Feb. 1, 1966 D. M. MARCO 3,232,319

METHOD FOR WEAVING CONTOURED THREAD-CONNECTED DUAL WALL INFLATABLE FABRIC ON A SINGLE SHUTTLE LOOM

Filed Dec. 9, 1963

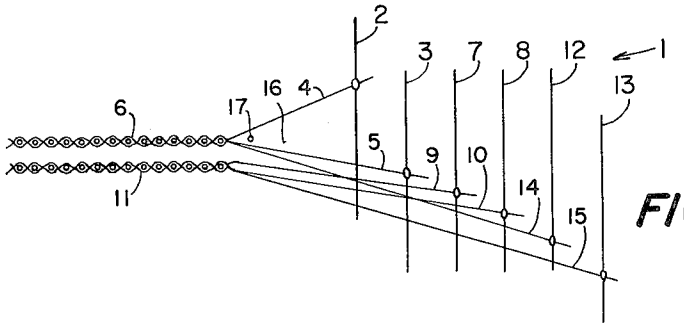


FIG.-1

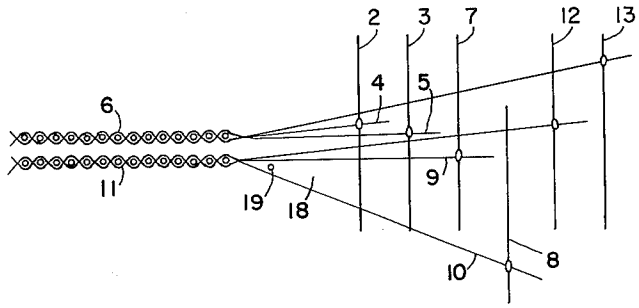


FIG.-2

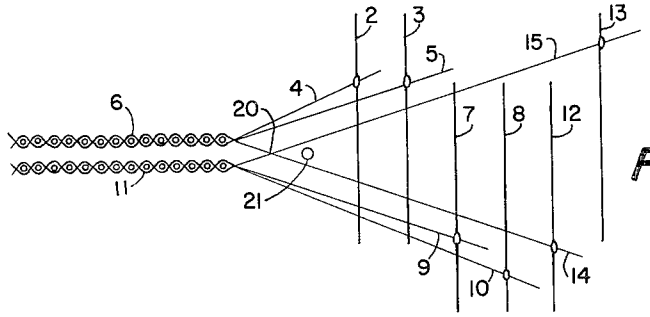


FIG.-3

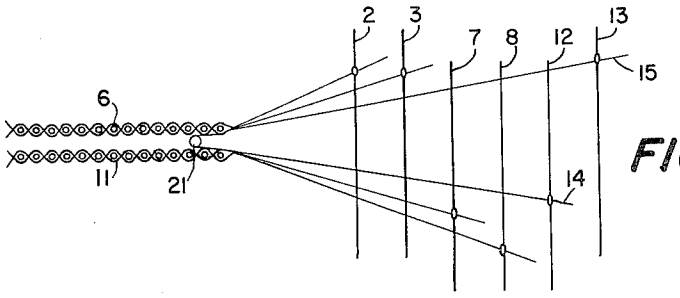


FIG.-4

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United States Patent Office 3,232,319 Patented Feb. 1, 1966

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METHOD FOR WEAVING CONTOURED THREAD-CONNECTED DUAL WALL INFLATABLE FABRIC ON A SINGLE SHUTTLE LOOM

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Filed Dec. 9, 1963, Ser. No. 329,043
3 Claims. (Cl. 139—20)

This invention relates to a method to weave contoured thread-connected dual wall inflatable fabric utilizing a single shuttle, or more particularly relates to the weaving of contoured thread-connected dual wall inflatable fabric on a single shuttle loom or a single fabric loom.

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 two directional or complex contoured inflatable fabrics. Thus, using the plush or carpet looms of the art only flat inflatable fabric of approximately three inches thickness is possible; however, 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 complex contoured inflatable fabric, as disclosed hereinafter, was developed, it was necessary to cut fabrics into strips and gores which were sown together to produce complex shapes such as used for airplane wings and tails. This procedure was not only costly and time consuming, but also precluded, to any great extent any attempt to produce such shapes with any satisfactory degree of uniformity.

Heretofore, the art of single fabric weaving on single fabric looms has been well known. In these looms generally only a single fabric is woven consisting of longitudinally running warp yarns and transversely running weft yarns. However, it would be possible by arranging the heddles controlling the warp yarns to weave two fabrics lying essentially adjacent to each other. However, this has not been done as it would require more time and probably would not effect as desirable a weave. It may be done to achieve a double thickness to a woven fabric by utilizing drop yarns to tie the fabrics together. However, there is no known method to extend the length of the drop yarns between the fabrics during the weaving thereof so that when the fabrics are completed and made air impervious and inflated a desired contour is attained between the fabrics because of the extended length of the drop yarns.

Therefore, it is the general object of the present invention to avoid and overcome the foregoing and other difficulties of prior art practices by the provisions of a method to weave complex contoured inflatable fabric on a single fabric loom by weaving two fabrics having drop yarns crossed over and extended therebetween to desired lengths during the weaving thereof.

A further object of the invention is to provide a method of weaving complex contoured inflatable fabric on a single fabric loom whereby two fabrics are woven with

drop yarns crossed over therebetween and with the drop yarns controllably and accurately extended during the weaving to insure a precision contoured inflatable fabric when inflated with a high strength to weight ratio.

Another object of the invention is to provide a method of weaving complex contoured inflatable fabrics on a single fabric loom which method is simple, highly accurate, extremely effective, and which is low in cost.

The aforesaid objects of the invention and other objects which will become apparent as the description proceeds are achieved by providing a method to weave complex contoured inflatable fabric on a single fabric loom which comprises the steps of weaving a top and bottom fabric of yarn so that the fabrics are in usbstantially parallel adjacent relationship, the fabrics composed of longitudinally extending warp yarn, moving the fabrics away from the weaving edge in adjacent relationship, weaving a plurality of drop yarns into each fabric, crossing the drop yarns over from one fabric to the other, extending the crossed over drop yarns between the fabrics to pre-determined lengths, and weaving the extended drop yarns into their respective fabrics.

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

FIGURE 1 is a schematic side elevation illustrating a single fabric loom operating four sets of warp yarn and two sets of drop yarn which shows the upper fabric being woven;

FIGURE 2 is a schematic elevation similar to FIGURE 1 except showing the lower fabric being woven;

FIGURE 3 is a schematic elevation similar to FIGURES 1 and 2 which shows the drop yarns crossed over; and

FIGURE 4 is a schematic elevation similar to FIGURES 1 through 3 which shows the crossed over drop yarns being extended between the fabrics before being woven into position to provide the desired contour between the woven fabrics when they are moved apart after weaving.

The concept of the invention presented hereinafter is that of weaving contoured inflatable fabric on a simple, single fabric loom. Thus, with reference to FIGURE 1, a single shuttle loom is schematically illustrated which used six heddles indicated generally by the numeral 1. The individual heddles 2 and 3 control longitudinally extending warp yarns 4 and 5 to weave an upper fabric 6. The individual heddles 7 and 8 control longitudinally extending warp yarns 9 and 10 which weave a bottom fabric 11. The individual heddles 12 and 13 control drop yarns 14 and 15 which are woven into the fabrics 6 and 11 to provide the contour therebetween as more fully described hereinafter. The yarn utilized for the invention is generally wire having a diameter of between about .0015 and about .005 inches, but otherwise, rayon, nylon, dacron or suitable yarn could be utilized to achieve the objects of the invention.

FIGURE 1 illustrates the first step in the method of the invention wherein the warp 4 for the upper fabric 6 is held upwardly by its heddle 2 and the warp 5 is held downwardly by its heddles 3 thereby forming a shed 16 into which a shuttle (not shown) is passed to place a weft yarn 17. The weft yarn 17 is beaten up into position in a conventional manner, such as by a standard lay and reed mechanism (not shown). Note that in FIGURE 1 only the warp 4 comprises the upper part of the shed 16 with the entire bottom portion of the shed 16 being composed of the other warps and the drop yarns.

FIGURE 2 illustrates the weaving of the bottom fabric 11 where the warp 10 is held downwardly by its heddle 8 and the remaining warp and drop yarns are held upwardly by their respective heddles to form a bottom shed 18 into

which a shuttle (not shown) may be passed to place a weft yarn **19** to weave the bottom fabric **11**. It should be understood that the sheds **16** and **18**, to form the top and bottom fabrics, could be achieved by different arrangements of the warp and drop yarns without changing the method of the invention. Again, conventional lay and reed mechanism (not shown) may beat the weft **19** into position. As an important feature of the invention the fabrics are taken away from the weaving edges in substantially straight and adjacent relationship instead of being wound on a roll. This allows the extension of the drop yarns as set forth hereinafter.

It should be noted with reference to FIGURES 1 and 2 that the drop yarn **14** comprises a portion of the upper fabric **6** and the drop yarn **15** comprises a portion of the lower fabric **11**. Thus, with reference to FIGURE 3 it is seen that the drop yarn **15** has been moved upwardly by its heddle **13** while the drop yarn **14** has been moved downwardly by its heddle **12**. This presents a cross over between the drop yarns **14** and **15** resulting in a cross over point **20**. It should be noted that when the cross over between the drop yarns is effected the warp **4** and **5** composing the upper fabric **6** are moved to the upward position and the warp **9** and **10** composing the lower fabric **11** are moved to the downward position. It is contemplated that the cross over normally will be made between about every two to about every twenty picks of the weft, but this could vary between the limits of about every one to about every 100 picks depending on the structure desired. Once the cross over has been made suitable means for extension thereof, such as a bar **21**, may be positioned behind the cross over point **20** in some suitable manner. The invention contemplates that the bar **21** may be of various shapes to provide variable extension to the drop yarns. Apparatus and methods for extension bars and extension are shown in co-pending applications Serial No. 328,874, now Patent No. 3,069,194 and Serial No. 341,719 also assigned to Goodyear Aerospace Corporation.

FIGURE 4 illustrates the final and most important step in the weaving which is the drop yarn extension where the bar **21** is moved forwardly between the fabrics **6** and **11** a suitable distance to provide the desired extension to the drop yarns **14** and **15**. With the drop yarn extension having been properly effected the drop yarn **14** and **15** are again woven into their respective fabrics. The bar **21** may remain in position to eliminate tangling of the extended drop yarns as more fully described in co-pending application Serial No. 341,719 cited above. When the weaving is completed and the fabrics **6** and **11** are made fluid impervious and the side openings covered the inflatable fabric may be inflated to provide a desired control between the fabrics **6** and **11** because of the extension of the length of the drop yarns between the fabrics when the drop yarns are crossed over. Thus, it should be understood that the extension of the drop yarns is the essential feature of the invention and not how or where extension is made, but merely that extension is made.

Thus, it is seen that the objects of the invention have been achieved by providing a method to weave deep piled contoured inflatable fabric on a single shuttle or single fabric loom by weaving two fabrics thereon in adjacent relationship with variable extending drop yarns between the fabrics provided during the weaving thereof. It should be understood that the yarn mentioned heretofore may be wire, nylon, rayon, dacron, or any other suitable material which will provide the desired strength-weight ratio. It is to be further understood that the drop yarn extension is made by crossing longitudinally extending drop yarns from one fabric to the other with the yarns being extended a desired length before being rewoven into their respective fabrics. Although extension is shown and described as being between the

fabrics, it should be understood that any method of extension could be utilized. Thus, even though the fabric layers are woven in substantially adjacent relationship to each other the drop yarn extension provides desired contours or shapes to the fabrics when they are made gas impervious and inflated, or moved apart in some other manner to move the fabrics apart to the extended length of the drop yarns.

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

What is claimed is:

1. A method to weave deep piled contoured inflatable fabric on a single shuttle, single fabric loom which comprises the steps of

weaving a top and bottom fabric of wire yarn having a diameter of between about .0015 and about .005 inches, said fabrics composed of longitudinally extending warp yarns and transversely extending weft yarns, said fabrics being in substantially adjacent relationship,

taking the fabrics away from the weaving edge in substantially straight and adjacent relationship,

weaving a plurality of drop yarns longitudinally into each fabric in substantially parallel relationship to the warp yarns,

crossing the drop yarns over from one fabrics to the other between about every two and about every twenty picks of the weft yarn,

extending the crossed over drop yarns pre-determined lengths relative to and between the fabrics where such extension is independent of any other weaving operation and where the extensions of individual drop yarns are variable across the width of the fabrics, and

subsequently to the extension thereof weaving the extended and crossed over drop yarns into their respective fabrics to secure them into position.

2. A method for making contoured inflatable fabric on a single shuttel, single loom which includes the steps of

weaving an upper fabric,

weaving a lower fabric in substantially adjacent relationship to the upper fabric,

weaving drop yarns longitudinally into the fabrics across the width of the fabrics,

crossing the drop yarns over between fabrics at a plurality of intervals along the longitudinal length of the fabrics,

extending the drop yarns variable pre-determined lengths relative to and between the fabrics after the cross over thereof,

retaining the drop yarns in their extended position to eliminate tangling thereof, and

subsequently weaving the extended and crossed over drop yarns into their respective fabrics to secure them into position.

3. A method to weave deep piled contoured inflatable fabric on a single shuttle, single fabric loom which comprises the steps of

alternately weaving a top and bottom fabric of yarn so the fabrics are in substantially adjacent relationship,

taking the fabrics away from the weaving edge in substantially straight and adjacent relationship,

weaving drop yarns longitudinally into and across the width of each fabric,

crossing the drop yarns over from one fabric to the other at substantially regular intervals,

extending the crossed over drop yarns variable predetermined lengths across the width of the fabrics

and independently of any other weaving operation, and

subsequently weaving the extended and crossed over drop yarns into their respective fabrics to secure them into position.

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