

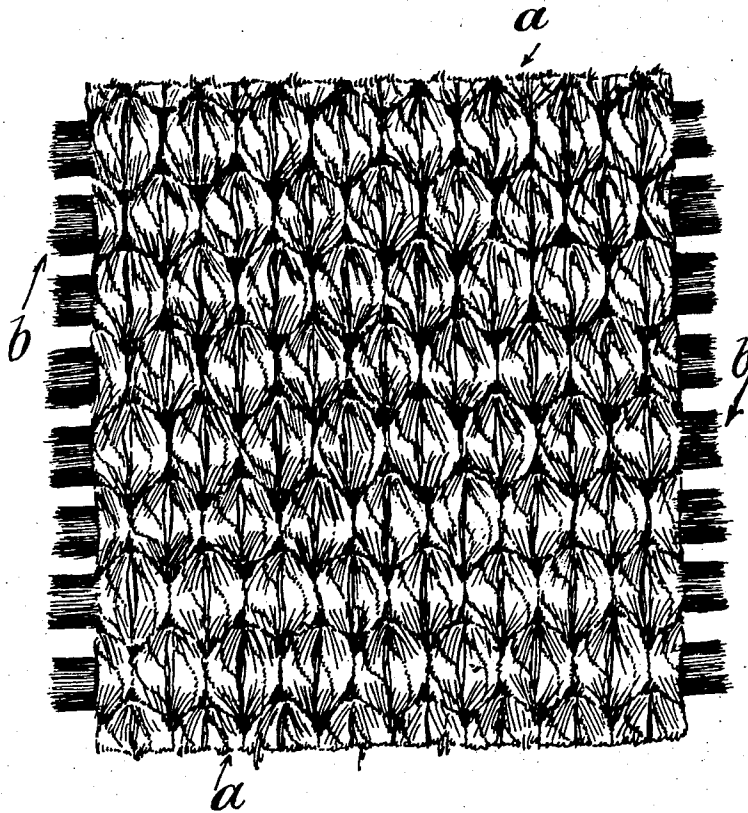
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WOVEN STRUCTURE RESISTANT TO PENETRATION BY WATER UNDER PRESSURE

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## UNITED STATES PATENT OFFICE

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## WOVEN STRUCTURE RESISTANT TO PENETRATION BY WATER UNDER PRESSURE

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The present invention relates to the production of fabrics made wholly or mainly from cotton yarns, and which are intended to substitute or replace water resistant flax fabrics, and which will be substantially equal to this latter in their power to resist penetration by water under pressure. The invention is especially applicable to the production of woven fire hose.

Flax fabrics of the kind named are capable of holding water under pressures, which may be as high as 200 lbs. per square inch, with very little leakage or percolation after the fabric has become saturated. This particular property—characteristic of specially designed flax fabrics—is due mainly to the swelling of the fibres when they are wetted, and in a lesser degree to the low elongation under tension characteristic of flax yarns. As a result, when wetted out under pressure the small interstices of the fabric structure, which is of dense and closely woven texture, are sealed, and when suitably woven the fabric can be made to have negligible leakage or percolation. Such flax fabrics do not depend on the addition of water-resistant filling agents such as rubber linings or the like, which are essential with cotton fabrics of known construction, even of the closest possible texture, in order to make them watertight under pressure.

We have discovered that the differences between the behaviour of flax and cotton in such fabrics does not arise entirely from differences in the essential properties of the two fibres, and that the desirable characteristics of flax yarns can be simulated with cotton yarns.

Under the present invention we produce water pressure resistant fabrics such as, for example, canvas fire hose, either wholly from cotton yarns in both warp and weft, or alternatively with such yarns as warp, in conjunction with weft yarns of flax, ramie or hemp. The fabrics produced according to our invention are so constituted that, on wetting, the interstices between the yarns close up, the fabrics becoming watertight in the same way as do fabrics constructed of flax yarns, and not as with ordinary water-resistant fabrics made from cotton yarns, such as tent canvas or fire hose, in virtue of surface unwetability, or the sealing of the interstices by rubber or other waterproofing agent. Fabrics according to our invention incorporate mercerised cotton yarns having low extensibility, high swelling power and high overall density, and their constituent fibres have a low degree of spirality round the axis of the yarn. The fabrics have their constituent yarns very closely set, leaving small interstices which are rapidly sealed by the swelling of the fibres. In the weaving we may

adopt the known device of running two or more warp yarns as one. The fabrics according to our invention have a high overall density.

It will be understood that all these special properties (which we obtain by means to be hereinafter specified) contribute to the water-resistant quality of the fabric. Mercerisation gives rise to rapid wetting. High swelling power helps to seal the interstices efficiently. High overall density or low overall specific volume means that the space to be filled by the swelling is relatively small. A low degree of spirality of the fibres minimises the inhibiting effect of twist on the swelling, leaving the fibres as free as possible to swell into the available space. The low extensibility of the yarn prevents any opening up of the structure when it is subjected to tension, such as is caused by the internal pressure of water in a fire hose. Close setting in weaving is facilitated by the soft yet compact structure of the yarns, and by the known method of running of two or more ends as one in the weaving.

The mercerisation of the cotton yarns is an essential means for producing yarns with the desired properties. This may be carried out on the yarn in the single or folded state or both, and care must be taken that the tension to which the yarn is finally subjected is such as to yield a length substantially equal to or even greater than the original length. During the carrying out of the process of mercerisation the yarn may either be allowed to shrink initially or may be prevented from shrinking. Furthermore in addition to the customary method of setting the stretched yarn by simply washing out the mercerising agent the yarn may also be dried under tension at an elevated temperature with the object of reducing still further the extensibility of the yarn. Our treatment may if desired include impregnation following mercerization of the warp yarn with a water-soluble adhesive or pure size. The main objective of such impregnation by adhesive or pure size is to improve the weaving qualities of the warp yarn under the high tension necessarily employed in weaving the dense texture required to produce a fabric which is watertight under pressure.

We also propose to treat the yarn following mercerization, and/or woven fabric, by impregnation with a mould inhibiting agent in order to render the material less susceptible to deterioration due to mildew growth.

Our preferred method of obtaining yarns whose fibres have low spirality is to employ a high grade long staple Egyptian cotton, spinning the singles yarn with a lower twist than customary and in subsequent folding or cabling operations

using reversed twist also less than normal, so that the spirality in the final yarn is not pronounced, the fibres thus being enable to swell freely on being wetted and so more readily seal up the interstices of the fabric.

For less stringent requirements, we may however, use a lower grade of cotton.

Our preferred form of weave is illustrated in the drawing attached hereto. It consists of plain weave, in which two threads of warp *a* run as one, and in which the warp threads *a* are relatively more crowded than the weft threads *b*. This is a well known weave for which no novelty is claimed and is one adapted for obtaining the type of fabric according to our invention, namely one in which on wetting, the fibres swell to form an impervious structure.

As one practical illustration and example of the way in which our invention may be carried into effect, we employ Egyptian cotton such as Giza 12 with a staple of  $1\frac{1}{4}$ " or more, in a singles count of, for example  $6\frac{1}{2}$ 's. This yarn in spinning is advantageously twisted to a factor (turns per inch divided by square root of counts) of approximately 2.5 and the singles folded or doubled with a reverse twist to a factor of approximately 3.0. The yarns are stretch mercerised in the singles state or as folded or cabled yarn, or as both.

At a proper stage it may be arranged to scour the material to remove the bulk of the non-cellulosic matter which tends to encourage mildew growth, and also preferably to remove the surface wax by which wetting of the fibres is retarded. In this practical example of our invention the warp would be of, for example  $4/6\frac{1}{2}$ 's, the warp ends advantageously running in pairs, and the weft of 16 fold for example  $6\frac{1}{2}$ 's which may be folded in a single throw or be cabled e. g.  $4/4/6\frac{1}{2}$ 's, the twists being preferably so combined that the low spirality of the fibres in the soft spun singles yarn is further diminished by the reversal of twist on folding.

With the above materials a fabric structure of for example 62 warp threads per inch and with, for example 12 picks of weft per inch produces when woven at suitable tension a cotton hose which will resist the pressures normally met with in the operation of fire engine pumps with quite a moderate degree of percolation or leakage—an achievement hitherto quite impossible with cotton yarns. In the weaving we should preferably adopt the known form of "double-plain" cloth design, yielding a tubular fabric; and we should impose a tension as high as practicable in accordance with current practice on the warp during weaving.

As an alternative we may employ warp yarn as described above in conjunction with weft yarn of flax or ramie, or hemp, of suitable count and fold, such as, for example 24 Lea 18 to 24 fold, with equally good results.

Fire hose prepared from the fibrous materials treated and acted upon and woven as above outlined is a highly desirable production and particularly is this so having regard to the present shortage of flax.

We may use along with the herein described cotton warps a proportion of flax, ramie or hemp warps, that is, both cotton yarns (treated and prepared as described) and flax, ramie or hemp warps in the weaving of the hose or the like.

To demonstrate how fabrics made according to our invention correspond in structure to water

resistant flax fabrics, we have examined a number of fabrics of both these kinds and also a number of cotton fabrics which have been constructed by known method with the object of obtaining a close impervious structure. We have selected for comparison fabrics of as nearly as possible the same weight per unit area. We have measured the overall specific volume by displacement of mercury and as a measure of closeness of set we have taken the threads per inch divided by the square root of the counts for both warp and weft, a quantity we term the "cover factor"; and in all cases we found that cotton fabrics made according to our invention approximated very closely to flax fabrics. For example a sample of flax canvas weighing 28.8 oz. per sq. yard had an overall specific volume of 1.12 ccs. per gram and the cover factors were 31.6 for warp and 18.9 for weft. For a cotton canvas constructed according to our invention weighing 29.2 oz. per sq. yard the corresponding figures were 1.11, 32.4 and 19.1. A high quality of ordinary cotton duck, weighing 28.8 oz. per sq. yard gave the respective values 1.38, 24.2 and 17.1, and this was typical of the best existing practice. The differences between the fabrics become more evident if one subtracts the specific volume of the fibre (0.65) from the overall specific volumes, when it is seen that the ordinary cotton duck has 0.73 cc. of air space per gram of cloth as against 0.46 and 0.47 for the other two fabrics.

When our invention is applied to the construction of fire hose, a similar equality with flax fabrics is maintained. In this range there is no comparable ordinary cotton fabric since no one has hitherto succeeded in constructing a sufficiently resistant cotton fabric. A flax fire hose weighing 49 oz. per sq. yard gave the three values 1.00, 50, and 17.6 and another, weighing 47 oz. per sq. yard gave 1.03, 51 and 18.7. A cotton fire hose made according to our invention, weighing 53 oz. per sq. yard gave 1.06, 48 and 19.5 and another weighing 52 oz. per sq. yard gave 1.03, 49 and 19.7.

We declare that what we claim is:

1. A water resistant fabric made from long staple cotton using a singles count of  $6\frac{1}{2}$  with twist factor 2.5, the singles doubled with a reverse twist of factor 3.0, the yarns mercerised to regain more than the original length and impregnated with a mould inhibiting agent, the warp being of four fold, the yarn running in pairs in the weaving, the weft being 16 fold cabled  $4/4/6\frac{1}{2}$  with cabling twist reverse to the doubling twist, the fabric being woven with 62 warp ends per inch and 12 picks of weft per inch.

2. A water resistant fabric according to claim 1 but having the weft yarns 16 fold in single throw.

3. A water resistant fabric according to claim 1 but using singles count differing from  $6\frac{1}{2}$ , the warp ends per inch and picks per inch varying substantially in proportion to the square root of the counts in accordance with known practice.

4. A water resistant fabric according to claim 1 but having the weft yarns 16 fold in single throw and using singles count differing from  $6\frac{1}{2}$ , the warp ends per inch and picks per inch varying substantially in proportion to the square root of the counts in accordance with known practice.

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