying operation tends to cause an adjustment of the fabric threads with relation to each other causing a shrinkage of the fabric under varying predetermined conditions which are automatically controlled and maintained. Intervening in these readjusting operations are the repeated squeezing or ironing actions of the successive pressure rolls tending to fix and set the threads and fabrics in readjusted and preshrunk condition so that the final fabric avoids any substantial further shrinkage.

We claim:

1. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through at least two treatment stages, determining the extensibility of the fabric between said stages, and automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility.

2. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through at least two treatment stages, determining the extensibility of the fabric between said stages, automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility, and maintaining a predetermined relative elongation and lateral extension of the fabric in each of said stages.

3. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a preliminary wet treatment stage and a drying stage in which shrinking occurs, determining the extensibility of the fabric between said stages, and automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility.

4. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a preliminary wet treatment stage and a drying stage in which longitudinal and transverse shrinking occur, determining the extensibility of the fabric between said stages, automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility, maintaining a predetermined relative elongation and lateral extension of the fabric in the wet treatment stage, and maintaining a predetermined relative elongation and lateral extension of the fabric in the drying stage.

5. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a preliminary wet treatment stage and a drying stage in which longitudinal and transverse shrinking occur, determining the extensibility of the fabric between said stages, automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility, maintaining a predetermined relative elongation and lateral extension of the fabric in the wet treatment stage, and maintaining a predetermined relative elongation and lateral extension of the fabric in the drying stage while subjecting the fabric to a transverse smoothing action during drying.

6. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a pretreatment stage and a drying stage, the pretreatment stage comprising transverse distension and flattening of the fabric to a predetermined width, and subjecting the flattened fabric to a wet treatment under longitudinal tension regulated to produce a predetermined relationship between the longitudinal and lateral extension of the fabric, the drying stage comprising progressive drying and shinking of the fabric and maintaining a predetermined relationship between the longitudinal and lateral extension of the fabric during such drying, determining the extensibility of the fabric between the preliminary treatment and drying stages, and automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility.

7. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a drying stage in which shrinking occurs and thence through a finishing stage, determining the extensibility of the fabric between said stages, and automatically regulat-

ing the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility.

8. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a drying stage in which shrinking occurs and thence through a finishing stage, determining the extensibility of the fabric between said stages, automatically regulating the rate of travel of the fabric through one of said stages in accordance with variations in such extensibility, maintaining a predetermined relative elongation and lateral extension of the fabric in the drying stage and maintaining a predetermined relative elongation and lateral extension of the fabric in the finishing stage.

9. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a preliminary wet treatment stage, a drying stage and a finishing stage; determining the extensibility of the fabric between the preliminary stage and the drying stage, automatically regulating the rate of travel of the fabric through one of said two last mentioned stages in accordance with variations in such extensibility between said stages, determining the extensibility of the fabric between the drying stage and the finishing stage, and regulating the rate of travel of the fabric through one of the two last mentioned stages in accordance with variations in the latter extensibility.

10. The method of maintaining a predetermined relationship between the elongation and lateral extension of tubular knitted fabric during continuous treatment in a series of stages in which variations in the extensibility of the fabric occur which comprises conveying the fabric as a continuous web through a preliminary wet treatment stage, a drying stage and a finishing stage; determining the extensibility of the fabric between the preliminary stage and the drying stage, automatically regulating the rate of travel of the fabric through one of said two last mentioned stages in accordance with variations in such extensibility between said stages, determining the extensibility of the fabric between the drying stage and the finishing stage, automatically regulating the rate of travel of the fabric through one of the two last mentioned stages in accordance with variations in the latter extensibility, and maintaining a predetermined relative longitudinal and lateral extension of the knitted fabric in the preliminary stage, the drying stage and the finishing stage.

11. The method of treating continuous lengths of wet tubular fabric comprising distending the fabric laterally as a flattened tube in wet condition, subjecting said wet flattened tube to a plurality of tensions and rolling pressures, predetermining the first tension and rolling pressure to reduce the liquid content of the material to a given point, reimpregnating the material with a different liquid between said rolling pressures and predetermining the amount of the second tension and rolling pressure to reduce the liquid content of the fabric below said content in the fabric delivered from the first rolling pressure.

12. The method of treating continuous lengths of wet tubular fabric comprising distending the fabric laterally as a flattened tube in wet condition, subjecting said wet flattened tube to a plurality of rolling pressures, predetermining the first rolling pressure to reduce the liquid content of the material to a given point, reimpregnating the material with a different liquid between said rolling pressures and predetermining the amount of the second rolling pressure to increase the liquid content of the fabric above said content in the fabric delivered from the first rolling pressure.

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