Sept. 9, 1930. H. F. SHERMAN 1,775,144

WOVEN FABRIC AND ART OF WEAVING THE SAME

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Fig. 1

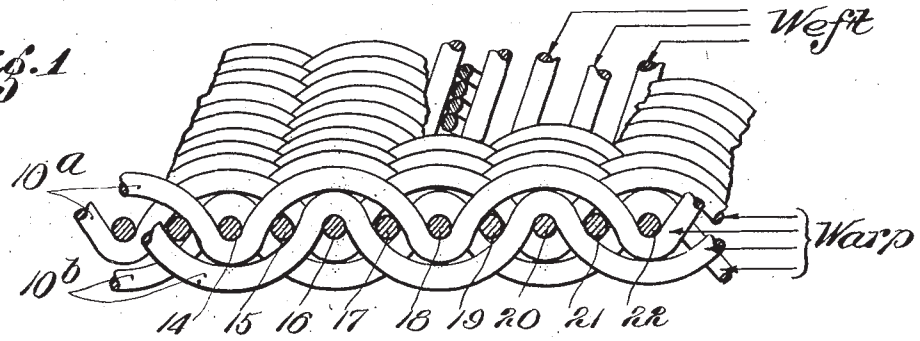


Fig. 2

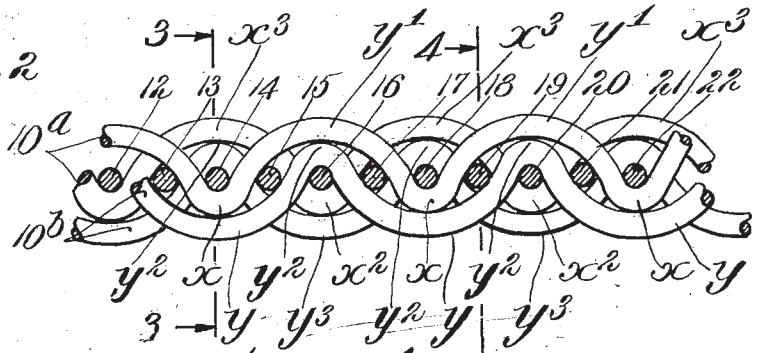


Fig. 3

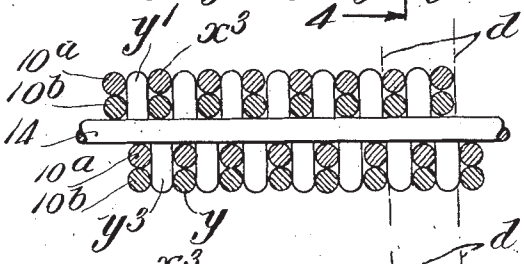


Fig. 4

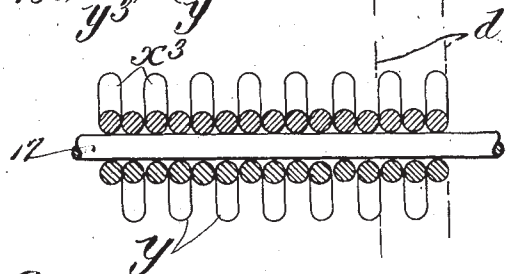


Fig 5

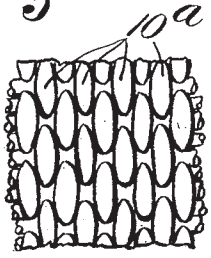


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Fig. 6

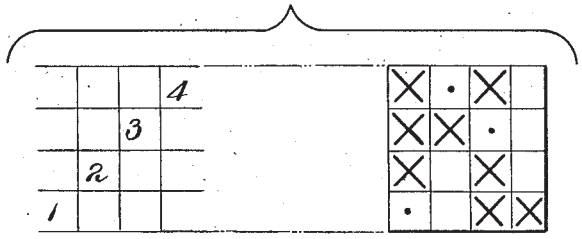
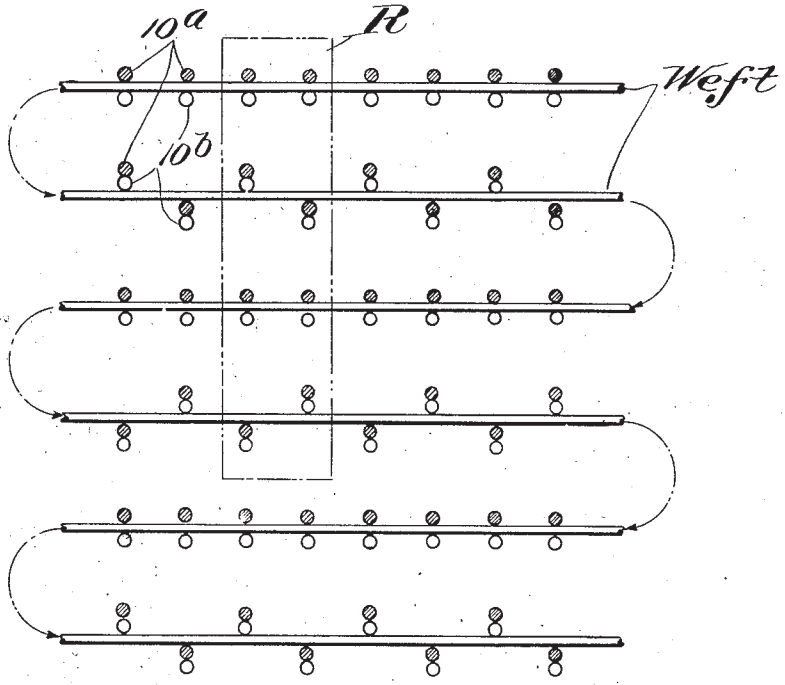



Fig. 7

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# UNITED STATES PATENT OFFICE

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## WOVEN FABRIC AND ART OF WEAVING THE SAME

Application filed January 22, 1926. Serial No. 82,986.

This invention relates to woven fabrics of the single-ply, unitary or single-shed type having certain new and useful characteristics, including great density, relative thickness in proportion to the thickness of the individual yarns comprising it, a symmetrical structure free from unbalanced or distorting stresses, a surface texture comparatively fine, smooth, level and free from ridges; and having wefts in a single plane lying straight in the fabric substantially without undulation. Because of these and other features this type of fabric displays the quality of inherent and recuperative resistance to bending and of maximum resistance to stretching distortions, both warp-wise and weft-wise.

The invention further provides fabrics of relatively great stiffness, comparably with the aggregate stiffness of their component yarns, as against bending or creasing, in whatever direction, of the completed fabric. A fabric of the kind in question is, moreover, characterized by capacity to have like surface textures on each face, the said surface textures being plain or patternless, in which similar dispositions of visible yarn formations recur at microscopic intervals, and without a symmetrical or preferential arrangement from formation to formation in respect to incident light; and capable of having any desired pattern by variation of surface appearances of warp runs on either or both faces. The uniform surface texture usually preferred may be that of the relatively thin fabric known as broadcloth, and much used for shirts, shirtwaists, and other garments for men and women. Since the surface resemblance of this cloth to broadcloth, both in texture and in gauge of its component yarns, when woven of yarns of the kind customarily used for broadcloth, is complete, this fabric is peculiarly suitable for the stiffer parts of garments customarily made of broadcloth, such as neckbands, collars, cuffs, pocket and placket facings, and other finishing edges and attachments. This fabric is also peculiarly useful for collars and cuffs intended to be worn in an unstarched or lightly starched condition, the weave structure of the fabric contributing by density, capacity for resistance to shrinking and stretching, and retentive stiffness of shapes given by cutting or sewing or hot pressing, qualities peculiarly useful in and for such garments.

A principal object of this invention is to provide a fabric and a mode of making it by the single weave system which shall possess the characteristics adverted to above. I have, moreover, provided a method of concatenating the yarns composing the fabric into a fabric characterized by simplicity, by the avoidance of complexity of movement of any system of the yarns in respect to any other system, and the avoidance of delay by repetition of picks without let-off; and therefore rendering it possible to weave the fabric on ordinary types of looms at as high speeds as single fabrics having the same number of picks of weft per linear unit of measure, and at a higher speed than any fabric of which I am aware containing so great a count of aggregate warp and weft per unit area. This naturally results in practice in capacity to make the fabrics at labor costs substantially no greater than in the production of plain-woven or single fabrics of lesser thickness, which do not have the qualities adverted to above or other valuable qualifications for use of the cloth of this invention.

The invention will be described with the aid of the accompanying drawings, in which:

Fig. 1 is a perspective, showing one edge of the fabric in warp-wise or longitudinal cross section, and partly broken away to show the disposition of the straight wefts in the completed fabric;

Fig. 2 is an analytical section in the direction of warps, corresponding to a portion of Fig. 1;

Fig. 3 is a section on the line 3—3 of Fig. 2;

Fig. 4 is a section on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary face view of either face of the fabric showing the surface texture;

Fig. 6 is a weave diagram showing one repeat comprising four ends of warp and four picks of weft and also showing the drawing-in draft; and

Fig. 7 is a diagram of successive cross sections at successive picks covering several lon-

gitudinal and lateral repeats of the weave structure.

Referring now to Fig. 2 the warps $10^a$ and $10^b$ to be interwoven in any square unit area may be provided in excess, for example in the proportion of substantially three to one in relation to the expected picks of weft; for example, the warp may comprise two hundred and forty 48/2's count cotton yarns to each linear inch, and the wefts may comprise eighty 40/2's count yarns to each linear inch; these proportions and yarn sizes are obviously relative, and are intended to be varied in accordance with the desired density, weight, resistance to bending, and other factors of the completed fabric. The warps $10^a$ and $10^b$ may be alike or different, but preferably are alike; all of the warps may be supplied under like tension from a single beam under control of any suitable let-off device.

A preferable relation of the warps to each other and the reed of the loom in which they are to be woven is sufficiently indicated in Figs. 3 and 4, in which the dents of the reed are indicated by dotted lines $d$ indicating that three pairs having members $10^a$ and $10^b$ respectively of warps are included between the same pair of reed dents; if desired, four or more pairs or only two pairs may be carried between a pair of reed dents.

Referring to Fig. 2, the warps $10^a$ are so engaged with the weft as systematically to confine warps $10^a$ to recurrent engagement with recurrent members of the weft series by passage around the weft and return toward the same face of the fabric in a bight embracing this weft. The warps $10^b$ similarly engage the same wefts as the warps $10^a$ in the same recurrent arrangement by passage around the weft from the other face of the fabric. The recurrent picks of weft so engaged by the respective warps $10^a$ and $10^b$ are shown as the even numbered picks 12, 14, 16, 18, 20, 22; etc., of an indefinite series, these wefts being laid by motion of the shuttle, for example, from right to left. Because of their symmetrical relation to the bights passed around them of the warps $10^a$ predominantly shed to one face and of the warps $10^b$ predominantly shed to the other face, it will be convenient to refer to this recurrent system of wefts as key wefts. They lock together mutual pairs respectively containing a warp $10^a$ and warp $10^b$.

It is characteristic of the fabric that the remaining and intervening wefts of the odd numbered series 13, 15, 17, 19, 21, etc., are engaged with, in contact with and surrounded by the warps $10^a$ and the warps $10^b$, but do not engage bights formed by passage around them of any warp. One function of these intervening wefts of the odd numbered series in relation to the warps engaging them is to maintain in tight, fixed and permanent relation to the key wefts the bights of the warps $10^a$ and $10^b$ wrapped around them, and another function is to cause the bends of the warps $10^a$ and $10^b$ into these bights to be sharp and narrow, and so to maintain the surface runs of the warps respectively as nearly in coincidence with the plane of each face of the fabric as possible. These effects are made possible by the balanced stresses in a warp-wise direction put upon the wefts of the even series by beating into the symmetrically shed warps the respective straight wefts of the odd and even numbered series. These relations will be evident from Fig. 2 of the drawing.

One result of the arrangements indicated is that all of the wefts, both odd and even series, lie in a median plane bisecting the distance between the surface planes of the fabric. While I refer to "wefts", it will be understood that odd and even series are the same yarn laid by respective passages of the same shuttle; see Fig. 7.

The recommended mode of interlocking the wefts with the warps for the useful effects above mentioned is evident from the drawings; that warp $10^a$ nearest to the observer in Fig. 2 is so shed by regular motions of the yarn as to pass under the key weft 14 and to pass over the wefts 15, 16, and 17, and again to pass under the weft 18, and so on.

Simultaneously, that warp $10^b$ nearest the observer in Fig. 2 is passed under the weft 14, under the weft 15, over the weft 16, under the wefts 17, 18 and 19, over the weft 20, etc. These two warps are in the same longitudinal plane transverse to the wefts.

Considering now the bights $x$ of the warp $10^a$ nearest the observer, it will be observed that they are in contact with the respective key warps 14, 18, 22; and that the warp $10^b$ nearest the observer being in the same longitudinal plane perpendicular to the general extent of the fabric as said bights $x$, lies upon them.

Therefore, to form the bottom face of the fabric the warps $10^b$ are depressed below the median plane of the cloth in closely-bound and tightly-laid runs having their apices at or near the points $y$.

It will be obvious that the warp $10^a$ similarly presents at the points $y'$, $y'$ exactly similar but symmetrically opposite elevated closely-bound floats at the points where the yarn $10^a$ nearest to the observer overlies the bights $y^2$, $y^2$, formed by the yarn $10^b$ nearest the observer upon passing under the wefts 13, 14, 15, over the weft 16, under the wefts 17, 18, 19, over the weft 20 and under the weft 21, etc.

Let us now consider the relation of that warp $10^b$ which passes under weft 13, over the weft 14, under the weft 15, under the bight $x^2$ of the corresponding warp $10^a$, under the weft 17, over the key weft 18, under the

weft 19, under the bight $x^2$ and weft 20, under the weft 21, etc. It is apparent that this warp $10^b$ is arranged in the fabric precisely as the other warp $10^b$ already considered, except that its engagements are by passing around the respective key wefts 14, 18, 22, systematically displaced from the engagements with the system of key wefts 14, 16, 20 of its adjacent warp $10^b$.

Turning now to the other members $10^a$ of pairs of warps $10^a$ and $10^b$, these as already mentioned have interlocked in the bights $x^2$ with the key wefts 16 and 20. Between these places they lie above the bights of one of the warps $10^b$ at the points $x^3$, $x^3$, $x^3$.

Therefore at the points marked $y$ or $y^3$ the fabric is thick in symmetrical relation to the plane defined by the centres of the wefts in a degree measured on each side of that plane by one-half the thickness of the wefts, the full thickness at the point marked $x$ of the warps $10^a$, and the full thickness at the point marked $y$ of the warps $10^b$. The fabric is thick to the extent of five diameters of its component yarns.

Looking at a fabric in section through the key weft 14. see Fig. 3, and comparing this with Fig. 2, the reason why the runs $y$ underlie the bights $x$ and the reason why the runs $x^3$, $y'$ overlie the bights $y^2$ of the yarns $10^b$ will be clear. The crossing engagements of the legs of the bights $x$ and runs $y'$ with the legs of bights $x^2$ and runs $y^3$ as will be apparent from Fig. 3, provide what amounts in effect to a reed dent or crossed lease in relation to the next pair of yarns of the system. The surface runs of the warps $10^a$ and $10^b$ are therefore obliged to stay on top of the bights taken around the key wefts 14, 16, 18, etc., not having room for lateral movement out of this position.

Referring now to Figs. 6 and 7, it will be observed that the pattern of which one repeat is indicated at R, Fig. 7 repeats every four picks longitudinally and every four warp-ends laterally. On alternate picks the warp pairs $10^a$ and $10^b$ are shed apart for passage of the weft, and in the intervening picks these pairs are shed as units alternately over and under the warp, the second and fourth pick having different pairs up. The surface pattern, Fig. 5, shows warps up over three and under one weft. It will be obvious that the pairs containing warps $10^a$ and $10^b$ respectively are representative of multiple groups of warps alternatively shed as a unit and separated for penetration by a weft or wefts.

When weaving is in a sufficiently massive loom with a heavy beat-up against a let-off functioning well to retain the relatively numerous warps, the condition of balance in the fabric is such as to limit capacity to stretch warp-wise and weft-wise practically equally. This is amply accounted for by the straight-lying wefts, see Figs. 1, 3 and 4, and the limited possibilities of elongation afforded by the key-weft-bound warp system, which can not stretch longitudinally without placing the included bight-and-weft structure under compression between the interlocked runs of the warps lying on the respective faces. If, as in many of the uses for this fabric, warp-wise and weft-wise strains are simultaneously to be resisted, maintenance of the warps in unstretchably interlocked form is aided by the longitudinally tense state of the weft, particularly the key wefts constituting the even-numbered series in Fig. 2.

It will be obvious to those skilled in weaving or the manufacture of clothing, airplanes, rubberized fabrics, bandages and splints, boots and shoes, suspenders, corsets, carpets, pressing cloths, filter-press and dust and fume filtering fabrics; hats, tents, sails and awnings, upholstery fabrics, artificial leather and cloth-covered books, trunks, boxes, bags and receptacles that the herein-described properties of this cloth are available for improvement of the materials of their said and other industries without change except adaptation of gauge and of the kind of component textile cordage adapted to the use in hand.

I claim:

1. Art of weaving thick fabrics of limited extensibility from relatively thin yarns comprising shedding alternate multiple groups of warps together and oppositely in respect to systematically recurrent picks of weft, and opening shed between members of said multiple group of warps for passage of intervening picks of the weft while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

2. Art of weaving thick fabrics of limited extensibility from relatively thin yarns comprising shedding alternate pairs of warps oppositely in respect to systematically recurrent picks of weft, and opening shed between the members of said pairs of warps for passage of intervening picks of the weft while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

3. Art of weaving thick fabrics of limited extensibility from relatively thin yarns comprising shedding alternate multiple groups of warps oppositely in respect to alternate picks of weft, and opening shed between members of said multiple group of warps for passage of intervening picks of the weft while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

4. Art of weaving thick fabrics of limited extensibility from relatively thin yarns comprising shedding alternate pairs of warps oppositely in respect to alternate picks of weft, and opening shed between members of said pairs of warps for passage of the remaining

picks of the weft while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

5. Art of weaving comprising as steps providing a warp containing a relatively great number of yarns in each unit of linear measure laterally of the fabric to be made comparably with the possible number of picks of weft in each such unit of measure longitudinally of the cloth, dividing the warp for shedding in multiple groups, and acting upon each such group of warps at regularly recurrent picks of weft to divide each multiple group for passage of the weft at that pick while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

6. Art of weaving comprising regularly shedding pairs of warps in respect to a median weft plane and in respect to regularly recurrent picks of key weft in said plane, each alternate pair of warps passing beneath and the intervening pairs passing above said recurrent key picks, and causing the members of said pairs to be opened as a shed for passage of weft in said plane at picks alternating with said key picks while holding the members of groups of warps shed together in the same plane to overlie each other transversely of the cloth.

7. Single-ply thick fabric of the unitary or single shed type having great density, relative thickness in proportion to the thickness of the individual yarns comprising it, a symmetrical structure free from unbalanced or distorting stresses, and having in respect to its median plane, in relation to recurrent key wefts and in the direction of its thickness a plurality of key-weft-interlocked bights overlaid by warp runs, said warp runs together constituting the surfaces of the fabric.

8. Single-ply woven fabric having therein wefts in a median plane and surface runs of warps interlocked with wefts at each end, and superposed upon the interlocking bights of similar warps of the other surface.

9. Single-ply thick fabric having in relation to recurrent wefts in the same plane and in the direction of its thickness a plurality of weft-interlocked bights overlaid by warp runs, said warp runs together constituting the surfaces of the fabric.

10. Single-ply thick fabric having wefts, and pairs of warps lying in the same longitudinal plane of the fabric transverse to the wefts, said warps severally having bights surrounding a weft and respectively extending from the direction of opposite faces of the fabric.

11. Single-ply thick fabric having wefts and pairs of warps lying in the same longitudinal plane of the fabric transverse to the wefts, said warps severally having bights surrounding a weft and respectively extending from the direction of opposite faces of the fabric, certain of the wefts intervening between said pairs of warps.

12. Single-ply thick fabric having wefts confined to the median plane of the fabric and pairs of warps lying in the same longitudinal plane of the fabric transverse to the wefts, said warps severally having bights surrounding a weft and respectively extending from the direction of opposite faces of the fabric, said warps penetrating said median plane at recurrent weft intervals.

13. Single-ply thick fabric having wefts confined to the median plane of the fabric and pairs of warps lying in the same longitudinal plane of the fabric transverse to the wefts, said warps severally having bights surrounding a weft and respectively extending from the direction of opposite faces of the fabric, said warps penetrating said median plane at recurrent weft intervals, members of alternate pairs of said warps penetrating said median plane in opposite directions at the spaces between the same pairs of wefts.

14. Single-ply thick fabric characterized by symmetrical warp and weft structure, the wefts being confined to a median plane, the surfaces of the fabric each exhibiting short longitudinal runs of warp superposed on an internal yarn crossing, said runs being in lateral contact and having like points in a parallelogram whose major diagonal lies warp-wise.

15. A single-ply thick fabric having wefts confined to a median plane and warps covering the wefts to form the surface of the fabric, the warps being arranged in pairs with one yarn of each pair superposed over the other, the yarns of each alternate pair passing together consecutively above and below alternate wefts but being separated into individual warps by the intervening wefts, the intervening pairs of warps following the same order but appearing on the reverse face at the said alternate wefts.

Signed by me at Boston, Massachusetts, this 20th day of January, 1926.

HAROLD F. SHERMAN.