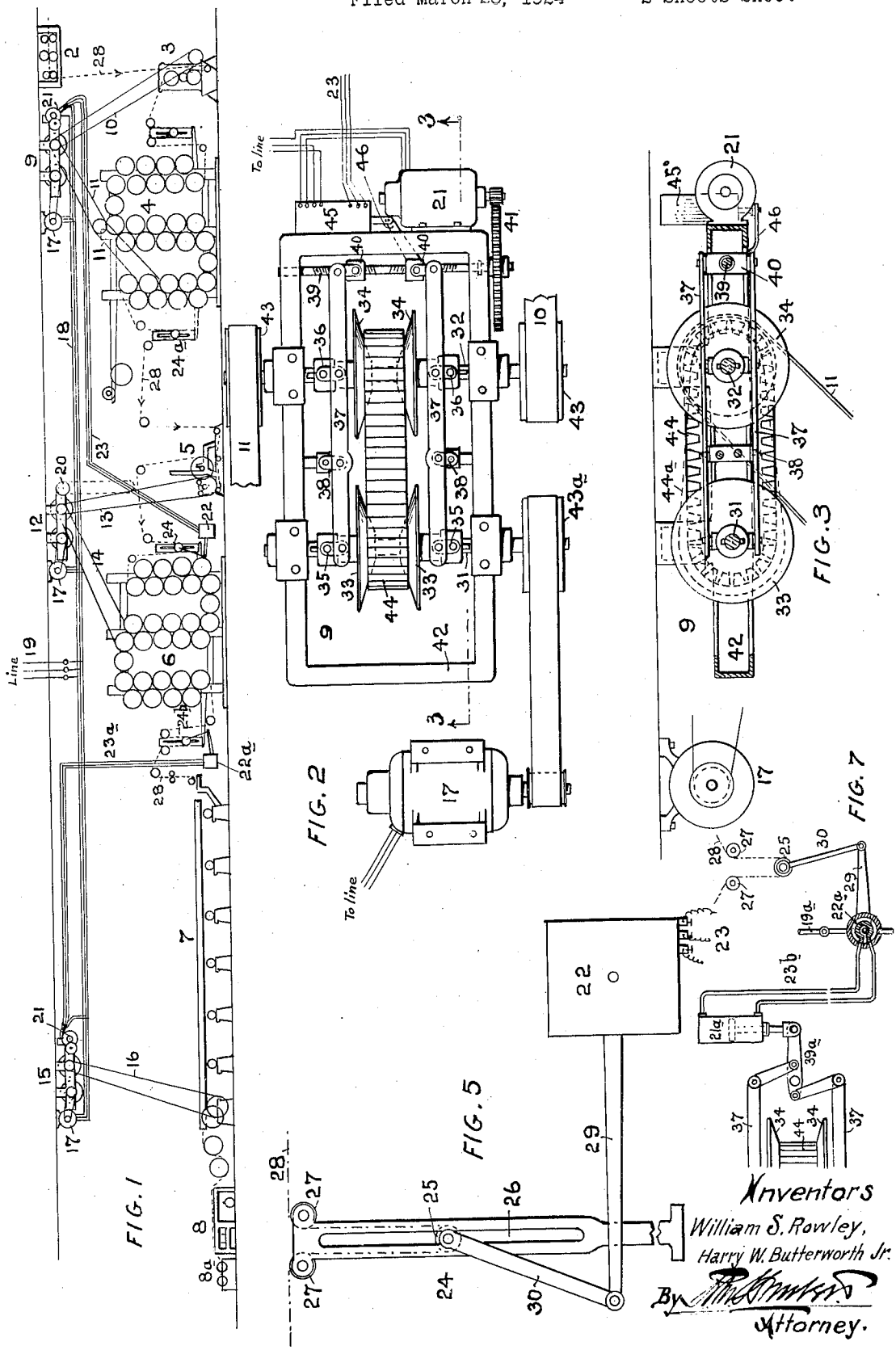
Nov. 27, 1928. 1,692,955

W. S. ROWLEY ET AL

METHOD AND MEANS FOR OPERATING TEXTILE RANGES

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FIG. 6

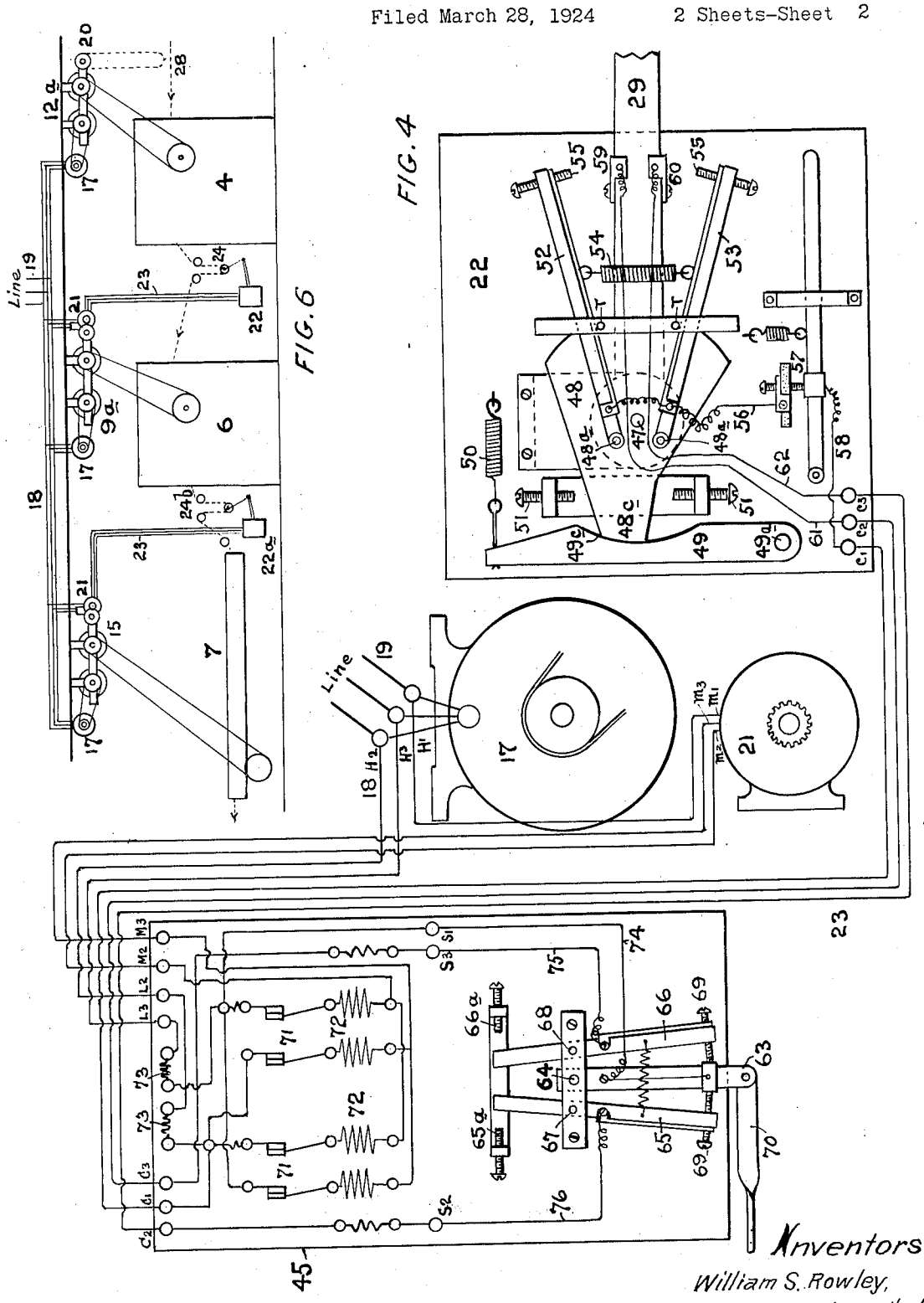


FIG. 4

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UNITED STATES PATENT OFFICE.

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METHOD AND MEANS FOR OPERATING TEXTILE RANGES.

Application filed March 28, 1924. Serial No. 702,564

It has heretofore been attempted in textile mills, but with indifferent success, to associate a plurality of different machines as a "range" for successively treating a strip or length of textile material in fabric or other form, whereby it undergoes the necessary treatments to bring it to a relatively finished condition and during which treatments the relative speeds of the machines or some of them have been controlled by variable speed alternating current motors, wherein it was intended that their speeds shall undergo relative changes commensurate with load changes due to varying conditions of the textile material, such as being of "light", "medium" or "heavy" goods, or due to variations of either of these and maintain a uniform tension on the goods. Experience, however, has shown that it is not practicable to employ variable speed alternating current motors in cases where the load varies, either when the range of machinery is operating upon materials whose weight varies at intervals along its length or where the range is required to operate different batches of goods having relatively different weights per yard, the reason for the failure to operate properly being that at the time that the increased speed is required of the motor, a heavier load is put upon it and interferes with its acceleration and, moreover, the changes in speed are not commensurate with requirements and hence the changes lag beyond.

A variable speed alternating current motor is responsive only when it is under a predetermined heavy load and is not primarily responsive where the load is relatively light and, therefore, it is not suitable for controlling the speed of a machine in a range while being governed as a result of varying loads and speeds in a previous or subsequent machine of the range.

We have found that variable speed alternating current motors can only be employed in a range of two machines, each driven by a separate variable speed alternating current motor, and only where the cloth was always of the same "weight" and the amount of speed reduction required would not be over 15% to 20%; but where the requirements in the mill consisted of light, medium and heavy weight goods, or any two of them, the said range of machinery thus provided does not operate successfully. To make operative ranges, where the goods to be treated varies in weight, we have employed an electric motor suitable for operation with light weight goods, associated with an extra motor to be temporarily coupled in circuit to assist the operation when the load increase is due to an increased weight of goods and the horse power required to move it reached a certain minimum. The extra motor would then act as a booster during the period that the additional horse power was required for that separate unit; then, if the horse power or load requirements would fall off, the additional motor would be automatically cut out of operation. These examples of endeavor to operate range machinery have been restricted in the number of machines employed in the range equipment and, moreover, were not sufficiently responsive to meet general requirements and we were compelled to resort to belt drives through "variators" or variable speed belt drives, the same being operated, as to change of speed transmission, by hand control, thus losing the automatic feature of regulation.

It is the object of our present invention to so combine the machine units of the "range", with variators driven at constant speed by electric motors (or otherwise), and automatic control devices for the variators, whereby the different machine units of the "range" are automatically adjusted as to speed to suit the changing conditions of goods being treated or processed, such for example, that should the length of the goods either stretch or shrink under an operation, the speed of the adjacent or next machine unit in line is automatically increased or decreased, as the case may be, to just the extent necessary to maintain a uniform tension on the goods.

Our object is further to provide an automatic system for operation and control of a range of machines, employed for carrying out any complete process or sub-process involving a plurality of successive operations or steps upon the material being treated, whereby all of the successive following or preceding operations are automatically controlled by means or devices governed by the condition of the goods in the adjacent machines preced-

ing or following, so that all units of the range definitely respond to "goods" requirements, initially or during continued operation, to insure a uniform tension in passing through the range.

Our object is further, to so operate the range that the primary governing machine unit thereof is intermediate of the first or preceding and last or succeeding units of the range, and combining therewith the automatic governing mechanisms extending to the preceding as well as to the succeeding machine units, whereby the range as a whole is quickly responsive to speed changes required to meet contingencies due to changing conditions of the goods being treated or processed. In this case, it may be assumed as certain that should the goods in the middle unit stretch or lengthen abnormally beyond predetermined speed of travel requirements, the automatic response to such condition would be to govern the preceding machine unit so as to increase its speed of operation and thereby remove cause for stretching in the middle machine unit, and to govern the succeeding machine unit to reduce its speed commensurately. The tension produced upon the goods in the middle machine unit having been relieved. The actual total length of the fabric or goods is something less and a corresponding lessened speed of the said succeeding machine unit is desirable. The result sought and attained is, that the fabric or goods shall travel with substantial uniformity as to speed through all of the series of machine units, whereby each and all shall perform their respective functions in an efficient and perfect manner.

It will be understood that where there are two or more machine units either preceding or succeeding the primary unit from which the control influence emanates, our improved system of automatic control will pass successively from one unit to the next and so on as far as control may be required.

In providing the initial control of the middle of three machines of the range, the preceding and following machines are readily and automatically kept under regulation to respond to speed changes in the middle machine. This system has the advantage over the initial control of the first machine of a series, because in that case the remaining machines are apt to induce disturbances one upon the other and because of that they do not respond primarily and definitely for variations in the speed of the first machine. In the case of initial control to the intermediate machine, immediate response and direct control of the preceding and succeeding machines of the range is insured, thereby making the installation flexible and accurately responsive to variable conditions arising in the operation of the range.

With the above and other objects in view, the nature of which will be more fully understood from the description hereinafter, the invention consists in the novel construction of method and means for controlling speeds of a plurality of machines operating as a "range" upon a continuous length of textile or other material, as hereinafter more fully described and defined in the claims.

Referring to the drawings: Fig. 1 is a diagrammatic elevation showing the general arrangement of our invention as applied to finishing cloth; Fig. 2 is a plan view of one of the variators for changing the speed of drive of the machine units; Fig. 3 is a vertical section of the same on line 4—4 of Fig. 3; Fig. 4 is a diagrammatic view, mainly in elevation, showing the electric control mechanism employed in our invention; Fig. 5 is an elevation of the means for operating the control switches; Fig. 6 is a diagram showing an elevation of a modification of the range of our invention; and Fig. 7 is a modified control means.

Keeping in mind that the illustrations forming a part of this specification are to be understood as examples of the application of our improvements, both as to the method and apparatus, and not by way of limitation to the scope of the invention in its adaptation to the various association of machines in their utilization for successive treatment upon a moving length of material to be successively treated to different operations, we will describe the examples shown to more fully disclose the character and nature of the invention.

In the preferred application of our invention, a typical arrangement of the apparatus may be considered as shown in Fig. 1, in whch is shown apparatus in a textile mill for imparting successive treatments to cloth; and in the particular apparatus shown, 2 represents a scutcher through which the cloth first passes and then successively through a water mangle 3, a dryer 4, a "tommy dodd" 5, a second dryer 6, a tenter machine 7, an atomizer 8, and then to a suitable winder 8^a. The water mangle 3 and the first dryer 4 are shown as being operated from a power transmitting device 9 which may be of the character illustrated in Figs. 2 and 3, and known as a variable speed transmission and the particular construction of which, in the example shown, is substantially that illustrated in Letters Patent No. 1,377,593, dated May 10, 1921, and which is driven by a constant speed electric motor 17. As shown, one of the belt wheels 43 of the said transmisson device operates the water mangle by a belt 10, and another of the belt wheels thereof drives the drums of the dryer 4 by a belt 11. This variable speed transmission is ordinarily adapted for adjustment under hand regulation, but, in the application of our present invention, certain of these variable speed transmission devices,

such as 9 and 15, for example, are provided with electric motors 21 for varying the speeds of the driven machines under automatic control of the cloth passing through the said machines, the said control of the variable speed of the power transmission being one of the essential features of our improvements. As shown in Fig. 1, the general construction of the variable speed transmission devices 9 and 15 are identical, and correspond to what is shown in Figs. 2 and 3. The variable speed transmission device 12, however, while in general construction, also follows that shown in Figs. 2 and 3, it differs in being only provided with a hand controlled means 20 in place of the automatic electric control. This manual control merely involves the employment of a chain wheel and operating chain upon the speed controlling shaft 39 of Figs. 2 and 3, the rotation of which is the immediate means for varying the speed of transmission. The construction of the variable speed transmission device with the manually controlled means of adjustment embodies that form of the device which is set out in Patent No. 803,535 before referred to.

With the foregoing explanations in mind, it will now be understood that the initial speed of travel of the fabric through the machines is to be determined by the manual adjustment of the variable speed transmission device 12 which controls the "tommy dodd" 5 and drying machine 6; and any variation due to stretching or shrinkage of the textile material being delivered to the drying machine 6 on the intake side or as it leaves the machine on the discharge side is caused to automatically control the variable speed electric motors 21 of the variable speed transmission devices 9 and 15 respectively, according to whether the change in the fabric occurs before entering the drying machine 6 or within the said machine and prior to leaving the same. It will also be readily understood that if the fabric 28 passing from the dryer 4 should be fed too rapidly to the dryer 6 (having the manual control), provision must be made for automatically slowing down the speed of the machines 3 and 4, so that the fabric will leave them at a speed approximating the speed of intake to the dryer 6, any slight variation in the length of the fabric from moment to moment being compensated for by the floating roll 24^a at the delivery end of the drying machine 4. This floating roll, however, cannot be relied upon for any great change in stretching or shrinkage when such action is sustained for a considerable length of time, and which might be due to changes in the density of the weave when such material changes occur and are maintained sufficiently to affect a floating roll 24 of the drying machine 6 arranged at its intake end. A sufficient movement of said floating roll, either downward due to stretching or upward due to shrinkage, will operate a control switch 22 which will correspondingly, through circuits 23, control the speed of the motor 21 so that the driving shaft of the variable speed transmission device 9 will respectively decrease the speed of operation of the drying machine 4, on the one hand, or increase its speed, on the other hand, so that the speed of the fabric 28 will, within reasonable limits, be fed through the machines 3 and 4 at a speed which will properly supply the requirements of the machine 6 whose speed is definitely determined under manual control. While the water mangle 3 is driven from the same driving shaft as the dryer 4, it is manifest that these two machines may be each driven from separate power transmission devices. In a similar manner, the "tommy dodd" machine may be driven from a separate power transmission device from that which drives the drying machine 6, but there would be no object in so operating it unless it, as in the case of the drying machine 4, was to be given variable speeds under similar electric control. In the particular association of machines shown in Fig. 1, it happens that the water mangle 3 and the "tommy dodd" machine 5 are of a nature which does not require any special speed control other than what is provided for by the transmission devices 9 and 12.

Considering now the speed control of the tenter machine 7 in its relation to the drying machine 6, it will be seen that the same general principle of control of the speed of the variable speed transmision device 15 is required, as in the case of the device 9, for the drying machine 4, but in this case, the control must be such as to insure the adjustment of the speed of the tenter commensurately with the varying speed of delivery of the fabric 28 from the drying machine 6, assuming, of course, that the treatment of the fabric in passing through machine 6 will cause varying changes in the length of the fabric. Such varying length may be due to changes of temperature in dryers or to moisture conditions or density of weave of the fabric, and in cases where different fabric are attached end to end, then the changes in length will be due to the different character of the fabric formerly treated by machine 6 as compared to the successive fabric which immediately follows the former fabric which has passed through said machine and into the tenter. The variations in length of the fabric 28 in passing from drying machine 6 to the tenter 7 will through the floating roll 24^b actuate the electric control switch 22^a and this, through electric circuits 23^a, will control the electric motor 21 of the variable speed transmission device 15 to cause the tenter 7 to be driven by the belt 16 at an increased or decreased speed, as the case may be, according as to whether the fabric 28 increases or decreases in length inter-

mediate of the two machines 6 and 7, and where it acts upon the floating roll 24b. This general action is the same in its control of the tenter 7 as what takes place in connection with the control of the dryer 4 and water mangle 3, except that it increases the speed of the tenter for an excess in the length of the fabric passing about the floating roll 24b instead of a decreasing of the speed of the machines 3 and 4 when an excess of the fabric passes about the floating roll 24. This is due to the fact that the machines 5 and 6, whose speed is manually controlled, are located intermediate of the tenter 7 on the one part and the machines 3 and 4 on the other part.

In case the "range" is laid out, as indicated in Fig. 6, as an example, it will be seen that the speed of the first machine 4 is manually controlled while the successive machines 6 and 7 have an automatic variable control wherein the machine 6 has its speed controlled to increase or decrease, as the case may be, with an increase or decrease of the speed of the fabric 28 leaving the machine 4. Similarly, the speed of the machine 7 is increased or decreased commensurately with the increase or decrease of the speed of the fabric as it leaves the machine 6. From this it will be understood that the speeds of the successive machines 6 and 7 may each increase or decrease in speed simultaneously even though the speed of travel of the fabric might be greater in passing through machine 7 than in passing through machine 6, this being possibly due to the fact that it is required to handle a fabric which may have stretched in passing through machine 6 and consequently require the handling of a greater length of fabric in a given time. It is also possible that the treatment in machine 6 might have produced a shrinkage in the length of the fabric and in that case, it is manifest, that the regulation of the speed of the machine 7 might result in a decreasing of the speed whereby it will handle a somewhat shorter length of fabric than that handled by the machine 6 in a given time. The point to be kept in mind is that all of the main machines which constitute the "range", irrespective of what is to be the particular treatment of the fabric or materials required to pass through the machines in succession, should be automatically controlled as to their speeds with the exception of the particular machine of the "range" which is to be manually adjusted to provide a predetermined speed in relation to which all the other machines should be caused to automatically adapt themselves to handle the fabric or material as it proceeds through the respective machines without requiring any further adjustment to the manually controlled machine which sets the predetermined normal rate of travel of the material as an initial basis for the automatic control of travel through the other machines. While ordinarily, the regulation of speeds of the automatically adjustable machines would be more for compensation, due to increasing lengths, nevertheless, in some characters of work, the shrinkage conditions might be largely dominant in respect to the requirement of regulation in certain machines and, therefore, we do not in any manner restrict ourselves as to the character of the regulation in speed. In the same machine, the speed may be increased at intervals above a normal speed to catch up with the stretching of the fabric coming from the previous machine; or where considerable shrinkage occurs from any cause, the machine to be regulated should have its speed decreased below normal and, therefore, our invention is to be understood as applying to regulation of speed in the various main machines of a "range" without regard to whether it is an increase or decrease of speed at any moment of time. The invention, however, must involve the control of the speed of a machine of the range by the changes in length of the fabric, at one or more places during its passing through the "range".

Referring more particularly to the construction of the variable speed transmission devices shown in Figs. 2 and 3, 42 is the main frame and is adapted for attachment to the ceiling so as to leave the floor space as clear as possible. 31 and 32 are two shafts journaled in parallel relation in the said frame 42, shaft 31 being the driving shaft and 32 the driven shaft, the latter provided with the pulleys 43 and from which the belts 10 and 11 transmit power to the range machines 3 and 4 (or others, as the case may be). The driving shaft 31 is also provided with a pulley 43a which may be driven by a belt and constant speed electric motor 17. This motor may be of any suitable type, but in the example shown, it is indicated as adapted for a three-phase electric circuit 18 receiving energy from the line circuits 19, Figs. 1 and 5. It is to be understood that, instead of the alternating current system shown, any suitable direct current system may be employed; and as a matter of fact, any source of power may be employed to drive shaft 31 at a constant speed, to fulfill the requirements of our invention. The shaft 31 is provided with two oppositely directed cone disks 33, one or both having a sliding connection with the shaft so as to be positively rotated with it, but relatively adjustable to or from each other. The other or driven shaft 32 is similarly provided with two cone disks 34, also relatively adjustable to and from each other. Arranged between the two sets of cone disks and traveling in contact with them, is an endless specially constructed transmission band 44, by which power is transmitted from driving shaft 31 to driven shaft 32. As shown, the cone disks of the two shafts are at equal distances apart and hence the shaft 32 is driven at the same

speed as that of the driving shaft 31. If now, the cone disks 33 of the driving shaft are adjusted closer together and the cone disks 34 of the driven shaft are correspondingly adjusted further apart, the transmission band 44 will assume the position indicated in dotted lines 44ª, Fig. 3, with the result that the driven shaft 32 will be rotated at a higher speed. If the reverse adjustment of the cone disks 33 and 34 be made, then the readjusted band 44 will cause the driven shaft 32 to be rotated at a slower speed than that of the driving shaft 31. By varying the degrees of adjustment of the disks any variation of speed desired may be had for the shaft 32 and its pulleys 43. The immediate means shown for insuring the relative adjustment of the disks, comprises the following features of construction: 37 are pairs of levers, two for each pair of cone disks, each pair consisting of one of the disks 33 and one of the disks 34, and these levers have a fulcrum connection at 38 relative to the main frame. At their opposite ends these levers are respectively linked at 35 and 36 with the hubs of the disks 33 and 34 by suitable connecting means which permit rotation of the disks with their shafts and as more fully set out in Patent No. 803,535, aforesaid. The levers 37 are extended at one end and linked in pairs to the respective blocks 40, 40, constituting nuts upon a speed controlling shaft 39, journaled in the main frame and having right and left hand screw threads (Fig. 2), one of the blocks receiving and operated by the right hand threads and the other by the left hand threads. When the shaft 39 is rotated in one direction, the blocks are adjusted toward each other and when rotated in the other direction, they are moved apart. Under the first of these adjustments, the disks 34 are caused to be moved nearer toward each other, while, at the same time, the disks 33 will be moved further apart. As a result of this action, the transmission band 44 will be caused to automatically adjust itself to the changed relation of the disks, so that the driven shaft 32 will rotate at a slower speed than normal. If, on the other hand, the shaft 39 is rotated in the opposite direction so as to move the blocks 40, 40, further apart and beyond the neutral position, then the disks 33 and 34 will be reversed as to their previous adjustment and the transmission band will assume a position shown in the dotted line 44ª, and the driven shaft 32 will rotate at a higher speed than normal.

To vary the speed of the driven shaft 32 and the driving belts 10 and 11 of the machines of the "range", it is only necessary to provide means for imparting the requisite reversal rotations to the controlling shaft 39 and such means may be as shown and to be now described. 21 is an electric motor geared to the shaft 39 by gearing 41 and normally at rest, but caused to rotate in either direction under automatic control influenced by the varying speed of travel of the fabric or materials being treated in the machines of the "range". An electric switch mechanism 45 is secured to the main frame 42 of the variable speed transmission machine and operated by a connection 46 attached to one of the blocks 40 to insure a definite limit of adjustment of the levers 37 and disks 33 and 34 when increasing or decreasing the speed of the driven shaft 32. This switch is directly controlled by the operation of the variable transmission device itself. In addition to the switch 45, there is provided the electric switch 22 controlled by the stretching or shrinking of the fabric, and acting to reverse the motor 21 from time to time as may be required to insure faster or slower speed of the driven shaft 32 to meet the requirements of the machines of the "range". The operating lever 29 of this reversing switch is actuated by a link 30 attached to the end of a floating roller 25 as shown in Fig. 5. This roller rests in a loop of the fabric web 28 where it passed down between guide rolls 27, 27. The floating roller 25 is guided in slotted guide frame 26 which is connected to or in fixed relation to the main frame of machine 4 of the "range" (Fig. 1). It will now be understood that if the fabric should stretch, the descent of the floating roller 25 will result and cause the switch lever 29 to be moved in a downward direction to cause the motor circuit 23 to be closed and the motor 21 to rotate in one direction. If the fabric should shrink, then the floating roller would rise and the switch lever 29 moved upward, causing the motor circuit to be again closed but the rotation of the motor in this case will be reversed.

The speed controlling motor 21 is normally out of action, but the moment the speed of travel of the fabric or material changes materially from the average or normal speed, such as by excessive stretching or shrinkage, the motor is put into action and rotates in the direction necessary to insure the proper change of speed for the driven shaft 32. As shown, the motor 21 in Figs. 2 and 3 runs clockwise when the speed of shaft 32 is to be increased above the normal and counter-clockwise when the speed of shaft 32 is to be reduced below the normal.

Because we have employed a three-phase electric circuit system, the wiring is somewhat complex, as will be understood from Fig. 4, but we do not restrict ourselves to the use of such a system, as an ordinary direct current system is equally adapted to our invention. Referring, however, to what is shown in Fig. 4, by way of example, all elements of the switches 22 and 45 are shown,

as are also the two motors 17 and 21 and the connecting circuits, and these will now be described.

Referring to the reversing switch 22, this comprises the actuating lever 29 pivoted at 47, which pivot also acts as the pivot for a plate 48, frictionally held to resist movement by having a heel 48e against which an arm 49 is pressed, said arm hinged at one end at 49a and having its other end connected with a tension spring 50. The arm 49 has its side next to plate 48 recessed on a curve 49e whose center of curvature coincides with the pivot 47. By this construction, the plate 48 may be shifted but will tend to stay wherever moved. Screws 51 provide means for limiting the extent of the oscillations or adjustments of the plate 48. 52 and 53 are two circuit closing arms and are respectively pivoted to the plate 48 at opposite sides of the pivot 47, as shown at 48a. These arms are connected by a tension spring 54 which tends to pull them together, but whose action is limited by pins T on the plate 48 against which the arms rest. The free ends of these arms have contact screws 55 which provide for adjustment and respectively coact with contacts 59 and 60 on the actuating lever. These contacts 59 and 60 are respectively connected by circuits 61 and 62 with terminal posts c^2 and c^3. The contacts of the two arms 52 and 53 are connected electrically to the terminal post c^1 by conductors 56 and 58 in association with a circuit breaking switch 57 which is normally closed. The terminals c^1, c^2 and c^3 are respectively connected with the conductors 23 leading to switch 45 and motor 21.

When the lever 29 contacts with the terminal screw 55 on arm 53, it both starts the motor 21 and controls its direction of rotation; and as the lever 29 continues to move it shifts the plate 48 with the arm 53 until one of the stop screws 51 arrest the further movement of the said plate 48, and on continuing its movement, the lever 29 causes the circuit closing contact 55 and its arm 53 to move against the action of the spring 54 while still maintaining the motor circuit closed. Assuming that this control of the motor 21 caused the variable speed transmitting device to reduce its speed and hence the slowing down of the speed of the fabric, the lever 29 will ultimately be moved upward with the result that the circuit through the arm 53 and its contact screw 55 becomes broken and a new circuit closing contact between the lever 29 and the contact screw 55 of the arm 52 will be completed, so that the motor will be reversed, and this condition continued as before except that the shifting of the plate 48 will be moved in the opposite direction until arrested. From the foregoing, it will be seen that a reasonable variation in the looseness or tightness of the fabric may take place with minor oscillations of the lever 29 and with the motor at rest without contacting with either of the screws 55, but if such variation in the looseness or tightness of the fabric becomes excessive, then in that event the lever 29 will make the desired contact with the contact terminal of either of the arms 52 or 53, as may be required.

Referring now to the switch 45, which is secured on the frame 42 of the variable speed transmission device and which is operated by the connection 46 extending from one of the blocks 40 moved by the screw 39 whose operation is dependent on the motor 21. The only important features of this switch are the means for limiting the operation of the motor 21 to a reasonable adjustment of the blocks 40 under the action of the screw shaft 39 and for stopping and starting the motor automatically when a predetermined adjustment of the blocks is accomplished and at a time when a permissible maximum increase or a decrease of the speed of the driving shaft 32 has been secured. 63 is a swinging circuit controlling arm pivoted at 64 and having its free end connected by a link 70 with the arm 46 extending from one of the adjustable blocks 40 before referred to. Pivoted at 67 to one side of the pivot 64 is a contact arm 65 having an adjustable contact screw 69 and adapted for making contact with the swinging arm 63. A second contact arm 66 is pivoted at 68 at the other side of the pivot 64 and is likewise provided with an adjustable contact screw 69, for also making contact with the contact arm 63, as is shown in Fig. 4. Contact 63 is connected with a wire 74 leading to a binding post S^1. The contact arm 65 is connected with a wire 76 leading to a binding post S^2, and similarly, contact arm 66 is connected with a wire 75 leading to binding post S^3. Of these binding posts, S^2 and S^3 connect with binding posts C^2 and C^3 respectively, and which, in turn, connect by electric circuits with binding posts c^2 and c^3, said circuits being a portion of those indicated at 23. Binding post S^1 is connected with binding post M^2, the circuit including one of the automatic electrically actuated cut-out switches 71, 72. It is also connected with the binding post L^3, the circuit including a fuse 73, as shown. This binding post S^1 is also connected with binding post M^3, the circuit including one of the automatic electrically actuated cut-out switches 71, 72. Binding post C^1 connects with both binding posts M^2 and M^3 and includes in series with each of said binding posts, one of the automatic cut-out switches 71, 72; and it is further connected with binding post L^2, including a fuse 73. No significance is to be applied to the fuses 73 or the automatic cut-out switches shown diagrammatically at 71, 72, as these are merely protective devices to open the circuits in case of a short circuit or overload from any cause.

Binding post C^1 connects with binding post c^1 of the control reversing switch 22 through one of the circuits 23. Binding posts M^2 and M^3 connect with two of the terminals m^2 and m^3 of the reversing motor 21, the remaining terminal m^1 thereof connecting with terminal H^1 of line circuits 19. Furthermore, the terminals L^2 and L^3 respectively connect through conductors 18 with the terminals H^2 and H^3 of line circuits 19, said line circuits being shown, by way of example, as part of a three-phase system. The power motor 17 is connected with the line terminals H^1, H^2 and H^3, as shown.

It will now be understood, when the range is functioning normally the power motor 17 is running and motor 21 is at rest. If the fabric passing through machine 6 is stretching abnormally, the lever 29 of reversing and circuit closing switch mechanism 22 is depressed and closes the circuit leading from terminal c^3; this, through the switch 45, controls the operation of the motor 21 while the reversing switch mechanism 22 controls its direction of rotation. The direction of rotation of the motor 21 under this adjustment of switch lever 29 is to rotate the screw shaft 39 anti-clockwise to speed up the succeeding machine 7 of the range, whereby its change of speed compensates for the increase in length of fabric delivered to it from machine 6. This operation on the screw shaft 39 continues with an increasing speed of machine 7 until the increase in length of fabric is compensated for, and said action will finally cause the floating roll 25 of machine 6 to rise to such an extent as to raise the lever 29 and open the motor circuit. This will prevent any further increase in speed of the machine 7, but if its then acquired speed is in excess of the requirement, the floating roller 25 and lever 29 will continue to rise with the result that the circuit will be closed through terminal c^2 and this will cause the motor 21 to be again energized but with its rotation reversed making shaft 39 rotate clockwise and reducing the speed of the machine 7. In this manner, the motor 21 is run in either direction required or stopped when necessary. If the fabric changes caused excessive adjustment of the blocks 40 by the shaft 39, then said blocks 40 would be moved to such an extent that the levers 65 or 66, as the case may be, would be brought into respective contact with the abutment screws 65^a and 66^a and cause the motor circuit to open and stop further adjustment of the blocks. This is an automatic safety means to limit the adjustment possible so that the variable transmission device cannot be adjusted beyond its limits. Normally, however, the cutting out of the motor 21 by the opening of the circuits 75 or 76 through the action of the switch arms 64 and 66 does not take place as the speed changes of the machine 7 will cause the floating roller 25 of the machine 6 to operate and control the stopping, starting and reversing of the motor 21 automatically, according to requirements. Another point to be kept in mind is that where the general lay-out of the "range" is as shown in Fig. 1, the variable speed transmission device 9 has its motor 21 controlled as to starting, stopping and reversing by the floating roller device 24 and the switch mechanism 22 controlled thereby arranged on the intake side of the machine 6 to avoid an excess of fabric being fed through the machine 4 and to the machine 6, the control of the motor being similarly accomplished to that described in Fig. 4 and its control of the motor 21 associated with the variable speed transmission device 15 for operating the machine 7 of the "range". However, in the case of the layout of the "range" indicated in Fig. 6, machine 4 being the primary machine whose speed is hand controlled, the motors 21 of the transmission devices in connection with the machines 6 and 7 of the "range" will be automatically controlled as first described in connection with the machines 4 and 7 of Fig. 1, but it will be manifest that the automatic control of the speed of machine 6 will reflect itself in further control of machine 7. The switch devices shown in Fig. 4 are similar in all cases and while we have shown that character of switch mechanism which we have found well adapted to the purpose in actual practice, we do not in any manner restrict ourselves thereto, as any form of switch mechanism that will accomplish the purpose may be employed in lieu thereof. Similarly, while we have shown a three-phase system, it is manifest that it is immaterial to our invention what electric system may be employed and whether with alternating currents or direct currents, so long as the switch mechanism is adapted to start, stop and reverse the motor, in accordance with the requirements as above stated.

We have also indicated the control devices as employing an electric motor 21 and electric switches 22 and 45, but it will be manifest that as these are only employed as a means for operating the shaft 39 and through it the levers 37 of the variable speed transmission devices; and it is not necessary that the controlling means shall be electrically actuated as the adjustment of the blocks 40 or the screw shaft 39 may be operated by any other power, such as hydraulic, pneumatic or steam, for example, under control of the shifting floating roller 25 and connections therewith. Thus, suitable types of rudder operating mechanisms where the rudder is controlled in its movement in either direction by cylinders and pistons under motive power and which motive power is controlled by a suitable pilot valve mechanism, may be adapted for controlling pur-

poses in our invention, in which case, (Fig. 7), the pilot valve 22ª would be controlled by the lever 29 under the influence of the slack or looseness in the fabric or textile material passing about the roller 25 and the motive power devices 21ª would, by suitable connection to the levers 37 of the variable speed devices 9 and 15, cause them to simultaneously move in opposite directions.

While we have described our invention more particularly in connection with the type of "range" illustrated in Fig. 1, embodying the particular machines, more especially 4, 6 and 7 therein shown, it is to be understood that our invention is applicable to all characters or "ranges" for control of a plurality of machines successively operating upon the same goods, irrespective of the character of the goods or the particular functions to be performed by the machine. Thus, for example, our invention is adapted to a cloth mercerizing "range", consisting of three roll padding machines, mercerizing tenter and compartment washing machine; similarly, the invention is adapted for a warp mercerizing machine, comprising a boiling machine and a drying machine with or without additional machines; also, the invention may be used for a continuous indigo dyeing machine "range" for warps consisting of two or more dye boxes together with a drying machine. These various examples will make it clear that the particular character of the "range" may be greatly varied. It is also to be understood that while in this specification reference is made to "textile fabric" and "textile material", these terms are only used by way of explanation of our improved method and means of control and are to be taken in no sense as limiting the invention to any particular materials to be treated, as the materials may be in woven form or unwoven form, such as in the case of warps, by way of example.

We have described our improved method and means in that particularity which we deem to be the best exposition of our invention, and that which we prefer in commercial practice, but we do not restrict or confine ourselves to the minor or secondary details, as such are susceptible of modification which may be restorted to as matters of mechanical skill and without a departure from the spirit of the invention.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. The herein described method of controlling the operation of a plurality of different machines constituting a "range", through which machines a textile material is required to pass in succession and by which the material is subjected to treatments of different kinds peculiar to the several machines, which consists in operating all of the machines of the "range" through which the textile material passes at approximately the same surface speeds allowing for possible shrinkage or stretching which may normally occur, manually regulating the speed of one of the machines of the "range", varying the speed of one or more of the other machines of the "range" whereby the surface speed is increased or decreased to compensate for stretching or shrinkage of the textile material while being treated as the case may be, and automatically controlling the increasing and decreasing of the speeds of the respective other machines by the degree of stretching or shrinking of the material undergoing treatment therein, and wherein further, one of the other machines immediately preceding the manually controlled machine and through which the textile material passes before passing through the manually controlled machine has its speed decreased or increased commensurately in accordance with the varying stretching or shrinking of the textile material and established at a point intermediate of its treatment in the manually controlled machine and the said other machine immediately preceding it in the "range".

2. In a "range" for treating textile materials, the combination of a plurality of machines comprising a series through which the textile material passes in succession, manually controlled power driving means for controlling the speed of an intermediate machine of the series, separate variable speed driving means for operating each of the machines of the series immediately on opposite sides of the intermediate machine whose speed is manually controlled, constant speed power means for operating each of the variable speed driving means, automatic means for controlling the speed of the machine from which the textile material passes to the intermediate machine by the looseness of the material being delivered to the intermediate machine, and automatic means for controlling the speed of the machine which receives the fabric from the intermediate machine by the looseness of the material in passing from the intermediate machine to the machine whose speed is to be automatically controlled.

3. In a "range" for treating textile materials, the combination of a plurality of machines comprising a series through which the textile material passes in succession, manually controlled power driving means for controlling the speed of an intermediate machine of the series, separate variable speed driving means for operating the machines of the series immediately on opposite sides of the intermediate machine whose speed is manually controlled, automatic means for controlling the speed of the machine from which the textile material passes to the intermediate machine by the looseness of the material being delivered to the intermediate machine.

and automatic means for controlling the speed of the machine which receives the fabric from the intermediate machine by the looseness of the material in passing from the intermediate machine to the machine whose speed is to be automatically controlled, and wherein further, the means for operating the machines and controlling their speed automatically each comprises a variable speed transmission mechanism, a constant speed motor for operating the variable speed transmission mechanism, a power device for varying the adjustment of the variable speed transmission mechanism whereby its speed of transmission to the machine may be increased or decreased as required, and controlling means influenced by the looseness of the fabric for controlling the stopping, starting and reversing of the controlling power means, whereby an increase in the looseness of the fabric will increase the speed of the variable speed transmission mechanism and a decrease in the looseness of the fabric will decrease the speed of the variable speed transmission mechanism.

4. The invention according to claim 3, wherein the motor device is an electric motor and the controlling means operated by the change in looseness of the fabric is an electric control and reversing switch.

5. The invention according to claim 3, wherein further, the machine through which the fabric is required to pass immediately preceding its delivery to the machine whose speed is automatically regulated is provided with manually controlled means for determining its speed, an additional fabric treating machine is arranged to treat the fabric before being received by the machine provided with the manually controlled means and said additional machine provided with driving means, and automatic means controlled by the tension of the fabric in passing from the additional fabric treating machine to and being received by the machine provided with the manually controlled means are provided for varying the speed of said additional fabric treating machine.

6. In combination, two machines operating on the same strip of material in series, said strip being arranged to travel from one of the machines to the other, means for forming a bight in the intermediate section of the strip between the two machines, a control member hung in said bight and movable transversely of its axis by the lengthening and shortening of the bight, a variable speed power means for driving one of the two machines, electrically operated means for controlling the speed of the variable speed power means to cause the machine to increase or decrease its speed as may be required, electric circuits extending from the electrically actuated means to the vicinity of the control member hung in the bight, and a circuit closing and reversing switch mechanism arranged close to and directly operated by the control member hung in the bight.

In testimony of which invention, we hereunto set our hands.

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