

June 17, 1969

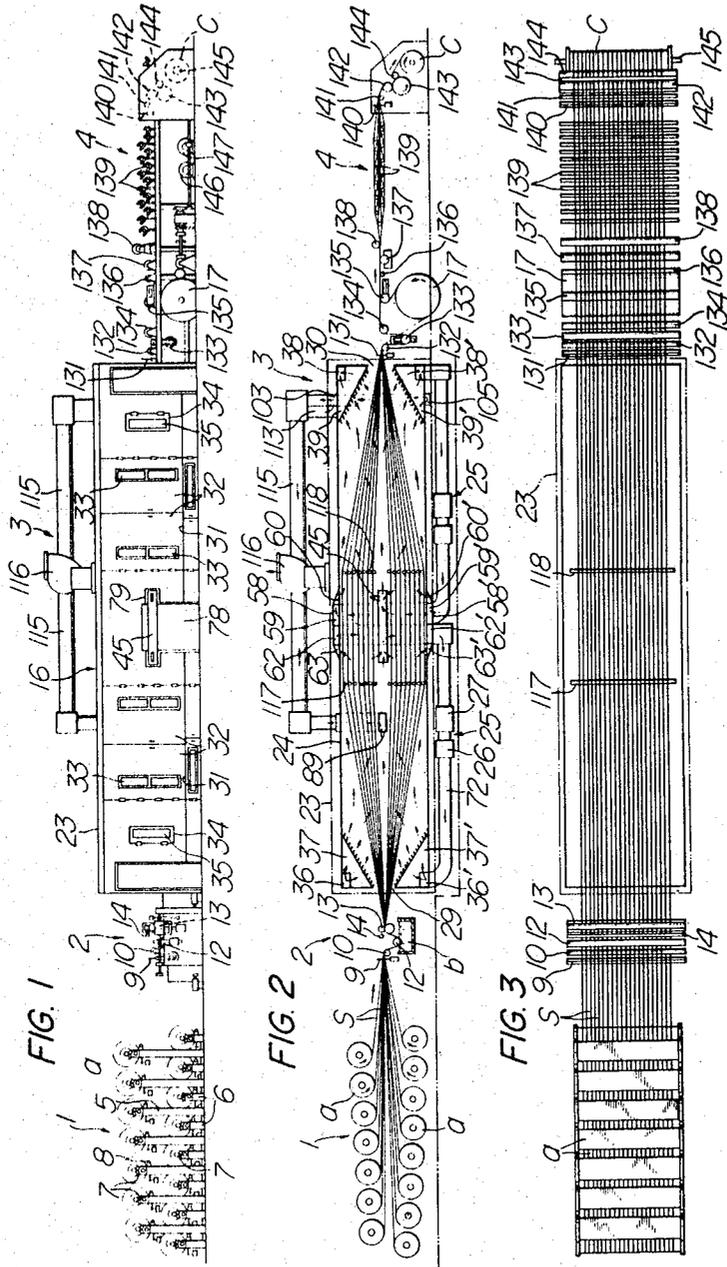
SUSUMU KURODA

3,449,808

METHOD OF AND APPARATUS FOR SIZING AND DRYING
WARPS OF MAN-MADE FILAMENT YARNS

Filed Aug. 8, 1967

Sheet 1 of 9



June 17, 1969

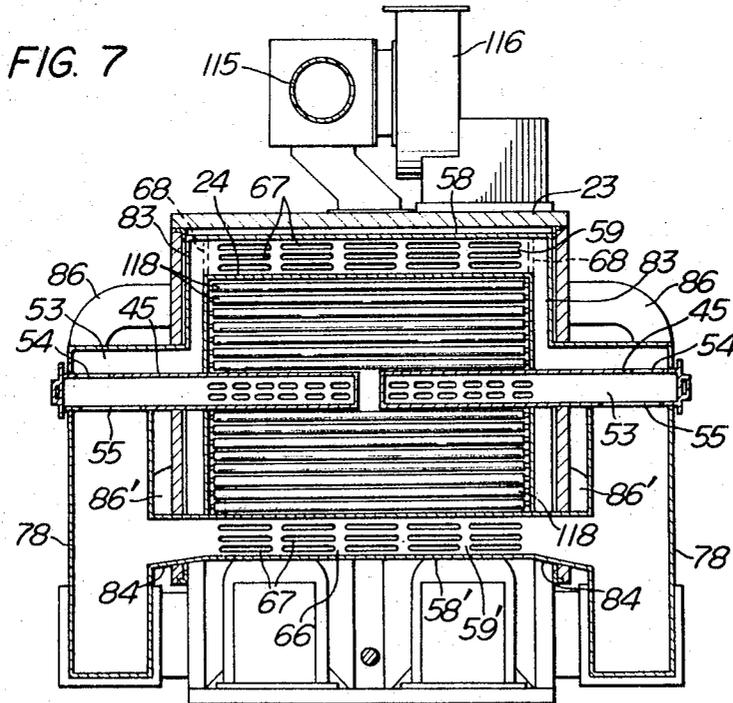
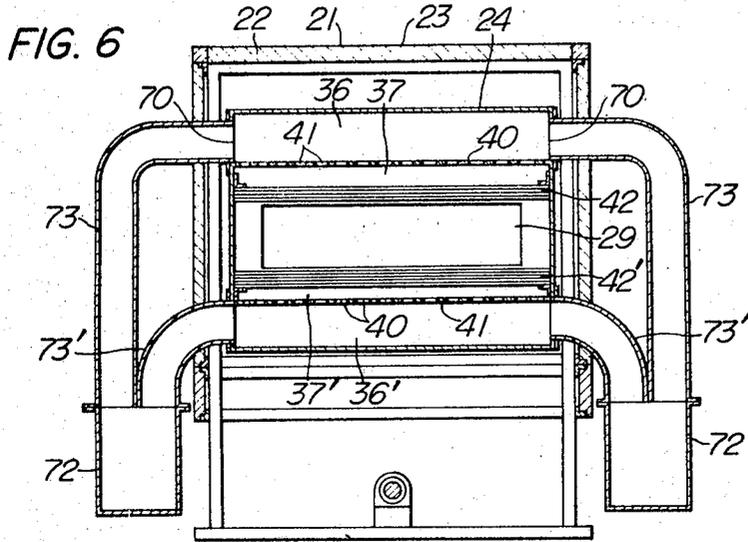
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Sheet 4 of 9



June 17, 1969

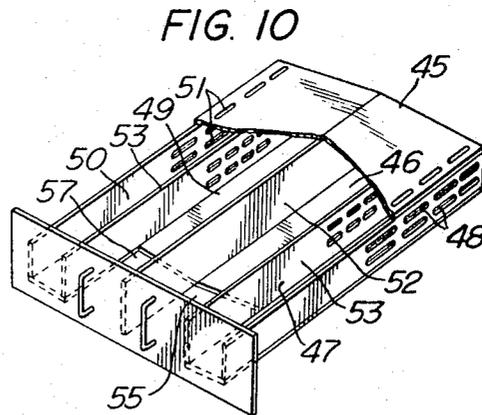
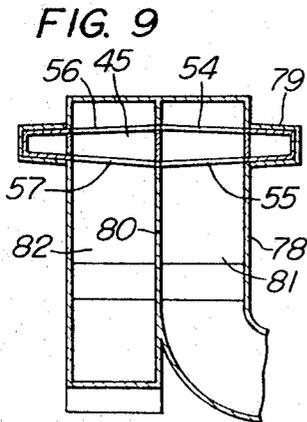
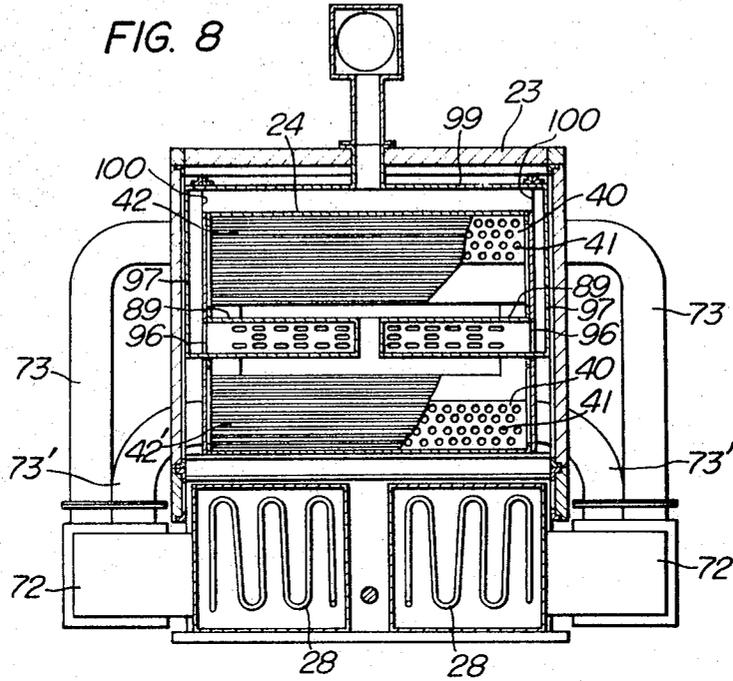
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Sheet 5 of 9



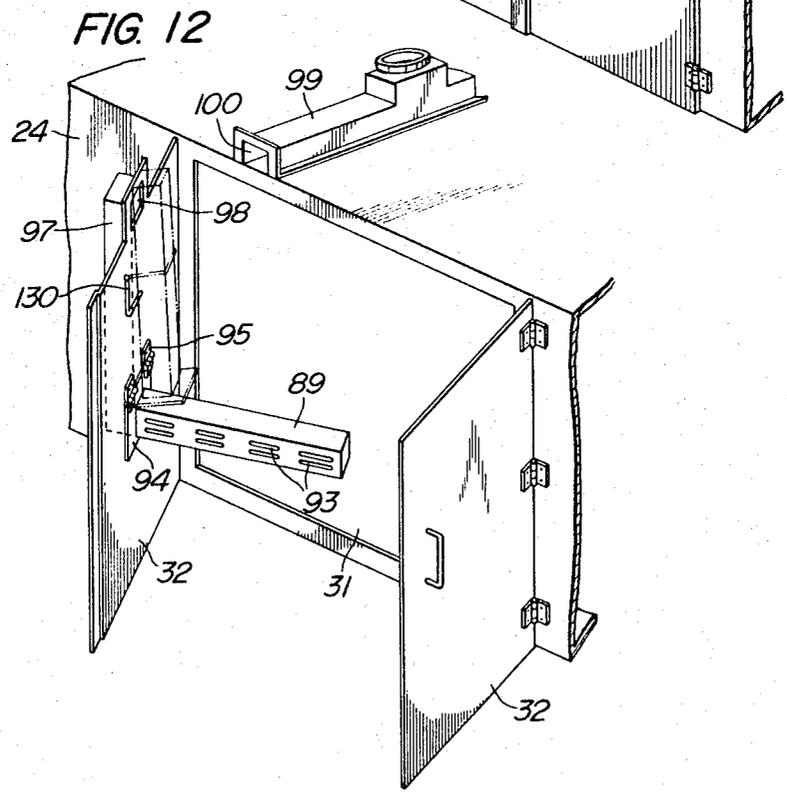
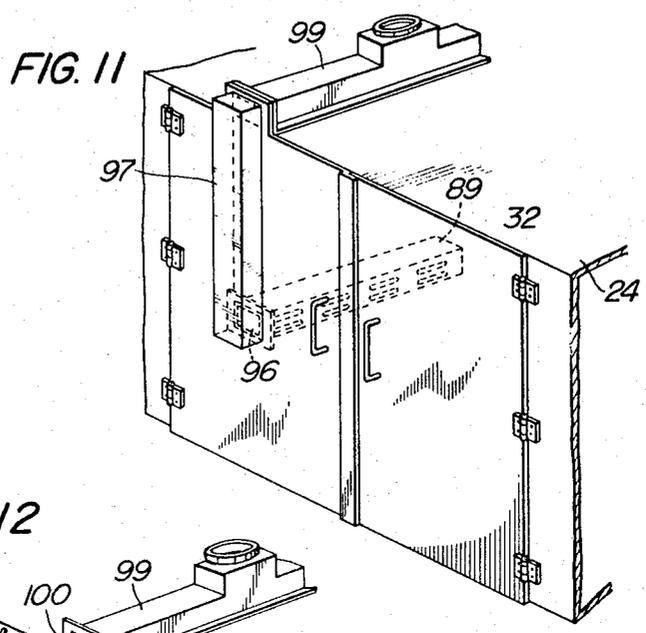
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Sheet 6 of 9



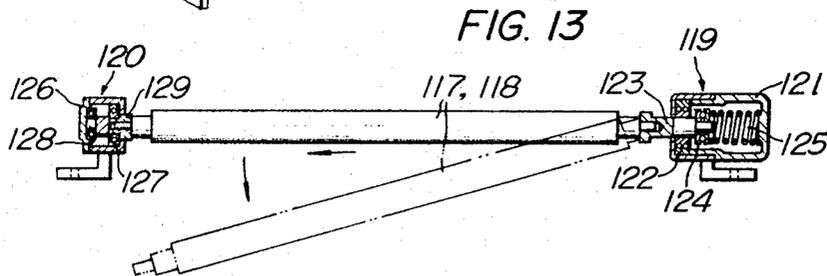
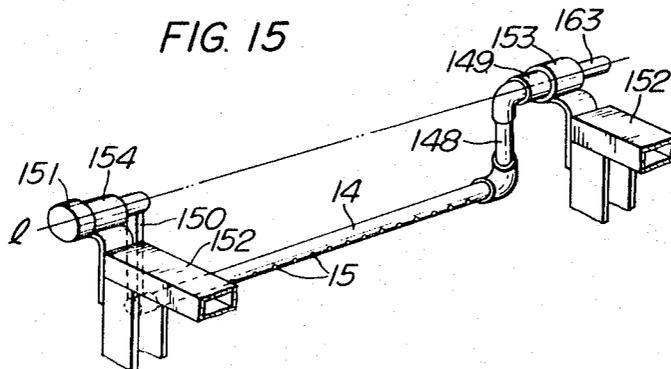
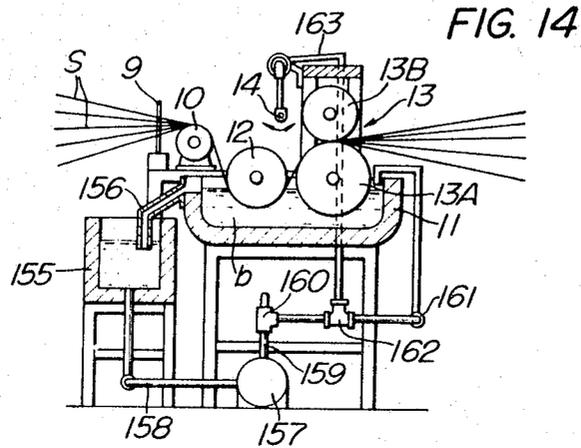
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Filed Aug. 8, 1967

Sheet 7 of 9



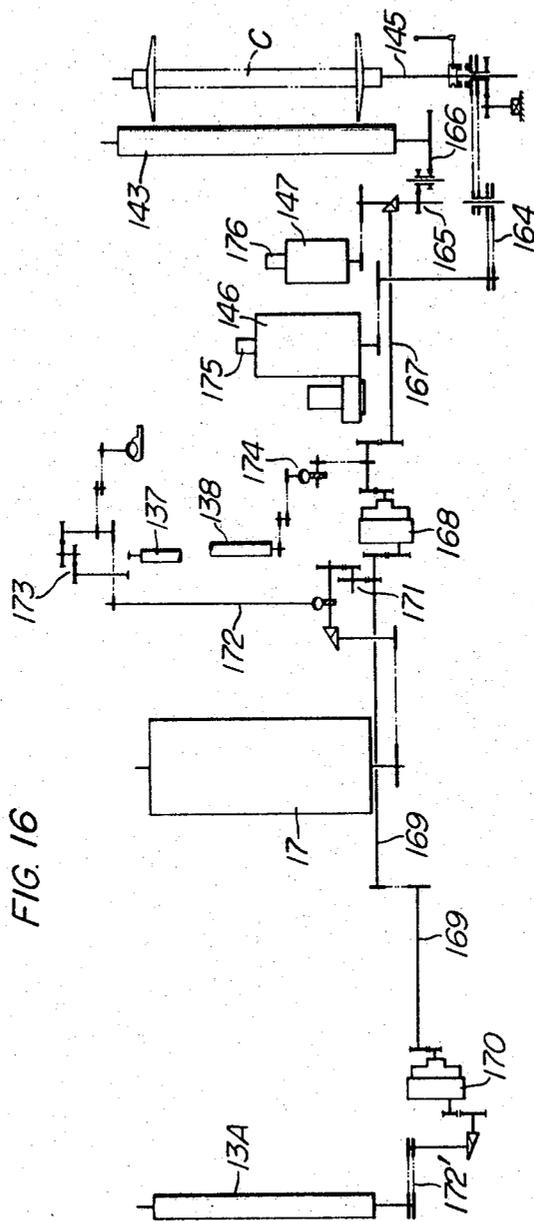
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Sheet 8 of 9



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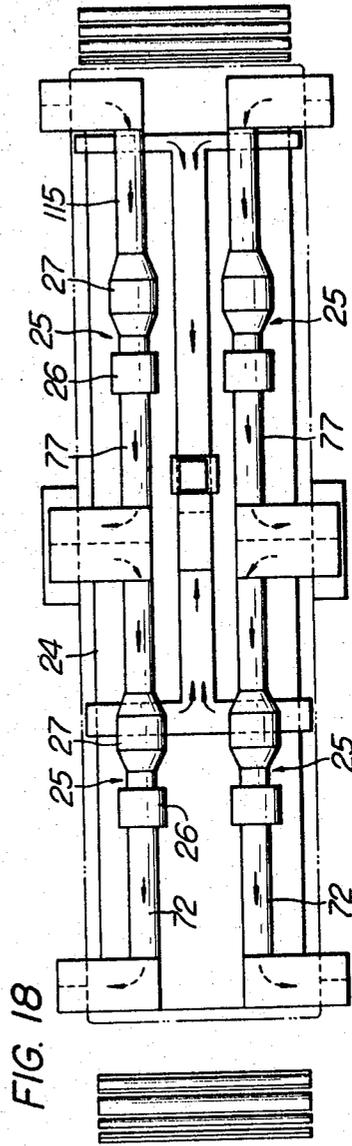
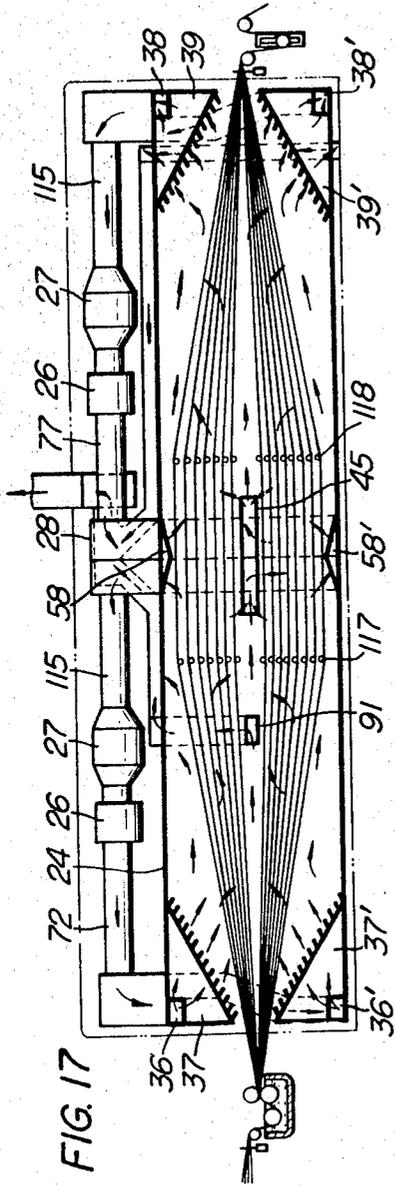
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Filed Aug. 8, 1967

Sheet 9 of 9



1

3,449,808

METHOD OF AND APPARATUS FOR SIZING AND DRYING WARPS OF MAN-MADE FILAMENT YARNS

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Filed Aug. 8, 1967, Ser. No. 659,145
Claims priority, application Japan, Aug. 24, 1966,
41/55,970

Int. Cl. D03j 1/02; D02g 3/36, 1/16
U.S. Cl. 28—28 **10 Claims**

ABSTRACT OF THE DISCLOSURE

A warp sizing and drying apparatus having a beam stand section, sizing section, a drying section and a take-up section. Warp sizing means with size solution spraying pipes are provided in the sizing section to effect a warp sizing operation. The drying section comprises hot air producing means and a drying chamber having compartments therein and conduits for discharging the hot air toward the wet yarns moving forward within the drying chamber to dry the wet yarns, said drying chamber further having means to remove the now moist air after drying the yarns.

The present invention relates to a method of and apparatus for simultaneous sizing and drying one complete supply of a large number of warps of man-made filament yarns as is required for the weaving of a single sheet of fabric, and also for winding-up the resultant warps on a single loom beam.

Warp sizing and drying apparatus of the prior art had a number of shortcomings. For example, there frequently occurred, during the sizing and drying process, snarling of yarns due to the contact between yarns; or there frequently occurred breaking of yarns or there developed fluffing of yarns when the yarns are divided after being dried, or there often occurred undesirable heat-setting of yarns or transverse deformations of the yarns resulting from the use of a heat-drying means such as a radiator, infrared ray lamps or a heated cylinder for drying sized yarns. For this reason, the sizing and drying apparatuses of the prior art employing the aforesaid drying means have been unsuitable for effecting simultaneous sizing and drying of a large number of loosely twisted or non-twisted man-made or synthetic filament yarns having a fine denier.

It is an object of the present invention to provide an improved, efficient sizing and drying method and apparatus which do not cause snarling of man-made or synthetic filament yarns during their being fed through the apparatus, nor cause breaking or fluffing of the yarns during the step of dividing the dry sized yarns, because of the novel steps of the method and the improved arrangement of the apparatus both designed to insure avoidance of contact between the processed yarns by first simultaneously sizing a large number of warps and then dividing the sized yarns during the following process of drying, and also designed to avoid the development of undesirable heat-setting or deformation of the yarns by drying the sized yarns with hot air to thereby effect the drying of yarns

2

uniformly and efficiently thus making the simultaneous sizing and the accompanying simultaneous drying of a large number of yarns possible, whereby said method and apparatus are suitable for efficiently effecting simultaneous sizing and simultaneous drying of a large number of loosely twisted or non-twisted man-made or synthetic filament yarns or such yarns of a fine denier which has been quite difficult in the apparatus of this kind of the prior art.

The drawings illustrate an example of the present invention, in which:

FIG. 1 is a right-side elevational view of the apparatus; FIG. 2 is a schematic side elevational view showing the manner in which the apparatus is operated;

FIG. 3 is a schematic plan view showing the manner in which the apparatus is operated;

FIG. 4 is a longitudinal sectional view, on an enlarged scale, of the aeration-drying section taken along the longitudinal center line thereof;

FIGS. 5 through 8 are cross sectional views taken along the lines A—A, B—B, C—C and D—D, respectively, in FIG. 4;

FIG. 9 is a cross sectional view taken along the line E—E in FIG. 5;

FIG. 10 is a perspective view, partly broken away, of an intermediate air conduit;

FIGS. 11 and 12 are perspective views, respectively, of an exhausting means, illustrating the state in operation and the state when opened, respectively;

FIG. 13 is a cross sectional view, on enlarged scale, of the bearings of a guide roller adapted to divide warps;

FIG. 14 is a transverse cross sectional view, on an enlarged scale, of a sizing section equipped with size-solution spraying means;

FIG. 15 is a perspective view, on an enlarged scale, of a size-solution spray pipe;

FIG. 16 is a schematic representation of a driving system;

FIGS. 17 and 18 are a longitudinal cross sectional view and a plan view, respectively, of an aeration-drying section provided, on the roof of the drying chamber thereof, with means for generating hot air.

As is shown in FIG. 1, the warp sizing and drying apparatus of the present invention comprises a beam creel section 1, a sizing section 2, a drying section 3 and a beaming section 4 which are arranged in series in this order longitudinal of the entire apparatus.

In the beam creel section 1 located in the rearward part of the apparatus are provided two groups of a plurality of beam creels 5 and 6 so arranged that the beam creels 5 in one of the groups are taller than the beam creels 6 of the other group, these two groups being arranged in an alternate relationship to each other. Each of the beam creels of the two groups is adapted to support a warpers beam *a* at the top of the creel by a bearing 7. In the instance of FIG. 1, the taller group consists of a row of seven beam creels of the type described, while the other group consists of a row of eight pairs of beam stand. Each of the paired beam creels 5 and 6 is provided with a band brake means 8 adapted to appropriately control the rotation of its own warpers beam *a*.

The sizing section 2 comprises a straight comb 9, a guide roller 10, an immersion roller 12 partly immersed

in the size solution contained in a size vat 11, a size-solution spray pipe 14 and a squeezing roller 13, which are disposed in this order as mentioned from the rearward section toward the forward section of the apparatus.

The drying section 3 comprises a drying unit 16 utilizing hot air and a heated drum 17. The drying unit 16 utilizing heated air stands on a depressed pit 18 formed in the ground. The drying unit 16 comprises a framework formed with steel struts 19 standing on the bottom face of the depressed pit and also with stays 20 made of steel bars disposed substantially level with the plane of the ground surface, and an oblong box-like drying chamber 24 made with steel sheets and contained in said framework in the longitudinal direction and resting on said stays 20 to which the drying chamber 24 is fixed. The external sides of the framework are provided with an external covering 21 made of steel sheets and lined with a glass wool material 22 to form a heat insulating wall structure 23 on five sides or surfaces of the framework excepting the side lying under the bottom of the drying chamber 24. A pair of hot air generating means 25 each comprising a combination of heating unit 27 having a plurality of steam-heating pipes 28 (FIG. 8) disposed in the air passageway and also comprising a fan means 26, are disposed symmetrically in both the forward and the rearward sections of the pit and under the drying chamber 24.

The drying chamber 24 and the heat insulating wall structure 23 are provided in their adjacent walls on both the rear and the front sides thereof, with an elongated inlet slot 29 and an outlet slot 30 for receiving and delivering sheet-form warps, respectively. The inlet and outlet slots extend in the direction of the width of these two box-like structures and are each disposed at a level substantially at the middle of the height of the drying chamber. On the lateral walls of said two structures, namely, the drying chamber and the heat insulating wall structure, are provided entrances 31 for allowing an operator to gain access to the interior of the drying chamber, said entrances being disposed in the opposite lateral side walls of these two structures in substantially the middle of the rear half and in substantially the middle of the forward half of the longitudinal lateral walls of these two structures and arranged so as to face each other on the opposite sides. Each of the entrances 31 is provided with a pair of hinged doors 32 adapted to open outwardly and equipped with a glass window 33. Also, an operating aperture 34 equipped with a hinged glass door 35 is provided on each of the lateral sides of said two structures near the both extreme end portions of the side walls in such manner that the operating apertures 34 located on one of the lateral side walls face the other on the opposite side walls.

The drying chamber 24 is provided, interiorly in the respective upper and lower corners of the rear end wall and also the forward end wall thereof, with perforated partition plates 40 each having a number of small openings formed therethrough and being bent at right angles and being attached to the adjacent two walls of the respective corners between the side walls of the chamber. The partition plates 40 in the upper and the lower corners of the rear end wall define in the portions a pair of pressure chambers 36 and 36' for regulating the air pressure. The chambers 36 and 36' each have rectangular cross section and extend between the opposite side walls of the drying chamber. The partition plates 40 in the upper and the lower corners of the forward end wall of the drying chamber define a pair of pressure reduction chambers 38 and 38' in a similar manner as do the plates 40.

Outside the respective pressure chambers 36 and 36' in the rearward end of the drying chamber 24, are provided air flow guide plates or air supply openings 42 and 42'. The air supply guide plate 42 extends laterally of the drying chamber 24 between the opposite side

walls thereof and also extends in an inclined direction between the upper edge of the inlet slot 29 and the inner surface of the ceiling of the chamber 24. The guide plate 42 is provided with a row of a plurality of uniformly spaced, parallel, air-flow rectifying plates 44 directed downwardly and forwardly and extending laterally of the chamber 24 between the opposite side walls thereof.

The air flow guide plate 42' extends laterally of the chamber 24 between the opposite side walls thereof and also extends in an inclined direction between the lower edge of the inlet slot 29 and the floor or bottom wall of the drying chamber 24. The guide plate 42' is provided with a row of a plurality of uniformly spaced, parallel, air-flow rectifying plates 44 directed in parallel upwardly and forwardly and extending laterally of the chamber 24 between the opposite side walls thereof. Thus, the air flow guide plates 42 and 42' form air supply chambers 37 and 37' of triangular cross section enclosing therein the pressure chambers 36 and 35', respectively.

Similarly, air suction guide plates or air suction openings 43 and 43' are provided outside the pressure reduction chambers 38 and 38', respectively. The guide plate 43 extends from the upper edge of the outlet slot 30 to the inner surface of the ceiling wall of the drying chamber 24 and is equipped with a row of a plurality of uniformly spaced, parallel, air-flow rectifying plates 44 directed rearwardly and downwardly. The guide plate 43' extends from the lower edge of the outlet slot 30 to the floor or bottom wall of the chamber 24 and is equipped with a row of a plurality of uniformly spaced, parallel, air-flow rectifying plates 44 directed rearwardly and upwardly. Thus, the air suction guide plates 43 and 43' form air suction chambers 39 and 39' of triangular cross section enclosing therein the pressure reduction chambers 38 and 38', respectively.

Intermediate air conduits 45, which are withdrawable and pass through the central portion of the drying chamber 24, protrude into the central portion of the drying chamber in the direction of the width thereof from both of the side walls of the drying chamber (see FIG. 7). Central air conduits 58 and 58' having trapezoidal cross sections are provided in the direction of the width of the drying chamber on the upper face of the ceiling wall and on the lower face of the floor wall thereof. Each of the aforesaid intermediate air conduits 45 (see FIG. 10), which is more or less flat and oblong in shape and which has closed ends, is divided into an air supply chamber 47 and an air suction chamber 50 by a central partition wall 52 provided therein longitudinally thereof, said air supply chamber 47 being located on the forward side, while the air suction chamber is located on the rearward side of the conduit 45. Each of said chambers 47 and 50 is provided, in parallel with the central partition wall 52, with partition plates 53 having a number of small throughholes near the innermost end portions of the intermediate air conduit, so as to provide at the rearward portion within the air supply chamber 47 a pressure chamber 46 adapted to regulate the pressure, and at the forward portion within the air suction chamber 50, a pressure reduction chamber 49 adapted to regulate the pressure. A plurality of air supply holes 48 and a plurality of air suction holes 51 are provided in the forward peripheral face and the rearward peripheral face of those portions of the walls of each of said intermediate air conduit 45 which protrudes into the drying chamber, said walls of said intermediate air conduit serving as the external peripheries of the air supply chamber 47 and the air suction chamber 50. Air passage openings 54 and 55, and air passage openings 56 and 57 are provided in the upper and the lower faces of the pressure chamber 46 and the pressure reduction chamber 49, respectively, near the walls of the base of the air conduits 45. The air passage openings 54 and 56 located on the upper faces of the air conduits are provided with a size smaller than that of the

air passage openings 55 and 57 located on the lower faces thereof.

Dual pipes 78 are provided vertically along both external sides of the heat insulating wall structure 23. Each of the pipes 78 is provided therein with a central partition wall 80 for dividing the pipe into a forward air supply piping section 81 and a rearward air suction piping section 82 to thereby provide separate passages.

Across the upper portion of each of the dual pipes 78 is horizontally mounted a drawer frame 79 by means of which the base portion of each intermediate air conduit 45 is slidably and drawably supported so that the innermost end portion of the conduit 45 passes through the walls of the heat insulating wall structure 23 and the drying chamber 24 and protrudes thereinto. The upper and the lower air passage openings 54 and 55 of each of the intermediate air conduits 45 face the above-mentioned air supply piping section 81 whereby the pressure chamber 46 of the conduit 45 communicates with the air supply piping section 81. Similarly, the upper and the lower air passage openings 56 and 57 of the pressure reduction chamber 49 face the above-mentioned air suction piping section 82 whereby the chamber 49 communicates with the section 82.

The central air conduits 58 and 58' having trapezoidal cross sections and provided on the upper face of the ceiling wall and on the floor wall are provided, by means of the respective central partition walls 65, 65 provided vertically and in the direction of the width of the drying chamber, with air supply chambers 60 and 60' and also with air suction chambers 63 and 63' forwardly and rearwardly, respectively, relative to the drying chamber. Air-supply openings 61 and 61' and air-suction openings 64 and 64' are provided, along the direction of the width of the drying chamber, on the ceiling wall and the floor wall and facing the inclined sides of the respective trapezoidal cross sections. Perforated partition plates 66 and 66' having a plurality of slits 67 are provided vertically at the rear end position of the respective air supply openings 61 and 61' and at the foremost end position of the respective air suction openings 64 and 64' in a direction of the width of the drying chamber. At the rear portion of the respective air supply chambers 60 and 60' are provided pressure chambers 59 and 59' adapted to regulate the pressure, and in the foreground of the respective air suction chambers 63 and 63' are provided pressure reduction chambers 62 and 62' adapted to regulate the pressure. The lateral end faces, which are located in the foreground of the pressure chambers 59 and 59', of the respective air supply chambers 60 and 60' provided along the entire width of the drying chamber, and the lateral end faces, which are located in the background of the reduced pressure chambers 62 and 62', of the respective air suction chambers 63 and 63', are closed with end plates 68, respectively. The upper and the lower air-supply openings 61 and 61' are provided with uniformly spaced parallel rows of air-flow rectifying plates 69 in a downwardly and forwardly inclined direction and in an upwardly and forwardly inclined direction, respectively, along the direction of the width of the drying chamber. The upper end the lower air-suction openings 64 and 64' are provided with uniformly spaced parallel rows of air-flow rectifying plates 69 in a downwardly and rearwardly inclined direction and in an upwardly and rearwardly inclined direction, respectively, along the direction of the width of the drying chamber.

The upper ends of the branched dual pipes 83 ascending upwardly along the side walls of the drying chamber and connected to the upper ends of the respective dual pipes 78 on both sides of the drying chamber, are joined to the opposite ends of the upper central air conduit 58. Branched dual-pipes 84 extending from the lower portion of the respective dual pipes 78 are connected to the opposite ends of the lower central air

conduit 58', respectively. The pressure chambers 59 and 59' and the pressure reduction chambers 62 and 62' of the respective central air conduits 58 and 58' are connected, via the air supply piping section and the air suction piping section which are formed in the foreground and the background of the respective branched dual pipes 83 and 84, to the supply piping section 81 and to the air suction piping section 82 of the dual pipes 78, respectively.

At the lower ends of the respective dual pipes 78 located on the opposite lateral sides, there is a connection between the air supply pipe 77 (see FIG. 4) connected to the fan means 26 of the hot air generating means located in the forward section on the same side and the air suction pipe 74 (see FIG. 4) connected to the heating units 27 of the hot air generating means located in the rearward section on the same side, and the air supply pipe 77 is thus connected to the air supply piping section 81 of the dual pipes, while the air suction pipe 74 is thus connected to the air suction piping section 82 of the dual pipes. The foremost ends of the upper and the lower branched air supply pipes 73 and 73' connected to the rear ends of the air supply pipes 72 connected to the respective fan means 26 of the heated air generating means on the opposite lateral sides are fixed to the walls of the respective upper and the lower corners formed at the rear ends of the opposite side walls of the drying chamber 24 after passing through the walls of the respective heat insulating wall structure 23 on both sides, and are passed through the air passage openings 70 which are formed in the corners of the opposite side walls so as to be connected to the opposite ends of the respective upper and the lower pressure chambers 36 and 36' located at the rear end of the drying chamber. The foremost ends of the respective upper and the lower branched air suction pipes 86 and 86' which are branched from the foremost end of the air suction pipes 85 connected to the respective heating units 27 of the hot air generating means located in the forward section on the opposite lateral sides of the under part of the drying chamber, are fixed to the walls of the upper and the lower corners at the forward end of the opposite side walls, and are led through the air passage openings 71 formed in the corners of the respective opposite side walls so as to be connected to the opposite ends of the respective upper and the lower pressure reduction chambers 38 and 38' located at the forward end of the drying chamber. The air suction pipes 74 and 85 are provided with air inlets 75 and 87 which are provided with dampers 76 and 88, respectively.

Exhaust conduits 89 protrude into the central portion, in the rear half section of the drying chamber, from the respective forward doors 32 of the operator's entrances 31 located on the opposite sides in the rearward section of the drying chamber and at a level identical with the height of the intermediate air conduit 45. Exhaust chambers 103 and 105 (see FIG. 2) are provided in the direction of the width of the drying chamber above the ceiling wall and also on the underside of the floor wall of the forward section of the drying chamber. Exhaust apertures 104 and 106 are open through the roof wall and the floor wall which are located at the levels of the lower and the upper planes of the upper and the lower exhaust chambers 103 and 105 respectively, so as to be led into the air suction chambers 39 and 39' located at the respective upper and the lower corners of the forward section within the drying chamber. The respective exhaust conduits 89 have their foremost ends closed, and contain a perforated partition plate 90 to provide a reduced pressure chamber 91 on the forward side and an air suction chamber 92 on the rear side (see FIG. 4). A plurality of air suction holes 93 are provided on the rear side face on the air suction chamber side. The upper edge of the flange 94 provided around the opening of the base portion of the conduit 39 is attached by hinge means 95 to

the inside face of the door 32. The face of the flange 94 is placed in abutment with the inside face of the door 32 so as to horizontally support the exhaust conduit 89 whereby the same is communicated, through the air passage opening 96 formed through the door 32, with the lower end of the vertical exhaust conduit 97 provided externally of the door 32 (see FIGS. 11 and 12).

The vertical exhaust conduits 97 are brought into communication with the opposite openings 100 of the upper exhaust conduit 99 provided transversely above the ceiling wall when the door 32 is closed, by placing the opening 98 provided through the face of the upwardly protruding portion of the conduit 97 from the door 32 in abutment with the opening 100. A vertical exhaust conduit 101 containing a damper 102 is connected to the central portion of the upper exhaust conduit 99. The upper end of the exhaust conduit 101 protruding upwardly through the wall of the heat insulating wall structure 23 is connected to a main exhaust conduit 115 located above the roof and connected to an exhaust fan 116 (see FIG. 4). Reference numeral 130 represents a latch for the exhaust conduit, said latch being pivotally attached to the inside face of the entrance door 32.

In the middle portion of the upper exhaust chamber 103 is provided a horizontal perforated plate 107. To the center of the upper face of the upper exhaust chamber 103 is connected a vertical exhaust conduit 108 containing a damper 109 therein. The foremost end of the exhaust conduit 108 protruding upwardly through the wall of the heat insulating wall structure 23 is connected to the main exhaust conduit 115. The lower exhaust opening 106 is provided with a perforated plate 110. The upper ends of the two exhaust conduits 111 and 111 connected to the opposite ends of the lower exhaust chamber 105 and vertically ascending along the external faces of the respective side walls (FIG. 5) are connected to the upper exhaust pipe 112 disposed adjacent to the upper exhaust chamber 103 (see FIG. 2) provided above the ceiling wall. To the central upper face of the upper exhaust pipe 112 is connected a vertical exhaust conduit 113 containing a damper 114 therein. The foremost end of the vertical exhaust conduit 113 protruding upwardly through the wall of the heat insulating wall structure 23 is connected to the main exhaust conduit 115.

At both the forward and the rearward positions relative to the intermediate air conduit 45 in the central portion within the drying chamber 24 are arranged, in the vertical direction, a row of guide rollers 117 and 118 (see FIG. 4) having Teflon-coated surfaces and adapted to divide the sheet-form warps, said guide rollers extending laterally of the chamber 24 and being supported by bearing fittings 119 and 120 mounted on the opposite lateral wall of the chamber 24. Those of said guide rollers 117 and 118 provided in the same number with that of the pairs of beam stands 5 are higher than the level of the plane of the upper face of the intermediate air conduit 45, while there are provided other guide rollers 117 and 118 in the same number with that of the pairs of beam creels 6 which are lower than the level of the plane of the lower face of the intermediate air conduit 45.

As is shown in FIG. 13, the bearing fitting 119 which is adapted to support one end of the guide roller contains double rows of ball bearings 122 whose inner race is capable of tilting inside the open end of the cylindrical casing 121. A spring 125 is tensioned between the thrust bearing 124 mounted at the rear face of the loose rotary bush 123 which is slidably mounted on the inner race of the bearings 122 and the inner bottom of the cylindrical casing 121. The bearing fitting 120 on the other side is such that a ball bearing 127 and a thrust bearing 128 are provided inside the open end and at the inner bottom of a cylindrical casing 126, respectively, and a rotary bush 129 is supported by these bearings 127 and 128. The guide rollers 117 and 118 have one end thereof inserted in the loose rotary bush 123 of the bearing fitting on one side,

and have the other end inserted in the rotary bush 129 of the bearing fitting on the other side, so that the guide rollers 117 and 118 are detachably mounted in said bearing fittings on both sides by utilizing said spring 125.

The beaming section 4 comprises a comb 131 disposed on the external side adjacent to the delivery outlet slot 30 of the drying chamber, and therefrom there are arranged in the forward direction, in the following order, a guide roller 132, a cushion roller 133 adapted to slide vertically, a guide roller 134, a cushion roller 135 adapted to slide longitudinally of the apparatus, a push-up roller 136, a waxing roller 137 partly immersed in the wax vat, a levelling roller 138, and a plurality of dividing rods 139; and in the forward end area, there are provided an expansion comb 140 adapted to swing vertically, a guide roller 141, a measuring roller 142, a beaming roller 143, a twitching roller 144 and a spindle 145 for driving a loom beam c. On the floor under the dividing rod 139 are provided a DC motor 146 for driving said spindle 145, a DC motor 147 for driving the waxing roller 137 and the levelling roller 138, a heated cylinder 17, and a squeezing roller 13.

FIG. 14 is a longitudinal cross sectional view, on an enlarged scale, showing the sizing section in detail. Reference numeral 9 represents a comb. Numeral 10 represents a guide roller. Numeral 11 represents a size vat having double structure so that steam is supplied into the space a top roller 13B adapted to be lifted upwardly. Numeral 12 represents an immersion roller which is adapted to be lifted upwardly. Numeral 13 represents a squeezing roller consisting of a bottom squeezing roller 13A adapted to be driven by the above mentioned DC motor 147 and a top roller 13B adapted to be lifted upwardly. Numeral 14 represents a size solution spray pipe disposed rearwardly of the top squeezing roller 13B. This spray pipe is provided, as shown in FIG. 15, with a plurality of spray orifices 15 formed in one row in the longitudinal direction of the pipe. One end of this pipe is closed. This closed end of the pipe is securely supported by the foremost end of a pivotal arm 150 which is pivotally supported by a fitting 154 attached to the rear face of one of the bearing guide frames 152 for the top squeezing roller 13B, said arm 150 being adapted to be fixed by a fastening screw bolt 151 at selected longitudinal position. To the other end of the pipe 14 is connected, in Z-shape, a bent pipe 148 formed by connecting an elbow joint and a short pipe together. A cap nut type joint 149 having therein a packing interconnects the pipe 148 and a size solution supply pipe 163 at its one end. The size solution supply pipe 163 is securely supported by a fitting 153 attached to the rear face of the other bearing guide frame 152 for the upper squeezing roller, and the spray pipe is thus attached in parallel with the axis of the top squeezing roller 13B for pivotal movement about the axis *l* connecting the centers of the bearings of the aforesaid two fittings 153 and 154, said axis *l* being parallel with said axis of said roller 13B. During the sizing operation, the spray pipe 14 is fixed in such manner that the spray orifices 15 are positioned at an appropriate pivotal position and opposite the rear peripheral face of the top squeezing roller 13B. Numeral 155 represents a size solution supply tank disposed rearwardly of the size vat 11 and having structure similar to the size vat 11 and the vat 155 is adapted to be heated with steam. Into this tank is led the foremost end of an overflow pipe 156 provided at the top of the rear wall of the size vat 11. Numeral 157 represents a pump. The foremost end of the suction pipe 158 coupled to the suction side of the pump is connected to the bottom of the size supply tank 155, while the delivery pipe 159 connected to the output side of the pump is connected, via a switchover valve 160, to the main supply pipe 161 having its end introduced into the size vat 11. To the main supply pipe 161 is connected, via a changeover valve 162, said size solution supply pipe 163 which is connected to the size solution spray pipe 14.

FIG. 16 is a schematic diagram showing the driving system. A DC motor 146 is coupled with a speed reduction mechanism 164 which is coupled to the spindle 145. The main shaft 165 which is driven at a reduced speed by a DC motor 147 is coupled to a speed reducing mechanism 166 which is connected to a beaming roller 143. The main shaft 165 is coupled to a transmission mechanism 167 which is connected to the input side of a speed regulator 168 which is coupled, at its output side, to a transmission shaft 169 so as to be coupled to a speed regulator 170 disposed in the rearward portion of the apparatus. Said transmission shaft 169 is also coupled to a speed reducing mechanism 171 which is connected to the shaft of the heated cylinder 17. A speed reducing mechanism 172' is coupled to the output side of the speed regulator 170 the rearward position, said speed reducing mechanism 172' is thus connected to the bottom squeezing roller 13A. The intermediate shaft of the speed reducing mechanism 171 is coupled to a worm gear speed reducing mechanism 172 which is coupled to a change-gear mechanism 173, thereby to be connected to the waxing roller 137. The transmission shaft 167 is also coupled to a worm gear speed reducing mechanism 174 which is coupled to the levelling roller 138. The respective motor shafts of the two DC motors 146 and 147 are coupled to DC generators 175 and 176 of the same type. Although not shown in the drawings, the output sides of both generators are connected to controlling means to drive the latter means by utilizing the difference in the voltages generated by these two generators 175 and 176 during the sizing operation, thereby to regulate the field current of the DC motor 146 adapted to drive the spindle 145, and thereby to reduce the rotation speed of the DC motor 146 in accordance with the increase in the depth of the yarn wound around the loom beam *c*, so that the yarn may be wound around the loom beam *c* under a uniform tension.

Description will next be made of the warp sizing and drying operation of the present example.

First, a warpers beam *a* on which a required yarn has been wound is mounted at its opposite shafts on the roller bearings 7 on the top of the pair of beam creels 5 and 6 in such manner as is shown by the dot-and-dash lines in FIG. 1. The number of warpers beams *a* required for obtaining the total number of warps necessary for weaving a desired fabric are mounted on the beam creels in the beam creel section 1. Also, a required loom beam *c* is mounted between the opposite spindles 145 in the beaming section. The drawing illustrates the instance where the warpers beams *a* are provided in the same number as that of the beam creels.

From the respective warpers beams mounted on the beam creels in the beam creel section 1 are withdrawn a number of yarns in a sheet form. The term "sheet" used in this application represents a large number of warps arranged in parallel relation with each other in a plane. The withdrawn sheets *s* of yarns are passed through the sizing section 2, the drying section 3 and the beaming section 4, successively, and the tips of the running yarns are fixed onto the loom beam *c*. As is shown in FIGS. 2 and 3, the respective sheets *s* of yarns withdrawn from the respective warpers beams *a* are passed through a comb 9 to divided the individual yarns so that they will not contact each other. The respective sheets *s* of yarns are adjusted so as to give appropriate widths. Thereafter the sheets *s* of yarns are passed around the guide roller 10 so that the respective sheets *s* of yarns are collected into one group and passed around the lower periphery of the immersion roller 12 which is half immersed in the size solution *b* contained in the size vat 11. Then the sheets *s* of yarns are then passed between the top and the bottom rollers of the squeezing roller means 13 so as to be squeezed in one group. The sheets *s* of yarns which have passed through the roller means 13 are then passed through the inlet slot 29 of the drying chamber while being again separated into the original respective sheets *s*. The

sheets *s* of yarn introduced into the drying chamber 24 are passed around the respective guide rollers 117 and 118 which are disposed in vertically arranged rows in both the rearward and the forward sections in the drying chamber 24 and which are adapted to divide the sheets *s* of yarns in accordance with the vertical arrangement thereof. The entire sheets *s* of yarns are divided into the two upper and lower groups. The sheets of yarn in each group are divided and spread, and more particularly, they are divided and spread when they pass above and under the exhaust conduit 89 and the intermediate air conduit 45 of the drying chamber, in accordance with the vertical arrangement of the guide rollers. The total sheets *s* of yarns which have been spread are then collected after passing through the guide rollers 118 located in the forward section, and the collected sheets *s* of yarns are passed through the outlet slot 30 and are led to the comb 131 disposed immediately in front of the outlet slot of the drying chamber 24 so as to be adjusted of the arrangement of the yarns forming the sheets *s* of yarns. Thereafter, the respective sheets *s* of yarns are passed around the guide roller 132 to be collected together into one group and passed around cushion roller 133 which is adapted to slide vertically, and therefrom to the periphery of the guide roller 134 and above the push-up roller 136 to be finally led to the waxing roller 137. Or, alternatively, in case it is intended to increase the speed of drying, the sheets *s* of yarns coming out from the guide roller 132 are passed around the heated cylinder 17, and, via the longitudinally slidable cushion roller 135, they may be led to waxing roller 137. The sheets *s* of yarns are then made to contact the upper periphery of the roller 137 and the lower periphery of the levelling roller 138, successively. Then the sheets of yarn which are now collected in one group are divided into respective sheets *s* of yarn by the dividing rods 139. Thereafter, the divided sheets *s* of yarns are passed through the expansion comb 140, and after adjusting the width of the sheets *s* of yarns to the beam width of the loom beam *c*, the sheets *s* of yarn are fed so as to pass through guide roller 141 measuring roller 142, beaming roller 143, twitching roller 144, and to be finally taken up by the loom beam *c* after collecting the entire sheets *s* of yarn into one group. The respective warpers beams *a* are imparted with braking force by the bands of band brake means 8, respectively, so that the rotation of each warpers beam *a* is appropriately controlled.

After the yarns have been passed through the respective parts of the apparatus, the respective heat generating means in both the forward and the rearward sections are started into motion, with the dampers 76 and 88 located at the respective air inlets and the dampers 102, 109 and 114 of the respective exhaust conduits being opened to an appropriate degree. Then the exhaust fan 116 is actuated. The two DC motors 146 and 147 are started simultaneously to rotate the spindle 145, thereby to rotate the loom beam *c*, the beaming roller 142, the heated cylinder 17 and the squeezing roller 13. As a result, the sheets *s* of yarns consisting of a number of appropriately tensioned yarns are delivered successively from the respective warpers beams *a*, and the delivered sheets of yarns are passed through the comb 9 and are divided into separate yarns so as to avoid contact of the yarns in the sheets *s*, and are given a predetermined width of sheets. After passing through the guide roller 10, the respective sheets *s* of yarns are collected into one group and are led into the size vat 11 to pass around the immersion roller 12 so that the group of sheets of yarns are passed through the size solution *b* contained in the size vat 11 and thus the yarns are coated with the size solution. Then, after the adhering size solution is appropriately squeezed when the sheets of yarn pass through the squeezing roller means 13, the sheets of yarn are immediately divided into respective sheets *s* of yarns of the respective warpers beams from whence they have come. Thus, as is shown in FIG. 2, the

respective sheets *s* of yarns are divided in vertical stages and are arranged in a diverging shape as they are transferred forwardly. The sheets *s* of yarns are then led to the inlet slot 29 of the drying chamber 24 and into the interior of the drying chamber 24. Via the dividing guide rollers 117 and 118 located in the rearward section and the forward section, the sheets of yarns are arranged so as to converge as they advance further so as to be delivered from the outlet slot 30 of the drying chamber 24 and to proceed onto the comb 131. The entire sheets *s* of yarn are divided into upper and lower groups in the drying chamber. The two divided groups pass through the interior of the drying chamber, sandwiching the exhaust conduit 89 and the intermediate air conduit 45, with the sheets in each group spaced apart from one another. The individual yarns also advance while being divided as defined by the combs 9 and 131 which are located in the forward and the rearward sections in the drying chamber 24.

When these two groups of sheets *s* of yarns pass through the drying chamber 24, the hot air currents produced from the respective heat generating means, located on the lateral sides in the rearward section, as the result of the actuation of the respective heat generating means, pass through the respective bilateral air supply conduits 72, the upper and the lower branched air supply conduits 73 and 73', and are forced into the respective pressure chambers 36 and 36' located at the upper and the lower portions in the rearward section in the drying chamber, and are uniformly forced into the forward sections of the upper and the lower air supply chambers 37 and 37', respectively. The heated air currents are then led through the respective air-flow rectifying plates 44 of the respective layers which are formed at the respective air-supply apertures 42 and 42' which are also called air-flow guide plates. Thus, the hot air currents are discharged under a uniform pressure from the spaces between the respective air-flow rectifying plates 44 of the upper air supply aperture 42 in a downwardly and forwardly inclined direction and also from the spaces between the respective air-flow rectifying plates 44 of the lower air supply aperture 42' in an upwardly and forwardly inclined direction. The hot air currents are thus applied under pressure onto the groups of sheets of yarns from both the upper side and the lower side as the sheets of yarn enter from the inlet slot 29 of the drying chamber and pass through the rearward section of the drying chamber 24 while being divided and arranged in divergent form.

The hot air currents which have been generated by the respective hot air generating means located on both sides in the forward section of the drying chamber are passed through the piping sections 81 of respective air supply conduits 77, 78 on both sides of the drying chamber 24, and further through the pressure chambers 46 within the air supply chambers disposed in front of the intermediate air conduits 45 and through the respective branched dual conduits 83 and 84, and are forced into the pressure chambers 59 and 59' formed in the respective air supply chambers disposed in front of the respective upper and the lower central air conduits 58 and 58', and are therefrom forced, through the plurality of holes formed in the respective partition plates 66 and 66', into the forward portions of the respective air supply chambers 60 and 60', and are discharged as rectified hot air currents of uniform pressure through the spaces between the two groups of air-flow rectifying plates 69 which are inclined in a downward and forward direction and an upward and forward direction, respectively, of the respective air-supply openings 61 and 61' formed in the ceiling wall and the floor wall of the drying chamber, while a part of the hot air currents is discharged, under uniform pressure, in the forward, upward and downward directions through the air supply holes 48 formed in the forward periphery of the intermediate conduits 45, and thus the hot air currents are applied under pressure onto the upper and the

lower groups of sheets of yarns which pass through the central portion of the drying chamber, from the inside central portion, and from above and below the two groups of the sheets of yarns.

A part of the hot air currents ejected from the upper and the lower air supply chambers 37 and 37' in the rear end of the interior of the drying chamber traverses the respective groups of sheets of yarns, as indicated by the arrows in FIG. 2, and another part of the hot air currents flows forwardly along the respective group of the sheets of yarns due to the suction force of the rear section of the air suction chamber 50 of the intermediate air conduit and due to the suction force of the rear sections of the air suction chambers 63 and 63' of the upper and lower central air conduits all of which have been uniformly reduced, via the intervention of the perforated partition plates 53, 66 and 66', of their pressures by the suction force exerted by the pressure reduction chambers 49, 62 and 62' of said intermediate and central air conduits, said suction force being caused by the communication of the air suction chambers with the suction sides of the respective hot air generating means in the rearward section.

Also, the hot air currents discharged from the air supply chamber 47 located in front of the intermediate air conduit located in the central portion in the drying chamber and from the air supply chambers 60 and 60' disposed in front of the respective upper and the lower central air conduits traverse the groups of the sheets of yarns, as indicated by the arrows in FIG. 2, due to the suction force of the rear sections of the respective upper and lower air suction chambers 39 and 39' which are located in the forward end of the drying chamber and which are uniformly reduced in pressure, via the intervention of the partition plates 40 and 40', due to the suction force of the reduced pressure chambers 38 and 38' located in the respective upper and lower air suction chambers which are reduced in pressure by being communicated with the suction sides of the respective hot air generating means located in the forward section of the apparatus, and said hot air currents flow in the forward direction along the respective groups of sheets of yarns. Accordingly, the sized wet groups of divided yarns which advance through the drying chamber are heated by those hot air currents which are discharged toward the yarns from the external sides, and as a result, the water adhering to or contained in the yarns evaporates and thus the yarns are dried.

A part of the hot air currents which have been discharged from the respective upper and lower air supply chambers 37 and 37' located in the rear end of the drying chamber and which have heated the wet yarns and absorbed the evaporated moisture thus now has a reduced temperature, namely, the part of the hot air current carrying a maximum degree of moisture after having traversed the groups of sheets of yarns that have just entered into the drying chamber and are wet in the maximum degree, is sucked, through the air suction holes 93 formed in the rear side periphery of the exhaust conduit 89, into the air suction chamber 92 and the pressure reduction chamber 91, and is exhausted outside the apparatus, via the vertical exhaust conduit 97, the upper exhaust conduit 99 and the vertical exhaust conduit 101 which are communicated with said pressure reduction chamber 91 and via the main exhaust conduit 115, by the exhaust fan 116. However, the majority of the hot air currents is sucked, through the upper and the lower air suction openings 64 and 64' provided with the downwardly and rearwardly inclined and upwardly and rearwardly inclined air-flow rectifying members 69 provided behind the upper and the lower central air conduits 58 and through the plurality of air suction holes 51 formed in the rear side periphery of the intermediate air conduit 45, into the air suction chambers 63, 63' and 50 and into the pressure reduction chambers 62, 62' and 49 of the air conduits 58, 58' and 45, respectively,

and then after passing through the branched dual pipes 83 and 84, the air suction piping section 82 of the dual pipes and the air suction pipe 74, it is sucked into the respective hot air generating means 25 located in the rearward section. When the aforesaid wet, hot air passes through the air suction pipe 74, external fresh air corresponding in amount to the air exhausted outside through the exhaust fan 116 is introduced, through the air inlet 75, into the air suction pipe 74 to be mixed with the wet, hot air current in the pipe 74, reducing the moisture content of the wet, heater air. This wet, heated air current sucked into the hot air generating means 25 is heated again in said reheating means 25 and the hot air thus reproduced is forced, through the air supply pipe 72, to both air supply chambers 37 and 37' to be ejected therefrom into the drying chamber 24 for heating and drying the sized wet yarns passing through the chamber 24, and is circulated in the rear half section of the drying chamber 24 through the aforesaid course.

The heated air current which, after being discharged from the air supply chambers 60 and 60' of the respective upper and lower central air conduits and from the air supply chamber 47 of the intermediate air conduit, has heated and dried the wet yarns, and which has absorbed the evaporated moisture and which now contains moisture is sucked, through the spaces between the air-flow rectifying plates 44 of the upper and the lower air suction 43 and 43' located at the forward end of the drying chamber, into the respective air suction chambers 39 and 39'. A part of said air current sucked in said chambers 39 and 39' is then sucked, through the upper and the lower exhaust apertures 104 and 106 opening into the respective air suction chambers 39 and 39', into the exhaust chambers 103 and 105, and via the vertical exhaust conduit 108 and the vertical exhaust conduits 111, 112 and 113 shown in FIG. 5, it is led into the main exhaust conduit 115, and is therefrom discharged externally by means of the exhaust fan means 116. The majority of the hot air currents excepting the aforesaid current, however, is sucked, via the air suction chambers 39 and 39', the pressure reduction chambers 38 and 38' formed in the respective air suction chambers, the upper and the lower branched dual pipes 86 and 86' and via the air suction pipe 85, into the hot air generating means 25 disposed in the forward section of the apparatus. At the same time, fresh air is sucked into the air suction pipe 85 through the air inlet 87 in an amount corresponding to the amount of the air exhausted from the air suction chambers 39 and 39' outside the apparatus by means of the exhaust fan means 116 and is mixed with the remaining hot air within the pipe 85, and the mixed air after being heated by said heated air generating means 25 is circulated in the forward half section of the drying chamber.

The respective sheets *s* of sized dry yarns which have been dried by the respective independent currents of hot air circulating in the rearward and the forward sections of the drying chamber and which are delivered outside the drying chamber from the outlet slot 30 of the drying chamber, are passed through the comb 131 and passed around the guide roller 132 so as to be collected into a single group, and this collected single group of sheets of yarns is then passed through the cushion roller 133 which is adapted to slide in the vertical direction, and through the guide roller 134, successively, and is brought into slidable contact with the upper peripheral face of the waxing roller 137 to be thereby coated with wax, and thereafter it is brought into slidable contact with the lower face of the periphery of the levelling roller 138 to have the coated wax levelled on the peripheries of the individual yarns. Thereafter, by the respective dividing rods 139, the grouped sheets of yarns are again divided into individual sheets *s* of yarns, and then the divided sheets *s* of yarns are adjusted in their widths, as they pass through the expansion comb

140, to the width of the loom beam *c*, and via the guide roller 141, measuring roller 142, the beaming roller 143 and the twitching roller 144, the sheets *s* of yarns are wound under the required tension by the loom beam *c*.

In case it is intended to increase the efficiency of operation by increasing the speed of operation of the apparatus of the present invention, it is to be noted that the feeding speed of the yarns may be raised and the yarns may be dried in the drying chamber 24 to such extent that they will never become adhered to each other even when they would be placed one on another and they will not cause deformation of their cross section even if they should be wound around the heater drum 17. Thereafter, the respective sheets *s* of yarns may be withdrawn from the drying chamber 24, and after the sheets of yarns have been passed through the guide roller 132 and placed together into one group, the grouped yarns may be passed around the rotary heated cylinder 17 which is heated by steam, to thereby perform the finish-drying of the yarns. Thereafter the finally dried yarns may be applied onto the cushion roller 135 adapted to slide longitudinally of the apparatus, and then the yarns may be brought into slidable contact with the waxing roller 137. Thereafter, in a manner similar to that already described, the yarns subjected to sizing and drying treatments, may be followed by the taking up of the resulting yarns in a group of yarns.

During the sizing operation, the pump 157 of the sizing section is activated throughout the period of operation, with the respective changeover valves 160 and 162 being shifted to the main supply pipe 161 side and also to the size-solution supply pipe 163, respectively, thereby to maintain a continued supply of size solution to the size-solution spray pipe 14 starting from the size-solution pipe 158, the changeover valve 160 of the delivery pipe 159, the changeover valve 162 of the main supply pipe 159, the changeover valve 162 of the main supply pipe 161, the size-solution supply pipe 163 and the bent pipe 148, whereby the size-solution is deposited continuously onto the rear peripheral face of the upper squeezing roller 13B from the size-solution spray orifices 15 in such manner that the size-solution is caused to flow through the nipping point of the squeezing roller means 13, thus preventing the drying of the size adhering to the yarns terminating in one group at the ambient space before reaching the nipping point of the squeezing rollers 13 in such case when the take-up operation is suspended because of the breakage of yarns or because a certain length of the sized and dried yarns has been already wound around the loom beam *c* and the same is being replaced, while also preventing the development of fluffing of yarns which are caused when yarns which have adhered to each other as a result of the dried size-solution adhering to the yarns are divided into individual sheets *s* of yarns after passing through the squeezing rollers 13. At the time of suspension of the wind-up operation, the push-up roller 136 of the beaming section is lifted upwardly so as to push up the groups of the sized and dried yarns thereby to separate the sized and dried yarns from the upper peripheral face of the waxing roller 137 to prevent the yarns from being coated with an excess amount of wax.

In case the sheets *s* of yarns delivered from the respective warpers beams are first applied to the respective parts in the drying chamber 24, the obstacles located in the drying chamber 24 are removed by opening the door 32 of the entrance to withdraw, outside the drying chamber 24, the exhaust conduit 89 which is hinged to the door 32, and raising the conduit upright as indicated by the dot-and-dash lines in FIG. 12 and anchoring it with the latch 130, and then withdrawing the intermediate air conduit 45 outwardly of the drying chamber to pull the innermost end portion out of the drying chamber 24, then moving each of the dividing guide rollers 117 and 118 toward the bearing fitting 119 by pressing them together with the loose rotary bush 123 against the spring

125 thereby to detach the ends of the guide rollers 117 and 118 located on the bearing fitting 120 from the rotary bush 129 of the bearing fitting 120, and after swinging each guide roller 117 or 118 about the bearing fitting 119 as indicated by the dot-and-dash lines in FIG. 13, and moving the guide rollers 117 and 118 to the left side to detach their ends from their positions wherein they have been inserted in the loose rotary bushes 123, respectively. Thereafter, the sheets *s* of yarns coming from the respective warpers beams are introduced into the drying chamber 24. Dividing guide rollers 117 and 118 are inserted into the sheets *s* of yarns which have been introduced into the drying chamber 24 and while thus dividing the individual sheets *s* of yarns, the guide rollers 117 and 118 are mounted onto the desired bearing fittings 119 and 120 so that the guide rollers are mounted onto the bearing fittings successively in this manner. After the respective sheets *s* of yarns have been tensioned, the intermediate air conduit 45 which has been withdrawn from the drying chamber 24 is inserted into the drying chamber 24 to pass it between the upper and the lower groups of sheets *s* of yarns. Also, the exhaust conduit 89 which has been kept upright is turned down by releasing the engagement of the latch 130 therefrom. Then, the door 32 is closed so that the exhaust conduit 89 is passed into the space between the upper and the lower groups of the sheets *s* of yarns. With the foregoing procedure, the preparatory arrangement in the drying chamber 24 is completed.

In the example illustrated, there is provided a single heated cylinder 17 in front of the drying chamber 24. It should be understood that several heated cylinders 17 may be provided as required, or alternately, the heated cylinder 17 may be omitted.

In the example of the present invention, dividing guide rollers 117 and 118 are provided forwardly and rearwardly of the intermediate air conduit 45 in the drying chamber 24. The dividing guide rollers 117 and 118 may be provided in one vertical row either forwardly or rearwardly of the intermediate air conduit 45. In the present example, there are provided dividing guide rollers in a number the same as the number of the paired beam creels. It should be understood that the number of the dividing guide rollers may be greater than the number of the beam creels. For example, in case there are provided fifteen pairs of beam creels which is an odd number as in the instant example, there may be provided a single vertical row consisting of sixteen dividing guide rollers. In this case, if the number of the warpers beams *a* which are required to obtain the total number of warps necessary for the desired fabric is about one half of the number of the paired beam creels, or namely, in other words, the number of the warpers beams is eight or less, the sheets *s* of yarns delivered from the respective warpers beams may be divided every alternate yarn to divide one sheet *s* of yarns into two sheets, and the divided two sheets may be taken up by two dividing guide rollers respectively so that the drying of the sheets of yarns may be performed with a coarser density of yarns as compared with the case wherein the number of the dividing guide rollers is the same as or less than that of the warpers beam stands.

The heated air generating means 25 may be provided on the top of the ceiling of the drying chamber 24 as shown in FIGS. 17 and 18. Also, the upper and the lower central air conduits 58 and 58' are provided below the ceiling wall and above the floor wall, respectively.

In the present invention, warpers beams, on which a required number of yarns necessary to obtain the total number of warps of a fabric, are mounted by their shafts, on the beam creels. The yarns fed from these warpers beams are passed through the sizing section to be sized, and thereafter the sized yarns are dried in the drying chamber by dividing them into sheets of yarns which are of coarse density of yarns. Thus, the yarns are arranged

at substantial intervals from each other during the sizing and the drying operations. As a result, contact of yarns and, accordingly, snarling of yarns, development of fluffing and breakage of yarns at the time of dividing dry sized yarns are prevented.

5 Furthermore, the yarns are dried in coarser density and in hot air currents, which provides a highly increased efficiency of the drying operation while also contributing to the avoidance of uneven drying of yarns, and to the avoidance of undesirable heat setting of yarns due to uneven heating of the peripheral faces of yarns. In addition, since the yarns which are placed in the most deformable condition at the time that the yarns are sized and become wet are not brought into pressure contact with any heated material, the yarns do not develop any cross sectional deformations. The yarns are subjected to substantially uniform tension during the drying operation in which the yarns which have been gathered together for the sizing operation are separated, immediately after the squeezing, into several sheets, are passed through the drying chamber in this state and are gathered together for being taken-up, since the sheets of the yarns during the drying operation are advanced along respective paths which are so arranged that there is minimized difference in length and in angle at turns of the paths. Thus, according to the present invention, there are obtained superior sized and dried yarns having round cross sections which will provide satisfactory feel when they are woven into clothing.

10 Since, in the present invention, two sages of independent hot air currents, which can be controlled as regards their respective temperatures independently, are formed in both the forward and the rearward sections of the drying chamber to dry sized yarns therein, the temperatures of the respective sections can be adjusted independently in accordance with the degree of moisture of the yarns that pass through the forward half and the rearward half of the drying chamber, so that the hot air currents used in the present invention are at a temperature which is lower than that employed in a drying apparatus utilizing one stage of hot air current. As a result, the development of undesirable heat-setting of yarns due to the yarns being exposed to hot air of a high temperature can be avoided, so that drying of sized yarns is performed with high efficiency. Also, all the yarns in a number required for a fabric are simultaneously sized and simultaneously dried and are then wound by a loom beam. Therefore, there is no uneven tension in the yarns being subjected to sizing and drying, and as a result, a quite desirable loom beam is obtained.

15 Since the apparatus of the present invention is of such numerous advantages as have been described above, the apparatus of the present invention is capable of efficiently performing simultaneous sizing and simultaneous drying of a large number of man-made long filaments, loosely twisted synthetic yarns, non-twisted yarns and yarns of a very small denier which should be protected from the development of undesirable heat-set effect due to the drying at a high temperature and from the development of fluffing which have been encountered with the conventional apparatus of this kind.

What is claimed is:

1. An apparatus for sizing and drying wraps of man-made filament yarns, including a beam creel section, a sizing section, a drying section and a beaming section in the successive order of warp treatment, said apparatus comprising a drying chamber in said drying section, said chamber comprising forward and rearward end walls respectively formed at the intermediate portions of their heights with an outlet and an inlet extending laterally with respect to the length of said chamber; a first group of air supply chambers provided respectively at the upper and lower portions of the rearward end of said drying chamber and extending laterally thereof, said first group of air supply chambers having a first group of air supply

openings facing said drying chamber at the respective upper and lower corners of said drying chamber rearward end; a first group of air suction chambers respectively provided at the upper and lower portions of the forward end of said drying chamber and extending laterally thereof, said first group of air suction chambers having a first group of air suction openings facing said drying chamber at the respective upper and lower corners of said drying chamber forward end; central air conduits laterally extending within said drying chamber in the central portion thereof and having therein a second group of air supply chambers and a second group of air suction chambers, each of said second group of air supply chambers being provided in the forward side of each of said central air conduits and having a plurality of air supply openings formed through the forward peripheral wall of said air supply chamber of said second group, each of said second group of air suction chambers being provided in the rearward side of said central air conduit and having a plurality of air suction openings formed through the rearward peripheral wall of said air suction chamber of said second group; upper and lower intermediate air conduits provided at the ceiling and floor portions respectively of said drying chamber in the longitudinally intermediate portion thereof, said upper and lower intermediate air conduits extending laterally of said drying chamber and having a third group of air supply chambers and a third group of air suction chambers, each of said air supply chambers of said third group being formed in the forward side of each of said upper and lower intermediate air conduits and having a second group of air supply openings facing said drying chamber, each of said air suction chambers of said third group being formed in the rearward side of each of said upper and lower intermediate air conduits and having a second group of air suction openings facing said drying chamber; means respectively in the forward and rearward outside portions of said drying chamber for producing hot air and each having an air supply pipe and an air suction pipe which are respectively connected to the opposite ends of said hot air producing means respectively, the air supply pipe connected to said rearward hot air producing means communicating with said first group of air supply chambers and the air suction pipe connected to said rearward hot air producing means communicating with said second and third groups of air suction chambers, the air supply pipe connected to said forward heated air producing means communicating with said second and third groups of air supply chambers and the air suction pipe connected to said forward hot air producing means communicating with said first group of air suction chambers; and a plurality of parallel dividing guide rollers vertically arranged within said drying chamber in the intermediate portion thereof and extending laterally between opposite side walls of said drying chamber, each of said dividing guide rollers being supported at the opposite ends by bearing means mounted on said opposite side walls of said drying chamber, and the number of said dividing guide rollers being greater than that of the beam creels in said beam creel section.

2. The apparatus as defined in claim 1 further comprising exhaust conduits provided within said drying chamber between said inlet and said central air conduit and extending laterally of said drying chamber, each of said exhaust conduits having a plurality of air suction holes in the rearward peripheral surface thereof; said first group of air suction chambers being further provided with air exhaust openings; said apparatus further comprising a group of air exhaust conduits provided outwardly of said drying chamber; and a main exhaust conduit having therein an air exhaust fan and communicating with said group of air exhaust conduits; said exhaust conduits and said first group of air suction chambers communicating with said main exhaust conduit through said group of air exhaust conduits, and the air

suction pipes connected to said forward and rearward hot air producing means being formed therein with air inlets respectively.

3. The apparatus as defined in claim 2 wherein each of said exhaust conduits is swingably hinged at its base portion to the inner face of a door of the rear entrance of said drying chamber.

4. The apparatus as defined in claim 1 further comprising dual pipes connected respectively to the air supply pipes and the air suction pipes which are connected to said forward and rearward heated air producing means respectively, each of said dual pipes being provided with a drawer frame each of said central air conduits being slidably supported at its base portion in said drawer frame with the free end thereof slidably projecting into the interior of said drying chamber through the side wall thereof.

5. The apparatus as defined in claim 1 wherein each of the bearing means mounted on one of the sidewalls of said drying chamber includes a cylindrical casing having an open end, a ball bearing disposed within said casing and having an inner race capable of being tilted with respect to the axis of said ball bearing, a rotary bushing loosely fitted into said inner race, a thrust bearing within said casing behind said inner race and a spring extending between the inner bottom of said casing and said thrust bearing for urging the latter into contact with the rear surface of said bushing, said bushing being adapted to removably receive one of the ends of each dividing guide roller; and each of the bearing means mounted on the other side wall of said drying chamber includes a second cylindrical casing, a second ball bearing and a second thrust bearing both disposed within said second casing, and a second rotary bushing supported by said second ball and thrust bearings, said second bushing being adapted to detachably receive the other end of each said dividing guide roller.

6. The apparatus as defined in claim 1 further comprising a heating cylinder provided in the forward side of said drying chamber.

7. The apparatus as defined in claim 1 further comprising upper and lower squeezing rollers disposed in said sizing section, a size solution spraying pipe formed therealong with a number of spraying apertures and positioned rearwardly of the upper one of said squeezing rollers, a size vat having an overflow tube, a size solution supply vat below the free end of said overflow tube, and a piping having therein a pump, said spraying pipe being connected to said size solution supply vat through said piping.

8. The apparatus as defined in claim 1 further comprising a comb and a guide roller disposed at the rearward end of said sizing section and a second comb and second guide roller disposed at the forward portion of said outlet of said drying chamber.

9. A method of sizing and drying a stream of warps of man-made filament yarns comprising the steps of gathering together a large number of yarns being fed in the form of sheets from warpers beams in a number required to form a single sheet of fabric, applying size to the thus gathered yarns, squeezing excess size from the yarn, separating the sized yarns, immediately after squeezing of the yarn, into sheets respectively corresponding to those from the warpers beams, introducing the separating sheets of yarns into a drying chamber, dividing the separated sheets of yarns into two groups in each of which the sheets of yarns are caused to slightly diverge forwardly while being advanced through a rearward section of the drying chamber, and to slightly converge forwardly while being advanced through a forward section of the drying chamber and delivered out of the chamber, subjecting the sheets of yarns while passing through the drying chamber to successive independent rear and front circulations of hot air in such a manner that the yarns are exposed to streams of hot air respec-

19

tively directed in a forwardly-downwardly direction and a forwardly-upwardly direction and passing through the sheets of yarns and to streams of hot air passing substantially along respective sheets of yarns for the drying of the yarns, and gathering together the thus dried sheets of yarns to wind the same on a single loom beam to form a complete sheet of sized yarns.

10. A method as claimed in claim 9 in which each of the separated sheets of yarns is further divided into two rows before being subjected to the stream of hot air.

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20

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U.S. Cl. X.R.

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