Nov. 16, 1965 W. N. HOWLEY, JR., ETAL 3,217,751

LOOM APPARATUS FOR WEAVING CONTOURED THREAD CONNECTED DUAL WALL INFLATABLE FABRIC

Filed Dec. 9, 1963 2 Sheets-Sheet 1

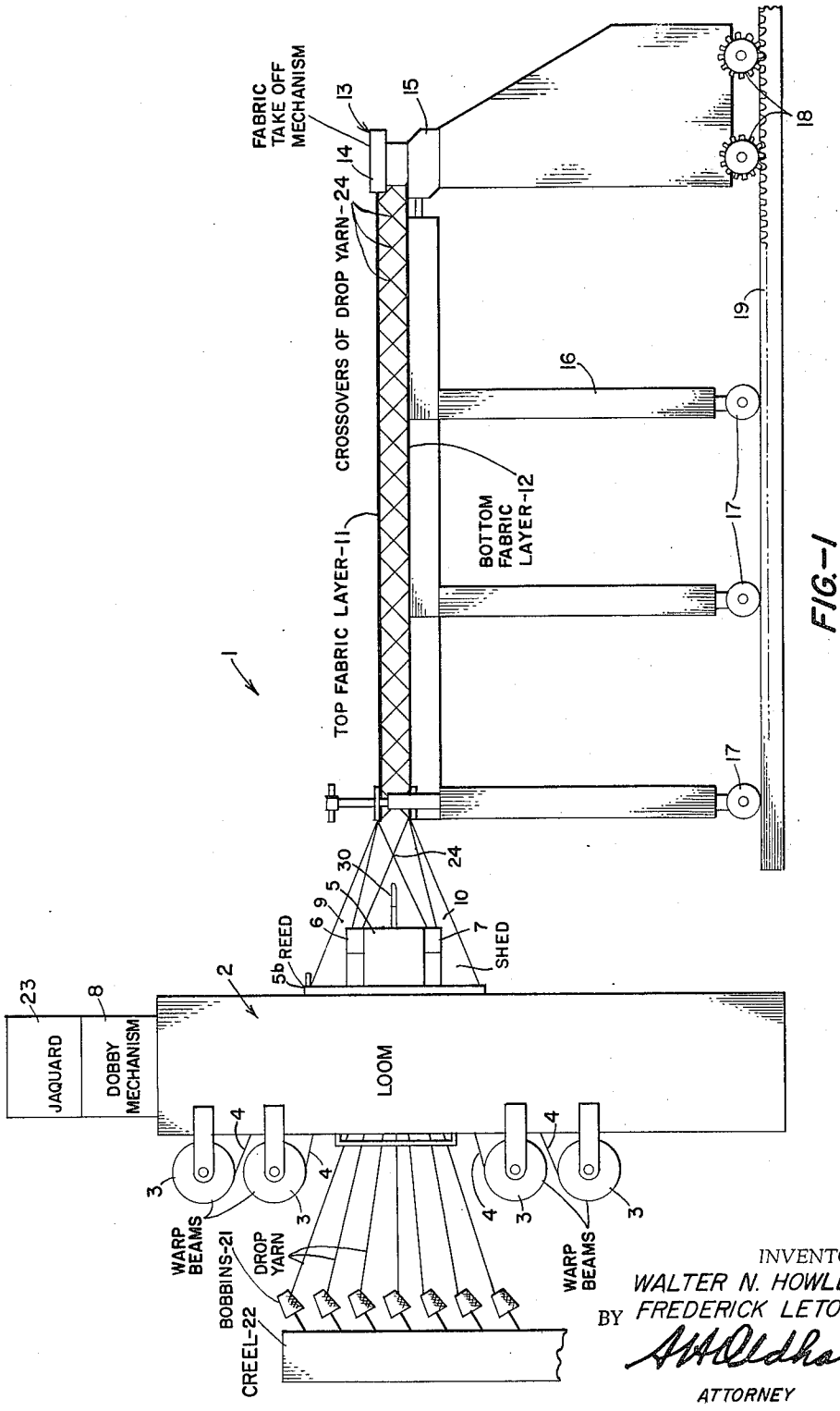

FIG.-1

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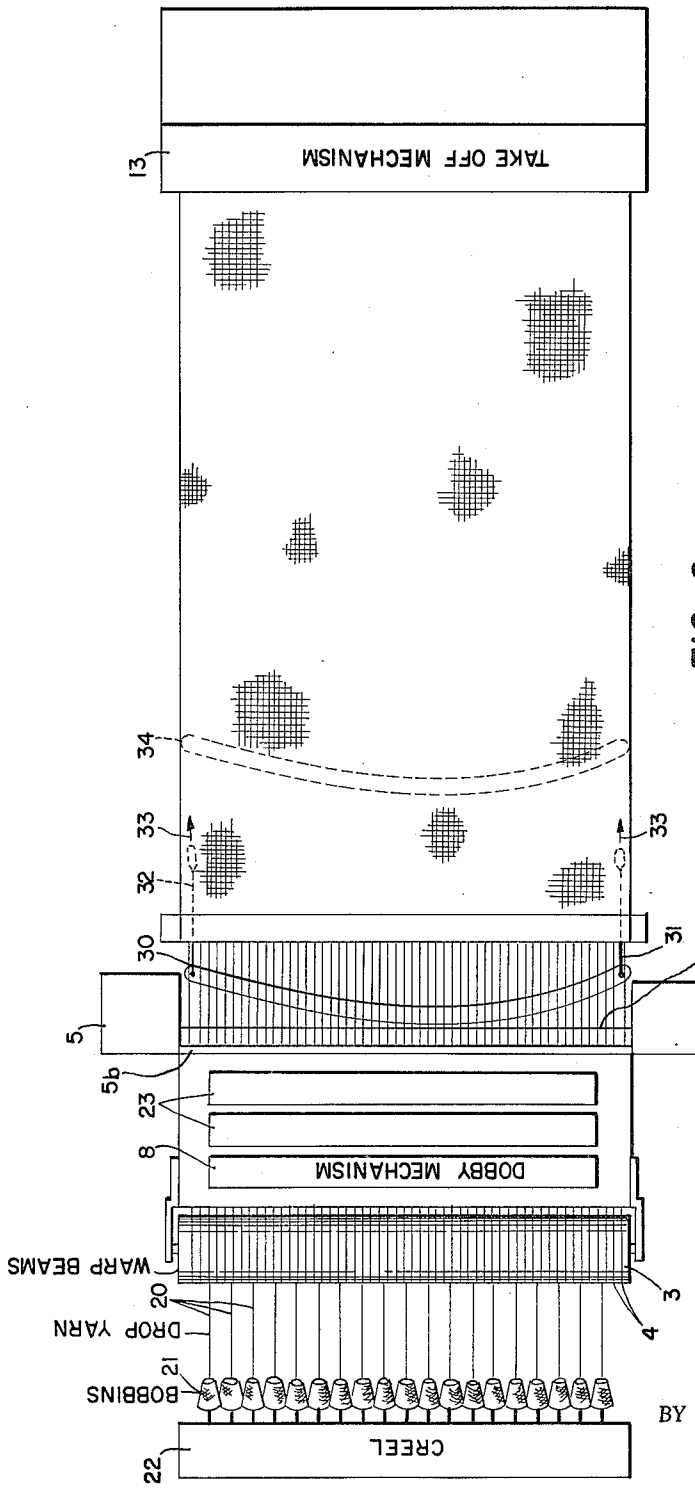

FIG.-2

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LOOM APPARATUS FOR WEAVING CONTOURED THREAD CONNECTED DUAL WALL INFLATABLE FABRIC

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2 Claims. (Cl. 139—20)

This invention relates to a loom apparatus for weaving contoured thread-connected dual wall inflatable fabric, and more particularly to apparatus for weaving a double fabric having drop-yarns of various lengths extending between the fabrics to provide a contour between the top and bottom fabrics when the fabrics are moved apart to the length of the drop-yarns.

The art of double fabric weaving utilizing a double fabric plush or carpet loom is well known wherein the drop-yarns are generally made from a tufted yarn so that the fabrics may be split down the center of the drop-yarns to form piled carpet. Generally, these looms for forming plush or piled carpet have been called plush or carpet looms. One loom of this type is a Wilson and Longbottom double shuttle plush loom made by the Wilson and Longbottom Limited of England, which loom is capable of weaving piled carpets. However, where it is desired to vary the spacing between the upper and lower fabrics to achieve desired contours, the art is lacking because there are no means known to properly vary the length of the drop-yarns. Further, problems arise in attampting to vary the length of the drop-yarns because of the frictional pull of the drop-yarns through the loom. Further, in order to achieve deeper or tapered fabric layers, it is desirable at times to vary the width of the upper and lower fabrics or to vary their angular relationship to each other without varying the length of the drop-yarns. These requirements cannot be met with the known art of double-shuttle or double-fabric plush or carpet looms.

Thread-connected dual wall inflatable fabric is manufactured and sold by Goodyear Aerospace Corporation of Akron, Ohio, under the trademark "Airmat" registered in the U.S. Patent Office.

Thread-connected dual wall inflatable fabric, hereinafter for simplicity called inflatable fabric, has been made with the threads sometimes called drop-yarns, of fine steel wire or of light but strong natural or synthetic fibers or filaments.

Inflatable fabric of this type when inflated provides a high strength per unit weight ratio. It consists of an upper and lower woven fabric connected by drop yarns of equal length for flat inflatable fabric or varying lengths for contoured inflatable fabric. At present, however, it is not possible to accurately and/or automatically vary the length of the drop yarns to make contoured inflatable fabric. Thus, using the plush or carpet looms of the art only flat inflatable fabric of approximately three inches thickness is possible, however, flat inflatable fabric can be made up to approximately six inches in thickness by including false picks to extend the drop-yarns which picks are later removed.

Until the technique of weaving contoured inflatable fabric, as disclosed hereinafter, was developed, it was necessary to cut fabrics into strips and gores which were sown together to produce shapes such as cones, spheres, and air foils. This procedure was not only costly and time consuming, but also precluded, to a great extent, any attempt to produce such shapes with any degree of similarity.

It is the general object of the invention to avoid and

overcome the foregoing and other difficulties of and objections to prior art practices by the provisions of a double-fabric loom which is capable of weaving parallel fabrics having extended drop-yarns therebetween to provide a desired contour between the fabrics upon movement of the fabrics away from each other to the length of the extension of the drop-yarns.

A further object of the invention is to provide a loom for weaving contoured inflatable fabric which is extremely simple, highly effective, and generally low in cost.

The aforesaid objects of the invention and other objects which will become apparent as the description proceeds are achieved by providing in a loom for weaving contoured inflatable fabric the combination of means to weave an upper and lower fabric comprising longitudinal warp cords and transverse weft cords, means to take off and extend the upper and lower woven fabric in parallel relation to each other, means to weave a plurality of drop-yarns between the upper and lower fabrics, and means to variably extend the length of the drop-yarns between the upper and lower fabrics when the fabrics are moved apart after weaving and the drop-yarns are pulled to their extended length.

For a better understanding of the invention reference should be had to the accompanying drawings wherein:

FIGURE 1 is a side elevation of a double-fabric plush type loom employing the embodiments of the invention;

FIGURE 2 is a plan view of the loom of FIGURE 1.

Weaving is the process of interlacing yarns, threads, strips, or strands of various materials in such a manner as to produce cloth or fabrics of an allied nature. All weaving operations are performed on machines called looms, which vary in construction according to the kind of fabrics they produce. Every woven fabric is composed of two systems of yarn, namely, the warp and the filling or weft. There may be two or more warps or two or more systems of filling. The majority of fabrics are, however, what are known as single cloths and are composed of one system of warp yarn and one system of filling yarn. The warp is that system of yarn that runs lengthwise of the fabric and consists of a large number of separate threads, or ends. The number of ends in the warp depends, of course, on the ends per inch in the cloth and the width of the fabric. Before being woven, the separate ends of the warp, which are of equal length and arranged parallel to each other in the form of a sheet of yarn, are wound tightly on a round roll which is journaled to the frame of the loom and constitutes a part of the loom which is known as the loom beam or the warp beam. In the process of weaving, the warp yarn is slowly unwound from the beam, which is placed at the back of the loom, while as the weaving progresses, the woven cloth is wound on a roll at the front of the loom known as the cloth roll. The filling is that system of threads that runs across the fabric from selvage to selvage and unlike the warp consists of a continuous thread or threads that are passed back and forth from one side of the cloth to the other and are interlaced with the warp. The filling is placed in the cloth one pick at a time by means of a moving part of the loom known as the shuttle, which travels back and forth across the loom from one shuttle box to the other. The filling is wound in the form of a bobbin or cop, which is placed on a spindle in the shuttle.

In order to produce a woven fabric each warp end is drawn through the eye of a heddle placed on any one of a number of frames known as harnesses. These harnesses, which are carried in the center of the loom, are operated by suitable mechanism such as a dobby or a jacquard so that any of them may be raised or lowered through the space of a few inches when desired. Since some of the harnesses are raised while others are lowered, a diamond-shaped opening, known as the shed, is made in the warp,

through which the shuttle carrying the weft is thrown. The shed then closes, after which a new shed is formed by the raising and lowering of other harnesses and the weft inserted as previously, thus interlacing the weft with the warp and forming a woven fabric. These two operations are known as shedding and picking. The shuttle is being thrown from one side of the loom to the other leaving the weft some distance from the edge, or, as is technically known, the fell of the cloth. It is necessary, therefore, after the insertion of each pick, to push the filling forward to the cloth that has already been woven. This operation is known as meeting up and generally is accomplished by a portion of the loom called the lay that carries an arrangement of vertical wires known as the reed, through which the warp is passed. The three operations of shedding, picking, and beating up are known as the principle motions of weaving and are common to all types of looms. In weaving any fabric these three operations are repeated over and over again as the cloth is made pick by pick.

Other motions are applied to looms, but they are of the nature of auxiliary motions and are not typical of any principle of the weaving process. The chief auxiliary motions are: (1) the let-off motion for controlling the warp beam and letting the warp unwind as fast as the cloth is woven while it at all times keeps the proper tension on the warp; (2) the take-up motion for winding the cloth on the cloth roll as it is woven by the loom; (3) the filling stop-motion for automatically stopping the loom in case the weft breaks; (4) the protector motion for protecting the warp yarn from being broken by the lay and shuttle in case the latter for any reason remains in the shed when the lay moves forward to beat up the filling; (5) the selvage motion for manipulating the selvage ends at each side of the warp in such a manner as to produce smooth and firm edges on the cloth.

Thus, with this background of weaving in mind the description of the weaving mechanism of the invention will be described. Particularly, with reference to FIGURE 1, the numeral 1 indicates generally the contoured inflatable fabric weaving apparatus of the invention which contains as its central mechanism a double-fabric weaving loom, indicated generally by numeral 2. In the loom 2 a plurality of warp beams 3 supply warp yarn 4 and a shuttle mechanism indicated by numeral 5, contains shuttles 6 and 7 to supply the filling or weft yarn. The warp yarn 4 is controlled by a dobby mechanism 8 so that sheds 9 and 10 are formed to receive the shuttles 6 and 7, respectively. A reed 5*b* is provided to beat up the weft yarn. Thus, a top fabric layer 11 and a bottom fabric layer 12 are formed. However, instead of utilizing a conventional take-up roll, the invention contemplates that a fabric take-off mechanism, indicated generally by numeral 13, to provide parallel fabric take-off be utilized. The take-off mechanism 13 operatively holds the upper top fabric 11 and the bottom fabric 12 in clamps 14 and 15, respectively. The clamps 14 and 15 hold the fabrics in substantially parallel relationship during the weaving operation. The take-up mechanism 13 is operatively connected to a collapsible support table 16 which table is mounted on rollers 17. The take-up mechanism 13 is mounted on geared rollers 18 which are removably aligned to a rack track 19. Thus, the take-off mechanism may be driven through the geared wheels 18 on track 19 in accordance with the picks per minute by the shuttle mechanism 5 to maintain proper movement of the fabrics to insure proper tensioning and weaving.

In order to provide the inflatable fabric characteristics and the contour thereof a plurality of drop yarns 20 wound onto bobbins 21 and mounted on a creel 22 are provided. The drop yarns 20 run longitudinally through the loom 2 in substantially parallel relation to the warp yarn 4, and are controlled by a jacquard 23. The drop yarns 20 are woven into the upper and lower fabrics in the same manner as the warp yarns, but are crossed from one

fabric to the other by the jacquard 23 to provide interconnection between the top and bottom fabric layers and to provide contour therebetween as will be more fully described hereinafter. It is contemplated that the drop yarn cross overs normally will be between about every two to about every fifteen picks, but could be between about 1 and about 100 picks. Thus, the top and bottom fabric layers are interconnected by a plurality of cross overs of drop yarn, indicated by numeral 24. The length of the drop yarns is varied by an extension bar, indicated generally by numeral 30, but described more fully hereinafter. The extension of the drop yarns is to provide a contour between the top and bottom fabric layers when the inflatable fabric is made fluid impervious and inflated.

FIGURE 2 illustrates a plan view of the loom mechanism 1 of FIGURE 1, and particular attention should be noted to the fact that the drop yarn 20 extends longitudinally in parallel relationship to the warp yarn 4. A single strand of weft or filling yarn 5*a* is indicated as having been passed transversely of the warp and drop yarns by the shuttle mechanism 5, and is ready to be beaten up by the reed 5*b*.

In order to provide an extension to the drop yarns 20 to determine the contour between the top and bottom fabrics in the inflatable fabric, an extension bar, indicated generally by numeral 30, is provided. Note with reference to FIGURE 1, that the extension bar 30 is placed behind the cross over 24 of the drop yarns 20 being woven into the fabrics. Means, such as connecting loops 31 and 32, respectively, may be connected to the ends of the extension bar 30 to pull it longitudinally between the woven fabrics in the direction of the arrows 33 to some desired position, such as indicated by the dotted line 34. In this manner, the drop yarns 20 are extended desired distances, according to the contour of the bar 34, so that when they are rewoven into the respective fabrics a certain length is determined between the top and bottom fabrics by the drop yarns 20 to achieve a contour therebetween when the inflatable fabric is made air impervious and inflated. The contour of the drop bar 30 may be pre-determined to provide an air foil shape, a blunt rounded nose cone shape or any other desired configuration of contour between the top and bottom fabric layers with such determination provided by the length of the drop yarns 20 between the fabric layers.

Thus, it is seen that the objects of the invention have been achieved by providing a double-fabric loom which utilizes a parallel take-up mechanism to provide proper tensioning to the fabrics during the weaving process. The fabrics are woven parallel to each other with a plurality of drop yarns interwoven therebetween, and with the length of the drop yarns being pre-determined by extension of the drop yarns before completion of the weaving into the fabric. In this manner when the completed fabric is made air impervious and inflated the drop cords extend to their full length to provide a desired contoured relationship between the fabric layers. It must be understood that this is a precision weaving process with the exact extension of the drop yarns being of critical importance. Thus, the picks per minute of weaving may be quite low with the emphasis being placed on the extension of the drop yarns and the proper weaving into the fabrics to maintain the desired extension.

It should further be understood that the principles of drop yarn extension, of gage angle control and of drop yarn pre-feed are the critical aspects of the invention, and that the mechanism disclosed is not necessarily the only mechanism to accomplish the desired results.

Thus, in accordance with the patent statutes, only one best known embodiment of the invention has been illustrated and described in detail. However, it is to be particularly understood that the invention is not to be limited thereto or thereby, but that the inventive scope is defined in the appended claims.

What is claimed is:

1. In a loom for weaving double fabrics in substantially parallel spaced relation wherein drop yarns extend between the fabrics,

means for extending every drop yarn during weaving to variable pre-determined lengths so that when said fabrics are moved apart to the length of the extended drop yarns a desired contour is attained between the spaced fabrics, said means comprising

a long rod having one edge thereof contoured to the shape desired for one side of the fabric, said rod adaptable to be placed transversely of the woven fabrics behind the crossed over drop yarns before the drop yarns are woven into the fabrics whereby the contoured edge is aligned substantially parallel to the woven fabrics, and

separate means engaging both ends of the rod to move said ends independently longitudinally towards and between said fabrics so the contoured edge of the rod extends said drop yarns a desired length according to the contour thereof and the longitudinal distance that each end is moved.

2. In a loom for weaving double fabrics in parallel spaced relation wherein drop yarns extend between the fabrics to determine the final spaced relation of the fabrics,

means for extending every drop yarn to variable predetermined lengths so that when said fabrics are moved apart to the length of the extended drop yarns a desired contour is attained between the spaced fabrics, said means comprising

bar means having one edge thereof contoured to the shape desired for one side of the fabric, said bar means independently positioned transversely of the woven fabric behind the drop yarns before they are woven into the fabrics with the contoured edge of the bar means substantially parallel to the fabrics, and

means to move said bar means independently of any other loom operation so as to extend said drop yarns a desired length according to the contour of said rod and the distance that it is moved.

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