HEAT SETTING OF TEXTILE FABRICS

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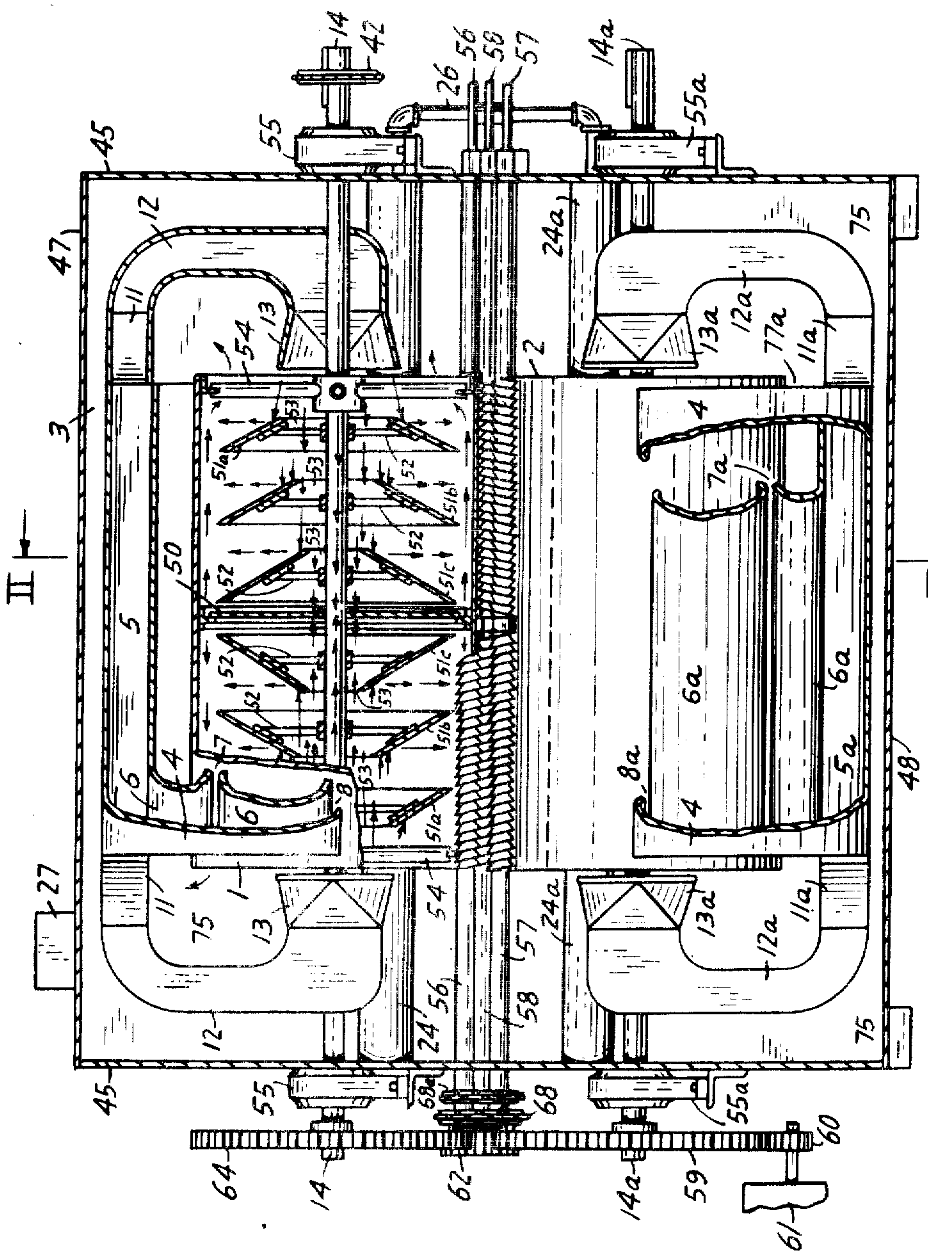

Fig. 1

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HEAT SETTING OF TEXTILE FABRICS

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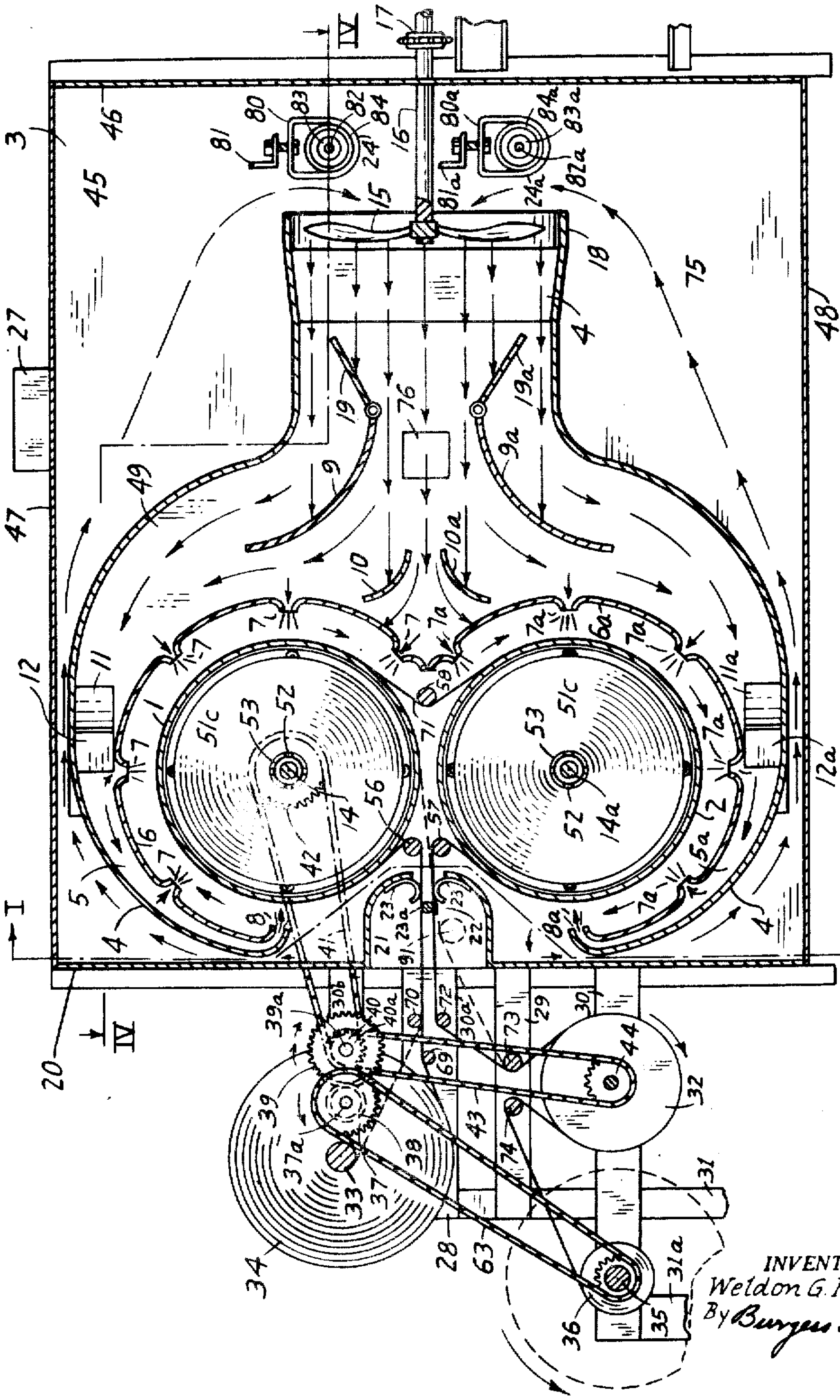

Fig. 2

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HEAT SETTING OF TEXTILE FABRICS

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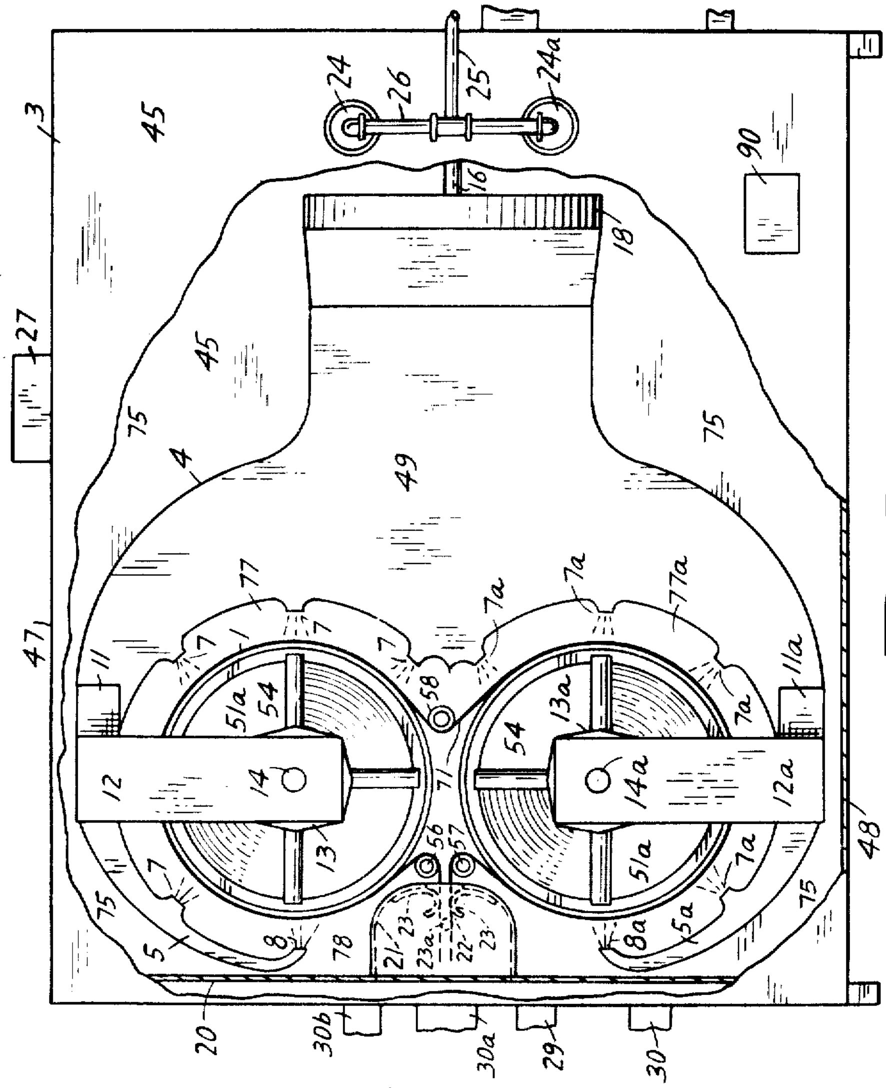

Fig. 3

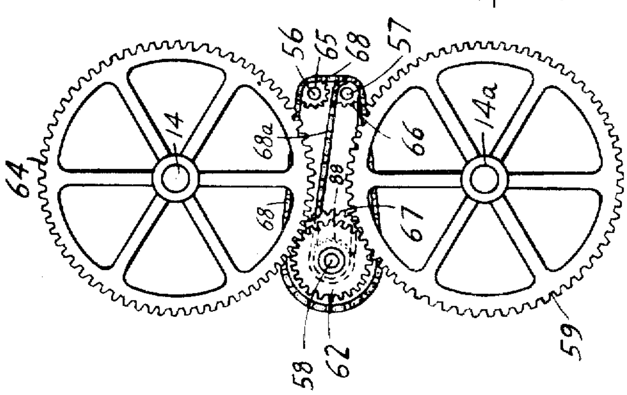

Fig. 5

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HEAT SETTING OF TEXTILE FABRICS

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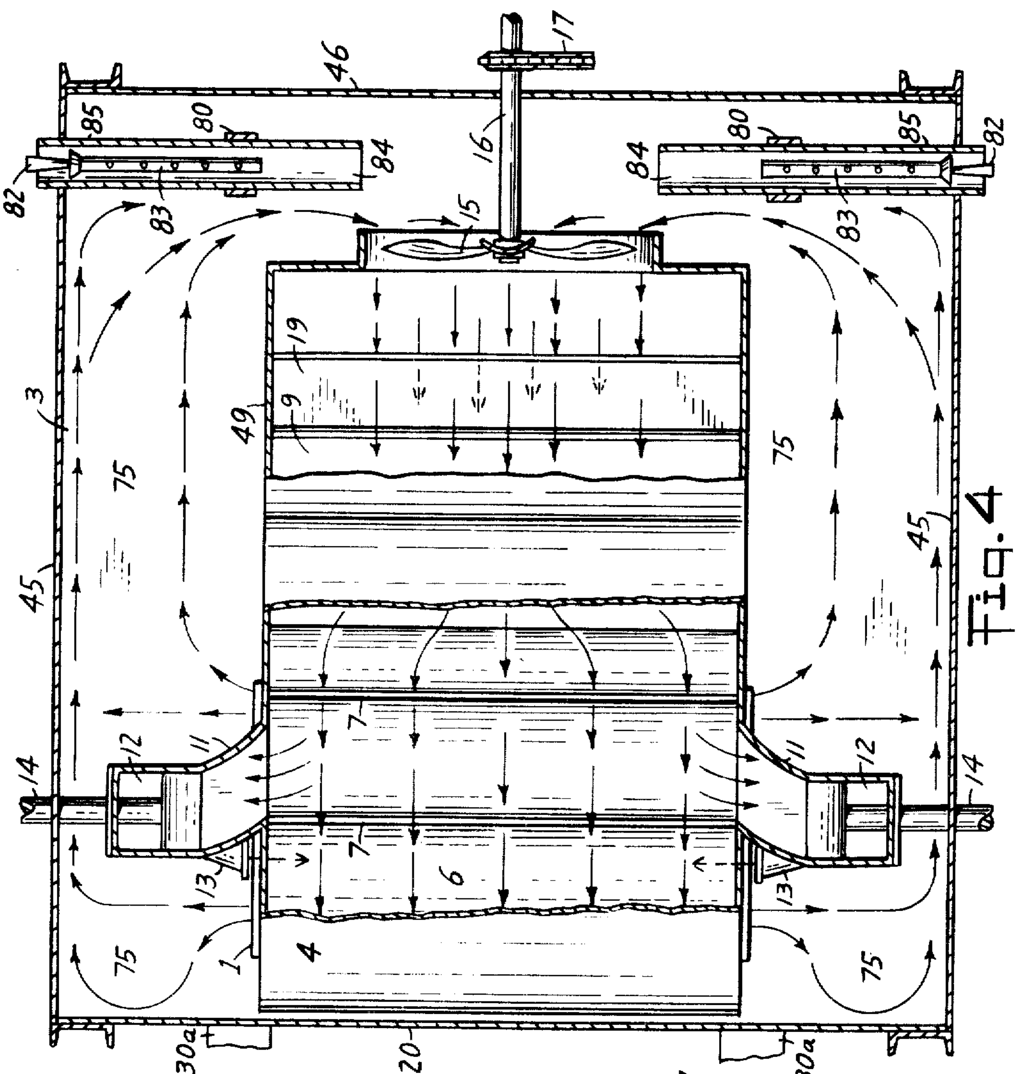

Fig. 4

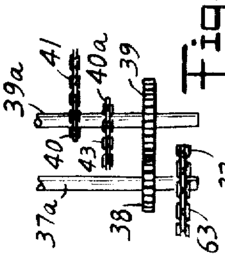

Fig. 7

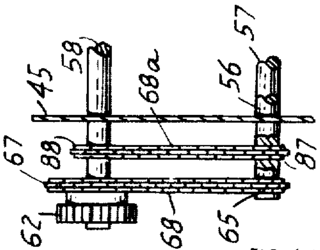

Fig. 6

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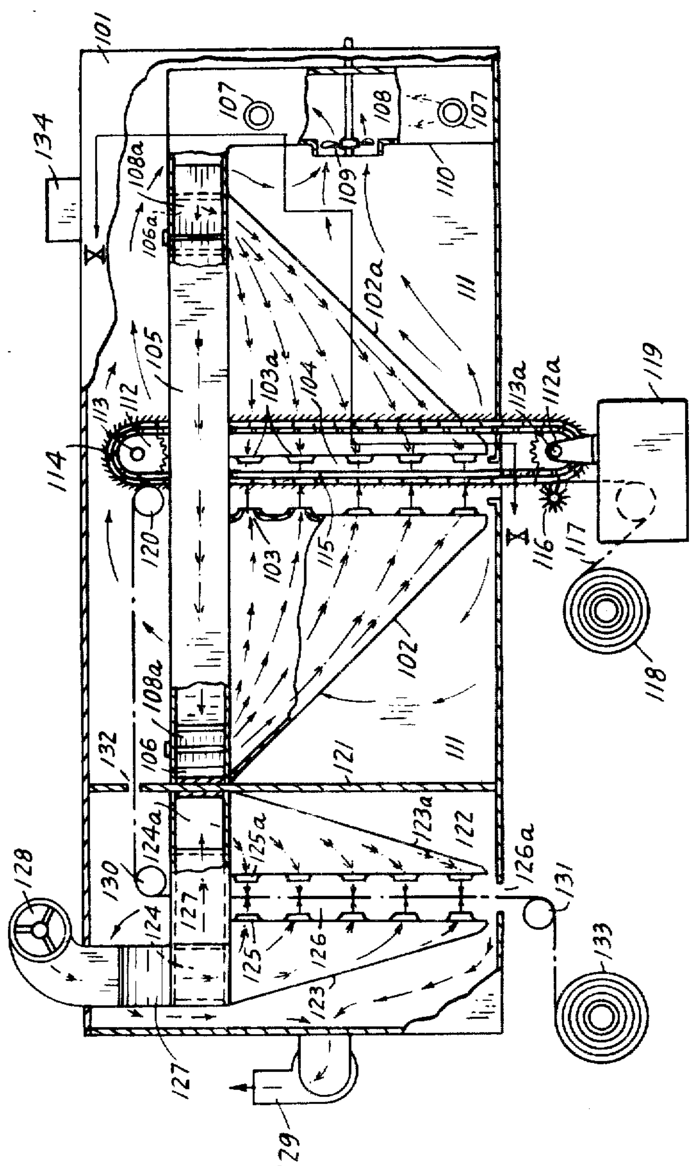

Fig. 8

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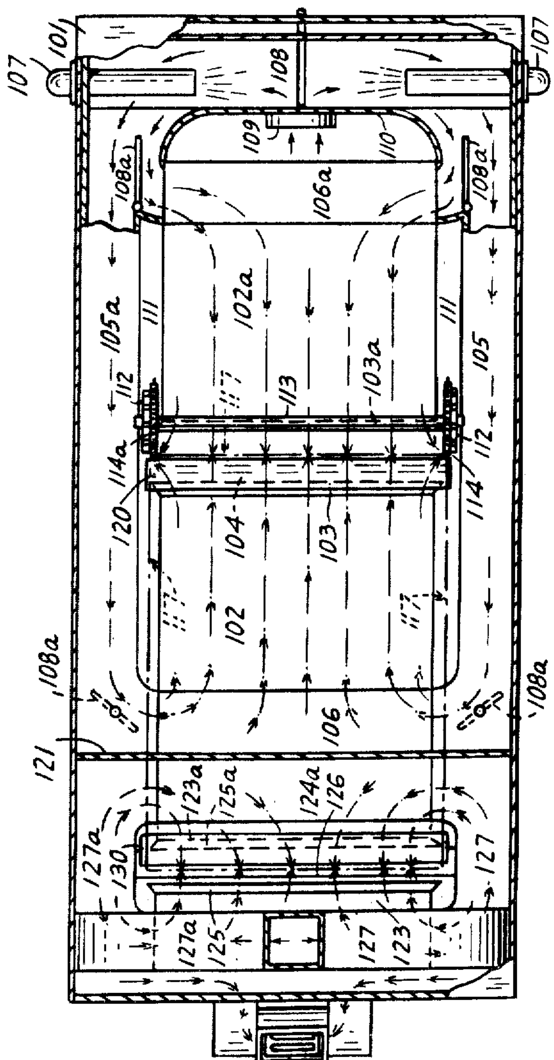

Fig. 9

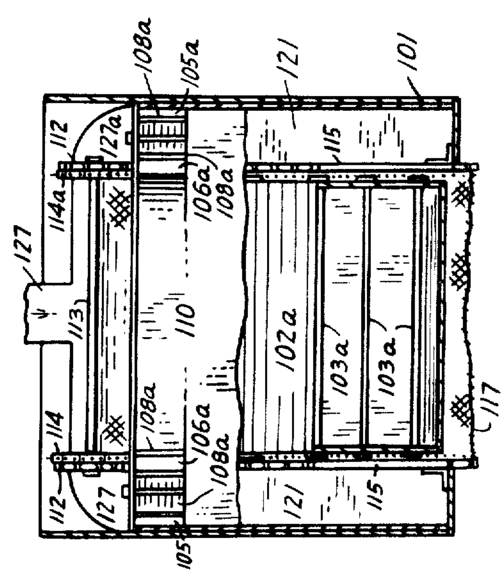

Fig. 10

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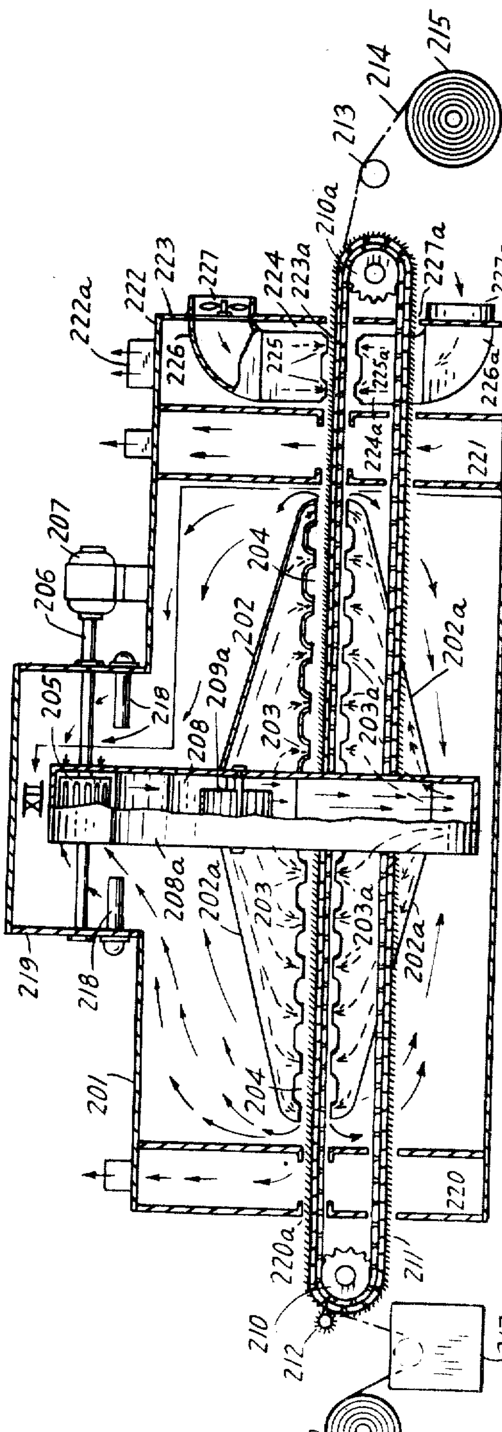

Fig. 11

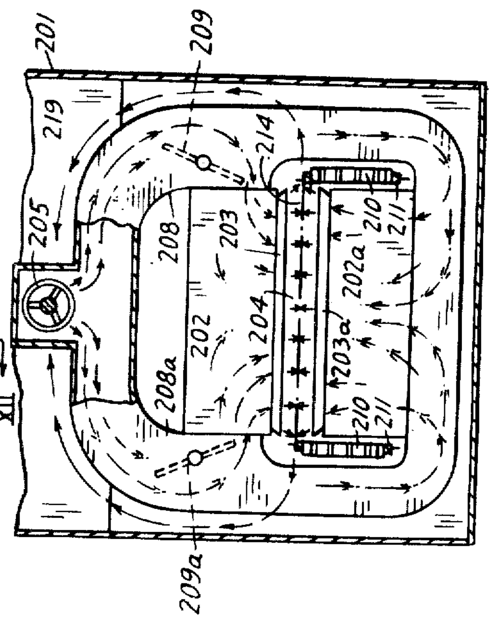

Fig. 12

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HEAT SETTING OF TEXTILE FABRICS

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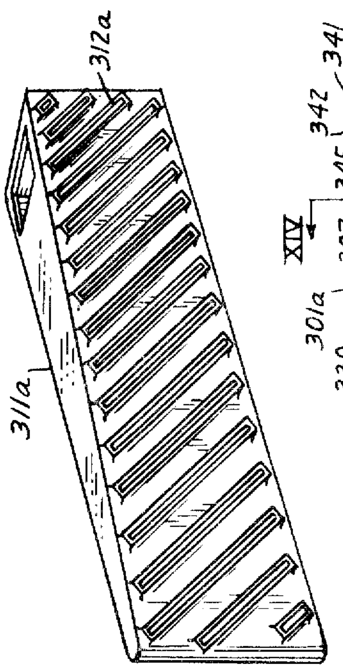

Fig.15

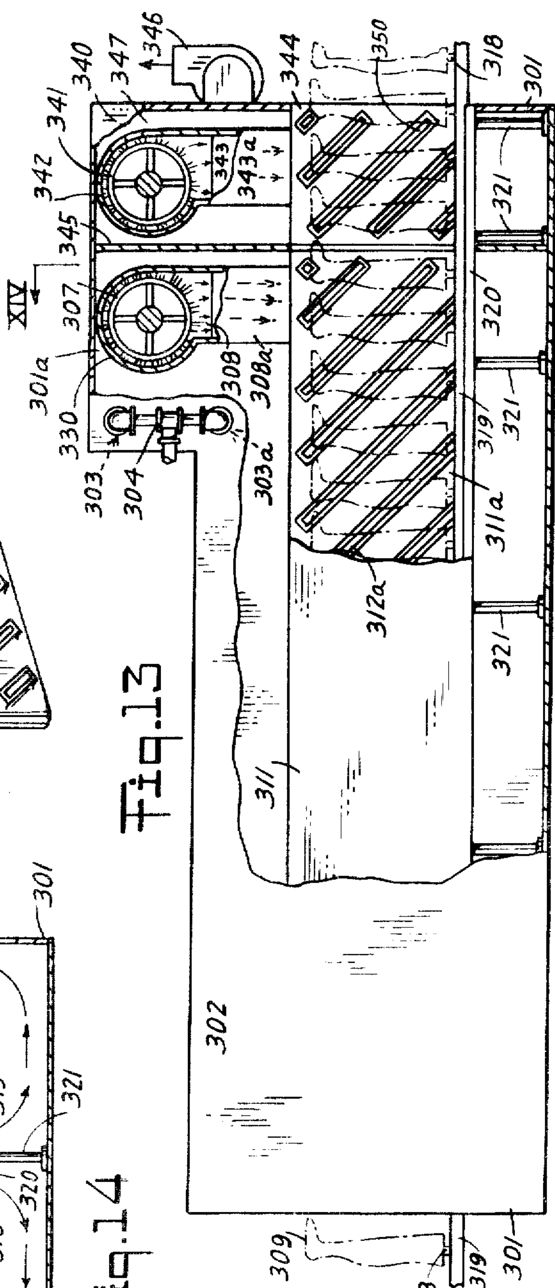

Fig.13

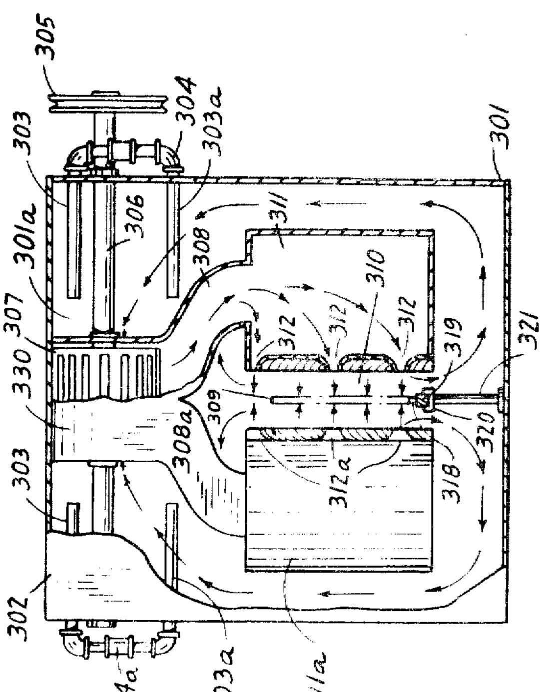

Fig.14

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UNITED STATES PATENT OFFICE

2,499,142

HEAT SETTING OF TEXTILE FABRICS

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Application July 14, 1948, Serial No. 38,713

15 Claims. (Cl. 8—130.1)

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This invention relates to new and useful improvements in the heat setting of textile fabrics and is a continuation-in-part of my copending application, Serial No. 790,679, filed December 9, 1947.

Certain woven fabrics consisting of or containing fibers made of certain synthetic materials, and notably polyamides, are deficient, inter alia, in hand, drape and resilience. In order to overcome such deficiency and improve the characteristics of these fibers, particularly with a view of putting to use the otherwise advantageous properties thereof, such as strength of fiber and elasticity, a "setting" treatment is resorted to. This setting treatment as hitherto practiced usually comprises a finishing step for the fabric (consisting of or containing synthetic polyamide fiber) and involves the heating of the fabric by pressing the same against a heated surface with substantially constant pressure between the fabric and the heated surface until the temperature of the fabric reaches a point just below the fusion point of the polyamide. Usually this requires heating of the fabric to a temperature which ordinarily should not substantially exceed 5–25° C. below the fusion point of the polyamide. The heating of the fabric under pressure to within the required temperature for the particular specific type of polyamide should not ordinarily exceed in the order of 60 seconds. The treating conditions are critical in their interrelation within relatively confined limits and relatively small increases beyond these limits of the heating period; treating temperatures or pressure may seriously impair the strength of the fibers.

Various means have been proposed in the past to accomplish a satisfactory setting of polyamide fiber materials on a production basis, utilizing the aforedescribed method. In one device suggested for this purpose the fabric is passed between two heated surfaces, such as two heated rollers, between which the fabric is placed under a predetermined uniform pressure over its entire width. Another device proposes the movement of the fabric along a stationary heated surface by means of a belt. In still another device the fabric web is carried over a roll, being pressed onto the same by a heated substantially stationary sleeve or shoe.

The hitherto proposed method and devices for the setting of polyamide fabrics are relatively cumbersome and inefficient in commercial operation, do not yield desirably uniform results, and require a relatively high amount of skill on the part of the operator. They do not readily lend themselves to the desired accurate maintenance and control of the relatively critical operating conditions required for a satisfactory setting of polyamide fibers and are encumbered by a relatively low operational output usually not materially exceeding 4–5 yards per minute.

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One object of the instant invention comprises, inter alia, the efficient, high speed, heat treatment of textile materials and particularly the heat setting of textile materials containing or consisting of polyamides.

Another object of the invention comprises the efficient high-speed heat treatment of webs of textile material and particularly the heat setting of such webs of textile materials containing or consisting of polyamide fibers.

A further object of the invention comprises the efficient high speed heat setting of preformed textile materials containing or consisting of polyamide fibers and particularly the heat setting of women's hosiery containing or consisting of polyamide fibers.

The foregoing and still further objects of the invention will appear from the following description read in conjunction with the drawings in which:

Fig. 1 is a cross-sectional front view, partly broken away, of the construction shown in Fig. 2, and viewed in the plane I—I thereof, and permitting the carrying out of one embodiment of the invention;

Fig. 2 is a cross-sectional side view of the construction shown in Fig. 1 in the plane II—II thereof, showing additionally the front portion of the device as well as cooling, feed and take-up arrangements;

Fig. 3 is a side view of part of the construction shown in Figs. 1 and 2 with part of the side of the outer housing broken away;

Fig. 4 is a top view of part of the construction shown in Fig. 2 in the plane IV—IV thereof;

Figs. 5 and 6 are side and top views respectively illustrating details of the driving arrangement for the rollers and scrolls forming part of the construction shown in the preceding figures;

Fig. 7 is a top view showing details of part of the driving arrangement for the cooling and pick-up roll as illustrated in Fig. 2;

Fig. 8 is a side view, partly in cross section and partly broken away, of a further construction permitting the carrying out of another embodiment of the invention;

Fig. 9 illustrates a top view of the construction shown in Fig. 8, partly in cross section and partly broken away;

Fig. 10 represents a cross sectional end view of part of the construction illustrated in Fig. 8 viewed in the plane X—X thereof;

Fig. 11 is a side view of a still further construction, partly in cross section and partly broken away, permitting the carrying out of the invention;

Fig. 12 is a cross-sectional view of part of the construction shown in Fig. 11 viewed in the plane XII—XII thereof;

Fig. 13 is a side view, partly in cross section and partly broken away, of still another alternative construction permitting the carrying out of a further embodiment of the invention;

Fig. 14 is a front view of the construction shown in Fig. 13, partly in cross section and partly broken away; and

Fig. 15 illustrates a perspective view of one of the high velocity heating gas chambers and nozzle surface thereof shown in Figs. 13 and 14.

In accordance with the invention a heat-settable textile material is substantially continuously passed through a heating zone, and preferably substantially at a rate of travel of about 36–144 yards per minute linear speed, substantially continuously directing high velocity heating gas current, preferably of the order of magnitude in excess of 400 feet per minute, of a predetermined heat-setting temperature for said material and preferably of about 300–500° F., (preferably for polyamide material about 400–475° F.) onto said material, while traveling through said heating zone and substantially over a length of travel of said material in said zone to substantially expose each portion thereof to said heating gas current for from 1 to 10 seconds, and preferably subjecting said material to cooling upon passing out of said heating zone.

Within one embodiment of the invention, as for instance applied to a polyamide fabric web, the same is passed in substantially extended state through the heating zone on an endlessly traveling web carrier, which preferably substantially moves said web at a rate of travel of about 36–144 yards per minute linear speed. The traveling web should be subjected to heating within the heating zone from both sides thereof. If one face of the fabric rests on or moves over a support or backing surface, supporting the fabric web substantially in its entire width between the self-edges thereof, that backing surface should be heated to the predetermined heat-setting temperature for the particular material to be treated, in which case the high velocity heating gas current is only applied to one side of the moving fabric web. Alternatively, if one face of the fabric is not so supported, as, for instance, when freely suspended between the carrier supported self edges, high velocity heating gas current is supplied to both faces of the traveling fabric web. In the absence of a solid support or backing surface, the application of the heating gas current to but one side of the fabric web, and particularly one of light weight material, may tend to produce sagging. The preferred application of the high velocity heating gas current to a moving fabric web is substantially in a direction transverse to the surface thereof. In the event a roll is selected as the carrier for the fabric web within the heating zone, the direction of the heating gas current is essentially in a plane or planes substantially radial to the circumference of the roll.

Within the embodiment of the invention, as applied to pre-formed pieces of textile material such as women's hosiery, and particularly those of polyamide fabric, the pieces are passed through the heating zone on setting forms secured to an endlessly traveling carrier preferably moving substantially at a rate of travel of about 36–144 yards per minute linear speed. The heating gas current is then substantially continuously directed within the heating zone from opposite sides thereof onto the form-supported pieces of material as they move through the heating zone, to impinge upon substantially all sides of the pieces. In this case, the preferred application of the heating gas current is substantially at an angle and preferably at an angle of 45° with the direction of travel of the form-supported material through the heating zone.

The term "heat-settable" fabric or similar expression used herein is intended to designate any textile material containing or consisting of fibers capable of being set (i. e. fixed) by the application of heat, into desired condition of modified characteristics.

Wherever in the specification and claims reference is made to polyamide fabrics or fibers or where such similar expression is used, the same is intended to connote any fabric or fiber consisting of or containing polyamide fibers and specifically polyamide fibers of synthetic linear polyamides.

Figs. 1 to 7 inclusive illustrate one form of device useful in carrying out my novel method. As there shown, two rolls **1** and **2** respectively, are mounted within an outer housing **3**. A branched housing **4** is mounted within the outer housing **3** and extends into curved branches defining the ducts **5** and **5a**. The inner surfaces **6** and **6a** of ducts **5** and **5a** define a heating space above the corresponding surface portions of the rolls **1** and **2**. The inner surfaces **6** and **6a** of the ducts **5** and **5a** carry the nozzles **7** and **7a** extending longitudinally of the surfaces of their respective rolls. The ends of the ducts **5** and **5a** are curved downwardly ending in nozzles **8** and **8a**. Baffles **9**, **9a** and **10** and **10a** respectively are arranged within inner housing **4** to properly direct heating gas to the various nozzles in the branched ducts. Ducts **5** and **5a** each carry branched portions **11** and **11a** respectively continuing as ducts **12** and **12a** which end in the flared openings **13** and **13a**. The axles **14** and **14a** of rolls **1** and **2** pass respectively through the flared ends **13** and **13a** and the adjacent portions of ducts **12** and **12a**. In this manner the flared ends **13** and **13a** open into the center of the rolls **1** and **2**.

A fan **15** mounted on shaft **16** and driven by the chain drive **17** from, for instance, a motor (not shown), is mounted inside the neck **18** of the housing **4**. Hinged baffles **19** and **19a** inside housing **4** permit adjustment of air flow through the branched portions created by the baffles **9** and **9a** respectively.

The front portion **20** of housing **3** carries the trough section **21** having the slotted aperture **22** supported by the rounded angle portions **23**. Pairs of opposing burners **24** and **24a** respectively are provided in the rear portion of the outer housing **3**, being supported by U brackets **80**, **80a** bolted to angle brackets **81**, **81a**. These are the conventional gas burners of the Venturi type comprising injector extensions **82**, **82a**, flared, perforated inner tubes **83**, **83a** and outer tubes **84**, **84a** carrying air inlets **85**, **85a**. Each pair of burners on the same side is supplied with fuel gas by way of suitable connections such as pipe **25** and branched pipe **26** (Fig. 3).

A frame structure 28 is secured to the front portion 20 of housing 3 and includes cross-supports 29, 30 and 30a and floor supports 31 and 31a. The frame structure supports cooling roll 32, shaft 33 for fabric feed roll 34, shaft 35 for fabric pickup roll 36 and guide rolls 69, 70 and 72. Auxiliary frame 30b at one side of the frame structure carries the gears 38, 39 and sprockets 37, 40 and 40a on shafts 37a and 39a (Fig. 7). As illustrated in Figs. 2 and 7, shaft 35 is driven through chain 63 by sprocket 37 on shaft 37a, which in turn is driven by the gear 38 meshing with gear 39 on shaft 39a driven by sprocket 40, chain 41, and sprocket 42 secured to the shaft 14 of roll 1. A second sprocket 40a on shaft 39a behind gear 39 drives through chain 43 and sprocket 44 the cooling roll 32.

As may be seen from Figs. 2 and 3, the outer housing 3 carries the closed side walls 45, rear wall 46, front wall 20, top wall 47 and bottom wall 48. Thus the entire housing 3 is completely enclosed on all sides with the exception of the slot 22 for the passing of a fabric web into the housing and the removal of the fabric therefrom. The top 47 of the outer housing 3 carries the fan exhaust 27.

The inner branched housing 4 carries the sides 49 thereby defining a completely closed duct system for a heating gas entering through the open neck 18 and forced out through the nozzle openings 7, 7a, 8 and 8a.

The construction of the heating rolls is illustrated, for instance, in Fig. 1. As there shown, the heating rolls, such as heating roll 1, carry in their center the substantially stationary wall or baffle 50 dividing the roll into two substantially equal halves. In each half a number of cones 51a, 51b and 51c are mounted onto the central axle by way of the flanged supports 52. Each cone carries a central opening 53 and the openings of successive cones are progressively smaller with the largest cone-opening at the outer end of the roll and the smallest cone-opening near the center of the roll. The cones are mounted in spaced relationship to the inner wall of the roll. Strengthening cross-braces 54 are provided within the rolls at the outer portions thereof. The roller shafts are mounted in the bearings 55 and 55a respectively. A series of scroll or expansion rollers 56, 57 and 58 (with conventional expansion grooving) are mounted within housing 3 and serve the proper guiding, extending and/or positioning of the traveling fabric web. The expansion rollers are preferably geared for a circumferential linear speed approximately 5–20% in excess of the circumferential linear speeds of the rolls 1 and 2. Gear wheel 59 (Fig. 1) is keyed to roll shaft 14a and is driven by the meshing gear 60, driven by suitable motor 61. Gear 59 meshes with gear 62 bearing supported and rotatable on shaft 58 (Fig. 5). Gear 62 engages gear 64 keyed to roll shaft 14. Sprockets 65 and 66 (Figs. 5 and 6) are keyed to shafts 56 and 57 respectively; sprocket 67 is secured to gear 62, freely rotatable with the same on shaft 58. Chain 68 establishes the driving connection between sprockets 65, 66, and 67 for rotation of their respective scroll rollers. Sprocket 87, keyed to lower scroll shaft 57, drives scroll shaft 58 by way of chain 68a and sprocket 88 keyed on scroll shaft 58.

In the practical application of the invention and as carried out, for instance, by the device illustrated in Figs. 1 to 7 inclusive, a web of textile material as, for example, on feed roller 34 (Fig. 2), is fed by way of the guide rollers 69 and 70 and scroll 56 through the slot 22 and onto roll 1 passing underneath lower surface 6 of duct 5. The fabric web indicated by the numeral 71 passes from upper roll 1 over scroll 58 and lower roll 2, passing the latter beneath the nozzled surface 6a of duct 5a. The web passes from roll 2 around scroll 57 out through the slot 22 onto cooling roll 32 by way of the guide rolls 72 and 73. The cooling roll is of the conventional hollow type provided with a circulating cooling water system (not shown). The fabric passes from the cooling roll over guide 74 onto the pickup roll 36 on shaft 35. Angle portions 23 extend over at least the width of the fabric web. They are vertically adjustable and are set with their smooth rounded portions to substantially tangentially engage the feeding and discharging web portions respectively. A guide roller 23a acts as a separator for the feeding and discharging web portions and is mounted to essentially form, with the angle portions 23, a seal against the passage of excessive amounts of cold air into the heating zone through slot 22. Fig. 2 illustrates the operation after a new roll of textile material has just been started. In that case roll 34 is fairly full with the pickup roll 36 relatively small. The situation as it occurs near the end of the original feed roll 34 is illustrated in dotted outline. In that case the feed roll will be relatively small and the pickup roll will be relatively large.

The burners 24 and 24a heat the air or other heating gas within the housing 3 and the fan 15 forces the air into the duct system of the inner housing. A portion of the air passes straight through and out of the centrally located nozzles 7 and 7a near the scroll 58. Other portions of the air are deflected by the various baffles 9, 9a, 10, 10a, being forced out through the various nozzles 7, 7a in the duct surfaces 6 and 6a of the ducts 5 and 5a. Still another portion of the air, forced into and through the duct system, is branched off into the ducts 11 and 11a respectively, passing thence through conduits 12 and 12a respectively and out of the flared duct openings 13 and 13a. The air issuing from the duct openings 13 and 13a will in part go through the cone openings, ultimately reaching and being deflected from the inner plate 50 to and outwardly along the inner periphery of the roll. By reason of the inwardly decreasing size of the cone openings, a portion of the air is deflected by each cone along the baffled cone surface and against the inner periphery of the roll. The air flows outwardly along the inner periphery of the roll into the outer space 75 within housing 3, being thence drawn back into the fan 15. The nozzles 7 and 7a are so shaped and dimensioned that they supply a relatively uniform forced heating gas current over substantially the entire width of the fabric and the nozzles are preferably radially positioned with respect to the circumference of the rolls defining essentially radial slots extending substantially across the width of the fabric web and substantially parallel to the axis of rotation of the respective rolls. The temperature of the air or other heating gas is thermostatically controlled to maintain a predetermined temperature or temperature range, the thermostatic element being diagrammatically illustrated as 76 (Fig. 2). The air or other heating gas forced out of the nozzles and directed against the traveling fabric web is forced out of the open sides 77 and 77a and the open ends 78 and 78a (Figs. 1 and 3) into the space 75 within housing 1, being thence also passed back into the fan 15 for recirculation through the system. After a certain period of operation an undesirable concentration of combustion gases and/or moisture may obtain in the heating gas which is recirculated through the system. In that event the exhaust 27 is used to draw off any desired amount of heating gas and preferably up to not in excess of 30%. Suitable provision should be made for replenishing the amount of exhausted heating gas. If air is used as the heating medium the same may be replenished, within certain limits, by outside air leaking in at various places including the slot 22. It is, however, recommended to provide a separate air inlet for the replenishment of exhausted heating air, such as the hinged panel door 90 (Fig. 3). A conventional air heating element (not shown) is preferably positioned within the inlet for the purpose of preheating the admitted air. There will thus be a minimum of interference with the desired temperature or temperature range to be maintained within the system. In many cases it is desirable and of advantage to pre-set the exhaust to a given rate and coordinate therewith the admission of make-up air to thereby automatically prevent undesirable accumulation of moisture and/or combustion gases.

The motor, such as motor 61, used for driving the rolls is preferably a variable speed motor. Alternatively any other conventional variable speed drive arrangement may be used. The rate of travel of the fabric web through the housing or heating zone must be carefully predetermined for the given fabric and a given finish to be obtained and to that end should be coordinated with the particular temperature or temperature range at which the heating is conducted. Thus a given treatment may called for a heating of the fabric at a given temperature or within a given temperature range for a given period of time. The speed of rotation of the rolls should then be so adjusted that the fabric web travels over the rolls and in and out of the housing in a period of time assuring that no part of the web has remained within the heating zone longer than the predetermined period. For this reason the provision of suitable cooling means, such as a cooling surface and/or an applicator for fluid refrigerant, is important in that it immediately removes any heat from the fabric web that may have any continuing effect and would thus tend to spoil the results obtained within the heating zone.

Within the preferred embodiment of my invention, the textile material is passed through the heating zone, i. e., in the case of the device illustrated in Figs. 1 to 7 inclusive, through the housing of the device at a rate of speed of approximately 36–144 yards per minute. The temperature within the heating zone is maintained, dependent upon the particular type of material used, at a predetermined heat-setting temperature or temperature range of 300–500° F., and specifically for polyamide material at about 400–475° F., and high velocity heating gas current is directed onto the fabric web as it travels through the heating zone, preferably at a velocity of an order of magnitude of at least 400 feet per minute. Satisfactory results are obtained when causing the heating gas current to be directed onto the fabric web at a velocity of an order of magnitude from 400–4000 feet per minute. The length of the heating zone is so dimensioned that the goods are subjected to the particular predetermined heat-setting temperature or temperature range for the material treated and at their particular speed of travel for at least 1 second but not exceeding 10 seconds.

Instead of using a multiple roll arrangement as illustrated in the drawings, a single web carrier roll may be provided. This may be, for instance, accomplished by appropriately mounting an auxiliary guide roll 91 which permits the fabric web to be carried over a single roll. In that case, the fabric would travel from scroll 56 over roll 1 and thence out of slot 22 over guide roll 91 direct to guide roll 73. This is illustrated by the broken outline of the fabric, as shown in Fig. 2.

In Figs. 8 to 11 inclusive, alternative devices are illustrated for the carrying out of the invention. While the device of Figs. 1–7 essentially shows a web carrier providing a support or backing surface over the entire width of the web, the device of Figs. 8–11 shows the web of textile material being carried through the heating zone on a pair of endlessly moving pin frames holding the self edges of the fabric web in a manner to substantially maintain and support the shape thereof. In this case, the fabric web is substantially freely suspended between the pin frame held self-edges thereof, and there is no support or backing surface on which the fabric web rides, such as is the case in connection with the illustration shown in Figs. 1 to 7.

Specifically referring to Figs. 8 to 10, 101 indicates a housing having mounted therein the wedge-shaped heating gas chambers 102 and 102a. Each of the chambers is provided with high velocity heating gas nozzles 103 and 103a, of the same type heretofore described in connection with Figs. 1 to 7. The heating zone is defined by the space 104 between the heating chambers 102 and 102a.

Heating gas ducts 105 and 105a are provided within the housing 101, supplying heating gas to the branched ducts 106 and 106a, arranged on top of the heating gas chambers 102 and 102a respectively, in open communication therewith. Thermostatically controlled pairs of gas-fired burners 107 and 107a are mounted in the heating space 108, communicating with the heating gas ducts 105 and 105a. Baffles 108a are provided in the heating ducts 105 and 105a at their intersection with ducts 106 and 106a, to balance the supply of heating gas to the heating chambers 102 and 102a. A fan 109, suitably driven by a motor (not shown) is mounted in an opening provided in the partition wall 110, separating the heating space 108 from the inner housing space 111.

A pair of sprocket wheels 112, on a common axle 113, is mounted within housing 101, and above the heating space 104. A corresponding pair of sprocket wheels 112a is mounted on common axle 113a outside of the housing 101, below the space defining the heating zone 104. Endless pin chains or belts 114 and 114a are driven by the sprockets and are controlled in their travel through the heating space 104 by the rigidly spaced pairs of guide rails 115. Two pin brushes 116 (only one is illustrated) are mounted for brushing engagement with the pins on the pin chain or belt, one for and adjacent each of the lower pairs of sprockets 112a. A web of fabric material 117, unwinding from the feed roll 118, passes the web into the over-feed device diagrammatically illustrated as box 119. Fabric take-off guide roll 120 is mounted adjacent the upper pair of sprocket wheels 112.

A separating wall 121, mounted within housing 101, defines, within the housing 101, the cooling compartment 122, carrying mounted therein the wedge-shaped cooling air chambers 123 and 123a, supplied with cooling air through cross ducts 124 and 124a. Cooling chambers 123 and 123a are provided with high velocity cooling air nozzles 125 and 125a similarly shaped and dimensioned as the high velocity heating gas nozzles 103 and 103a. The cooling chambers 123 and 123a are positioned to define the cooling zone 126. Branched cooling gas ducts 127 and 127a are supplied with cooling gas, such as air, through the centrifugal fan 128, and pass the cooling air to the cross ducts 124 and 124a and thence into the cooling chambers 123 and 123a. A motor driven exhaust 129 is provided in communication with the cooling space 122. Guide rolls 130 and 131 are mounted to pass the fabric through the cooling zone 126 as it is passed from the take-off roll 120, through partition slot 132 into the cooling part of the device. Fabric wind-up roll 133 is mounted to reel up the fabric web as it passes out of the cooling zone, guided by guide roll 131. Exhaust 134 is mounted on top of the housing, serving to balance the heating gas system within housing 101, and to take off a certain amount of heating gas air in the manner and for the purpose illustrated in connection with the similar exhaust of the device exemplified by Figs. 1 to 7.

In the practical application of the invention as it may be carried out by use of the device shown in Figs. 8 to 10, the fabric web is passed from the feed roll 118 into the over-feed device 119, and both edges thereof are then pressed into the pins of each endless pin chain 114 by way of the pin brushes 116. The fabric web held in shape and position by the pin chains at each side thereof and controlled by the rigid rail frame 115, moves through the heating zone 104 and is taken off the pin chain over the guide roll 120, thence passing through the slot 132 over the guide roll 130 through the cooling zone 126 out of the device through the slot 126a over guide roll 131 onto wind-up reel 133. As the fabric travels through the heating zone 104, high velocity heating gas current impinges upon both sides of the fabric being directed onto the same, through the high velocity heating gas nozzles 103 and 103a in heating gas chambers 102 and 102a. The feed of the pin chains 114 on sprockets 112 and 112a is so arranged that the chains travel at a rate of linear speed of from about 36–144 yards per minute. Thermostatic controls (not shown) are provided to substantially maintain the temperature of the heating gas current to about 400–475° F. The balance of heating gas current within the system and the force imparted thereto by the fan 109 supplying the heating gas current through the various ducts to the high velocity heating gas nozzles 103 and 103a, are so arranged that the velocity of the heating gas current as it impinges upon the traveling fabric web is in excess of 400 feet per minute, and preferably between 400 and 4000 feet per minute. As the fabric is moved out of the heating zone and into the cooling zone 126, high velocity cooling air impinges upon the same on both sides thereof, thereby rapidly cooling the same and moving it out of the danger zone or temperature that might cause overheating or oversetting of the material.

The length of the heating zone as defined between the nozzled surfaces of the heating gas chambers is so arranged that the goods moving therethrough are exposed to the predetermined heat-setting temperature at their particular speed of travel for from 1–10 seconds. It is advisable, depending on the particular construction used, to include in the effective dimension of the heating zone the entire path of travel of the goods from the point of entry into the heating portion of the device to the point of entry into the cooling portion thereof. The total exposure of each portion of the material to said predetermined heat-setting temperature is thus limited, not to exceed substantially 10 seconds.

Figs. 11 and 12 illustrate an alternative embodiment of the device shown in Figs. 8 to 10 inclusive for carrying out the invention. As there illustrated, there are mounted within housing 201 the double wedge-shaped heating chambers 202 and 202a, provided with the high velocity heating gas nozzles 203 and 203a, and defining between their nozzled surfaces the heating space 204. A centrifugal fan 205, mounted on shaft 206, and driven by motor 207, supplies high velocity heating gas through the branched ducts 208 and 208a, communicating with the heating air chambers 202 and 202a. Suitable heating gas control baffles 209 and 209a are provided to adjust the balance of heating gas supplied to the chambers 202 and 202a. Pairs of sprockets 210 and 210a are provided. Sprockets 210 and 210a carry the pair of endless pin chains 211 which are mounted on sprockets 210a to act as a web carrier through the heating zone 204. Two pin brushes 212 (only one illustrated), one mounted adjacent each of the pair of sprocket wheels 210, serve to press the self-edge of the fabric web into contact with the pins. A web take-off roll 213 is mounted near the sprocket pair 210a and serves to guide the fabric web 214 to the wind-up reel 215. The fabric feed roll 216 passes the fabric into the over-feed device 217 whence it passes onto the pin frame 211. A pair of gas-fired burners 218 are provided in the fan housing 219. Exhausts 220 and 221 serve to balance the heating gas system within the device. A fabric web cooling arrangement 222 is provided at the pick-up end of the device and comprises the housing 223, cooling gas chambers 224 and 224a, provided with the high velocity cooling gas nozzles 225 and 225a, and supplied with cooling gas through the ducts 226 and 226a, provided with the fans 227 and 227a respectively.

In the practical application of the invention, by the use of a device as exemplified in Figs. 11 and 12, the fabric web is passed from the feed roll 216 to the over-feed device 217 onto the pairs of endless pin chains 211 being pressed with the self-edges thereof into the pins by means of the brush wheels 212. The fabric web is carried by the pin chains or belts through the slot 220a at the feed end of housing 201, through the heating zone 204 and out of the slot 227a at the pick-up end of housing 201. The fabric web 214 is taken off the endless pin chains 211 by way of and over the take-off and guide roll 213, being thereafter wound up on wind-up reel 215. The endless pin chains are suitably driven to move at a speed of about 36–144 yards per minute. The heating gas current is thermostatically maintained at a temperature of about 400–475° F., and is forced through the heating ducts 208 and 208a into the heating gas chambers 202 and 202a by way of the centrifugal fan 205. The high velocity heating gas nozzles and propelling force of the centrifugal fan are so adjusted that the heating gas issues out of the nozzles 203 and 203a to impinge upon the sides of the traveling fabric web at a velocity of about 400–4000 feet per minute, the length of the zone within which the fabric is subjected to heat-setting temperatures being so dimensioned that the fabric at its speed of travel passes therethrough in from 1–10 seconds.

The over-feed arrangement 217, as well as the corresponding over-feed arrangement 119 (Fig. 8) serve to feed the fabric in substantially slackened condition to avoid undue tensioning as a result of shrinkage during the heat treatment.

As the fabric moves through the cooling zone 223a, defined between the nozzled surfaces of the cooling gas chambers 224 and 224a, cooling gas, preferably high velocity cooling gas, supplied by way of the propelling fans 227 and 227a, and the ducts 226 and 226a, is forced through the nozzles 225 and 225a to impinge upon the sides of the traveling fabric web 214 and is then exhausted at 222a.

The devices exemplified by Figs. 2 to 12 lend themselves advantageously to the application of the invention to relatively loose weave fabric webs, and particularly tricots. For these, it is essential that the heat setting be carried out while the fabric web is substantially rigidly maintained at a uniform width to avoid uneven shrinkage and the formation of an uneven wavy web. For best results, it is of advantage not only to slightly over-feed the fabric prior to its passage into the heating zone, but also to adjust the distance between the carrier portions of each pair of endless pin chains to allow for at least mean shrinkage in width during the heat treatment of the goods.

Figs. 13 to 15 show a construction for the application of the invention to pre-formed pieces of textile material such as, for instance, women's hosiery. As there shown, 301 indicates a housing having a fan extension 301a. Housing 301 carries side, top, and bottom closure plates 302. Two wedge-shaped heating gas chambers 311 and 311a carry respectively the high velocity heating gas nozzles 312 and 312a, and are arranged within housing 301 to define between their nozzled surfaces the heating zone 310. A centrifugal fan 307 is mounted on shaft 306 driven by pulley 305. The fan 307 is surrounded by open-ended fan housing 330 from which branched heating gas ducts 308 and 308a lead respectively into the heating gas chambers 311 and 311a. Branched gas pipe connections 304 and 304a supply the gas-fired burners 303 and 303a. Multiple hosiery supports 309 are carried by the studs 318 secured to the endlessly attached chain members 319 slidingly engaging the rigid rail 320 mounted on the supports 321.

A cooling compartment 340 is arranged at the delivery end of the device and carries the centrifugal fan 341 mounted in fan housing 342 connected to the branch ducts 343 and 343a leading to a pair of wedge-shaped cooling gas chambers 344. The fan and duct arrangement of the cooling compartment 340 are similar to the fan and duct arrangement supplying heating gas current. The cooling gas chambers 344 are similarly constructed to the chambers 311 and 311a except that they are shorter. A separating wall 345 divides the heating portion of the device from the cooling portion thereof. An exhaust fan 346 carried by the cooling chamber 340 communicates with the interior of the housing 347 of cooling compartment 340.

In the practical application of my invention as applied to pre-formed textile materials such as women's hosiery, and as carried out by the device illustrated in Figs. 13 to 15, pieces of pre-formed fabric material are placed on the multiple forms continuously moving into, through, and out of the device. The forms continuously move with their interconnected chain members 319 through the slide track 320. The chain members 319 are arranged in conventional endless band fashion (not shown) so that after they have left the device at the delivery end thereof, they are returned to the entrance end of the device. An operator places the pre-formed pieces of textile material such as hosiery, onto the forms at the entrance end of the device, and another operator takes the heat-set material off the forms as they come out of the delivery end of the device. The conventional driving means for the chain (not shown) are so arranged and adjusted that they move the chain through the device at a speed of travel of about 36–144 yards per minute. The length of the heating zone through which the goods are passed is so arranged and dimensioned that for a predetermined speed of travel the goods are in the heating zone for a period of from 1–10 seconds. Heating gas is continuously sucked into the interior of the centrifugal fan 307 and propelled by the fan into the ducts 308 and 308a whence it is passed into the heating chambers 311 and 311a and then out through high velocity nozzles 312 and 312a. The propelling force of the fan is so adjusted that the high velocity heating gas will impinge upon the fabric traveling on the forms through the heating zone with a velocity of about 400–4000 feet per minute. The high velocity heating gas, after having impinged upon the fabric, is deflected into the interior of the heating portion of the housing 301, thence circulating back to the fan 307, passing the heating area 301a. The gas-fired burners 303 and 303a are thermostatically controlled to so maintain the temperature of the returning heating gas that the same is delivered into the heating zone at a temperature of about 400–475° F.

After the goods have passed the heating zone 310, they pass through the cooling compartment 340. In the cooling compartment, a centrifugal fan 341 has its open ends in direct communication with the outside air. Fresh air is continuously drawn into the interior of the fan and peripherally propelled through the branched ducts 343 and 343a into the pair of cooling gas wedges 344 whence relatively high velocity cooling air is propelled through the nozzles 350 onto both sides of the material as it moves through the cooling passage defined by the opposing nozzled surfaces of the wedges. The cooling air is then exhausted through the fan exhaust 346.

When using a device for the treatment of preformed materials such as illustrated in Figs. 13 to 15 inclusive, I find it of advantage, as there exemplified, to arrange the high velocity gas nozzles opening into the heating zone, and preferably also those opening into the cooling passage, at an angle with the direction of travel of the material to be treated, and preferably at an angle of 45° with that direction.

Though air is the preferred heating gas useful in the practice of my invention, it is possible and sometimes advisable within the dictates of special conditions and circumstances to use another gas, and preferably an inert gas, as the heating medium. This is particularly recommended in those cases where particular tints or shades tend to heat-oxidation, in which case impairment of the shades can be avoided by the use of a non-oxidizing heating medium.

Though the invention has been specifically exemplified in connection with the heat setting of polyamide materials, the same has proven useful for the heat setting of other textile materials, and particularly those for which heat treatment is conventionally resorted to for the procurement of a particular result or finish. Experience has proven that in many of these cases my invention has rendered such finishing treatments more efficient and economical and less subject to operator's control than was heretofore possible with conventional methods or devices, and in many of these cases the use of the invention for these special heat treating purposes has made it possible for the first time to subject the goods to the particular heat treatment at high operational speeds.

A specific example of the usefulness of my invention for the heat setting of goods other than polyamides is, for instance, the heat treatment of acetates. In this case, a fabric web consisting of or containing acetate fibers is fed into, for instance, the device illustrated herein in Figs. 1 to 7 inclusive, at speeds between 36–144 yards per minute and a total exposure time of 1–10 seconds, with the temperature within the heating zone between 300–360° F. A very desirable chintz-like glazing effect is obtained in this manner. For the purpose, therefore, of assuring the greatest flexibility of range and usefulness of a device useful for the carrying out of my invention, I prefer to have the heat control thereof cover a range of from 300° F. or lower, to about 500° F. or higher.

I claim:

1. Method for the heat setting of heat-settable textile materials which comprises continuously passing a fabric of such a material through a heating zone and substantially continuously directing heating gas current at a velocity of an order of magnitude of at least about 400 feet per minute of a predetermined heat-setting temperature for said material onto the same while traveling through said heating zone and substantially over a length of travel of said material in said heating zone to substantially expose each portion thereof to said heating gas current for from 1 to 10 seconds.

2. Method in accordance with claim 1 in which said heating gas current is directed onto said material while at a predetermined heat-setting temperature for said material of 300–500° F.

3. Method in accordance with claim 2 in which said material is subjected to cooling upon passing out of said heating zone.

4. Method for the heat setting of heat-settable textile materials which comprises continuously passing a web of such material, while in extended state, through a heating zone, substantially continuously directing heating gas current of a velocity of an order of magnitude in excess of about 400 feet per minute and of a predetermined heat-setting temperature for said material of about 300–500° F. onto said web, while traveling through said heating zone, substantially uniformly over the width thereof and over a length of web travel therein to substantially expose each portion of the moving web to said heating gas current for from 1–10 seconds, while limiting the total exposure of each web portion to said predetermined heat-setting temperature not to exceed substantially 10 seconds, and subjecting said web to cooling upon passing out of said heating zone.

5. Method in accordance with claim 4 in which said web is a polyamide fabric web, in which said heating gas current is directed onto said web while at a predetermined temperature of about 400–475° F.

6. Method in accordance with claim 4 in which said web is passed in substantially extended state through said heating zone while substantially freely suspended between the self-edges thereof, and in which said heating gas current is directed substantially onto both sides of said web.

7. Method in accordance with claim 6 in which said web is substantially maintained at a rate of travel of about 36–144 yards per minute linear speed.

8. Method in accordance with claim 7 in which said web is a polyamide fabric web and in which said heating gas current is directed onto both sides of said web while at a predetermined temperature of about 400–475° F.

9. Method in accordance with claim 4 in which said web is continuously passed in substantially extended state through said heating zone while supported over substantially its entire width between the self-edges thereof, in which the supporting surface for said web is substantially maintained at a temperature of about 300–500° F., and in which said heating gas current is directed onto the surface of the traveling supported web.

10. Method in accordance with claim 9 in which said web is substantially maintained at a rate of travel of about 36–144 yards per minute linear speed.

11. Method in accordance with claim 10 in which said web is a polyamide fabric web, in which said supporting surface is substantially maintained at a temperature of about 400–475° F., and in which said heating gas current is directed onto said web while at a predetermined temperature of about 400–475° F.

12. Method for the heat setting of heat-settable textile materials which comprises continuously passing multiple pre-formed, form-supported pieces of such material through a heating zone, substantially continuously directing heating gas at a velocity of an order of magnitude in excess of about 400 feet per minute and of a predetermined heat-setting temperature for said material of about 300–500° F. onto said material, while traveling through said heating zone, substantially uniformly over the same and over a length of travel of each piece in said zone to substantially expose each portion of such piece to said heating gas current for from 1–10 seconds, while limiting the total exposure of each web portion to said predetermined heat-setting temperature not to exceed substantially 10 seconds, and subjecting said pre-formed pieces to cooling substantially immediately upon passing out of said heating zone.

13. Method in accordance with claim 12 in which said heating gas current is directed onto said pre-formed pieces to impinge upon substantially all sides thereof, at a velocity of an order of magnitude of about 400–4000 feet per minute.

14. Method in accordance with claim 13 in which said heat-settable material is polyamide material in which said heating gas current is directed onto said pieces at a predetermined temperature of about 400–475° F.

15. Method in accordance with claim 14 in which said form-supported pieces are continuously passed through said heating zone while substantially maintained at a rate of travel of about 36–144 yards per minute linear speed.

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