Aug. 25, 1953 M. MAYER, JR., ET AL. 2,649,864

ATTACHMENT FOR WEAVING HIGH DENSITY FABRICS

Filed April 24, 1951 3 Sheets-Sheet 1

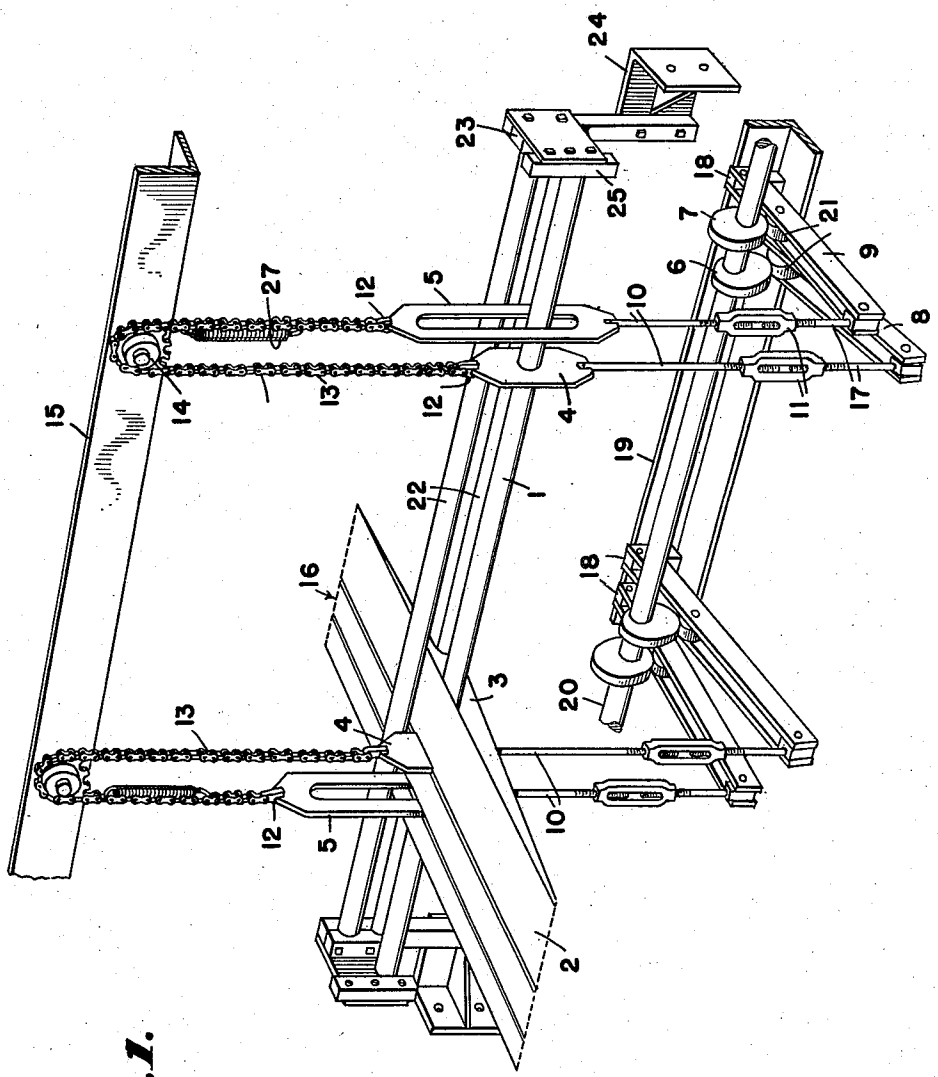


Fig. 1.

INVENTORS
M. MAYER JR.
G. J. KYAME

BY L. M. Mantes
ATTORNEY

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Fig. 2a

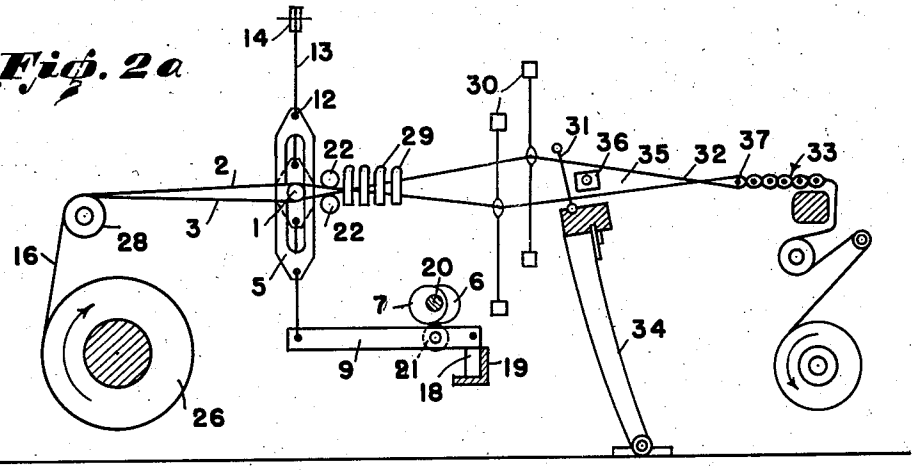


Fig. 2b

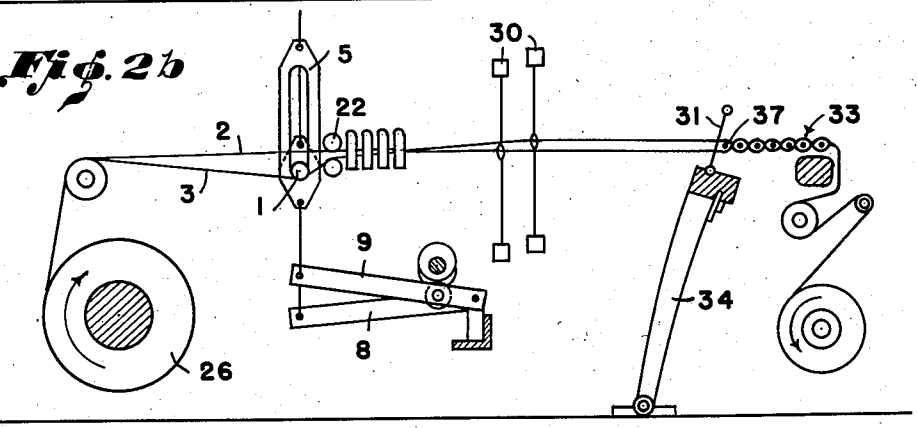
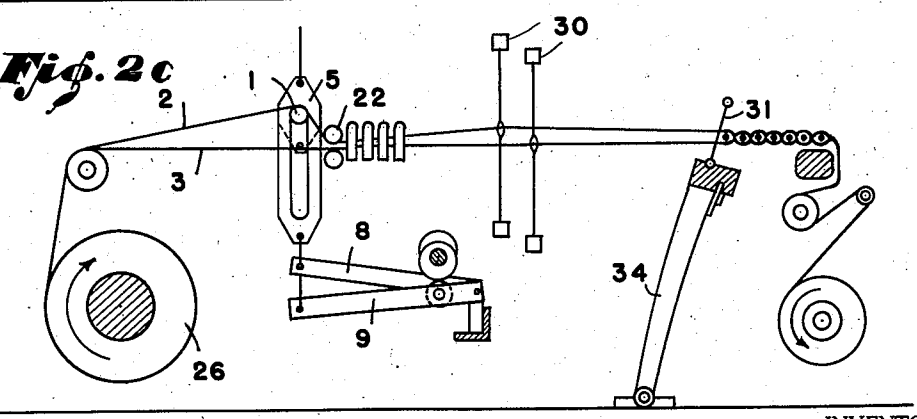


Fig. 2c



INVENTORS
M.MAYER JR.
G.J.KYAME

BY L. M. Mantell

ATTORNEY

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Fig. 3.

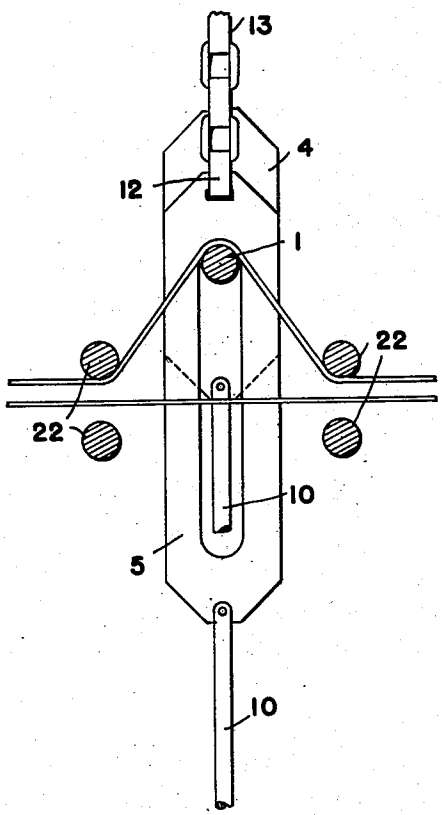
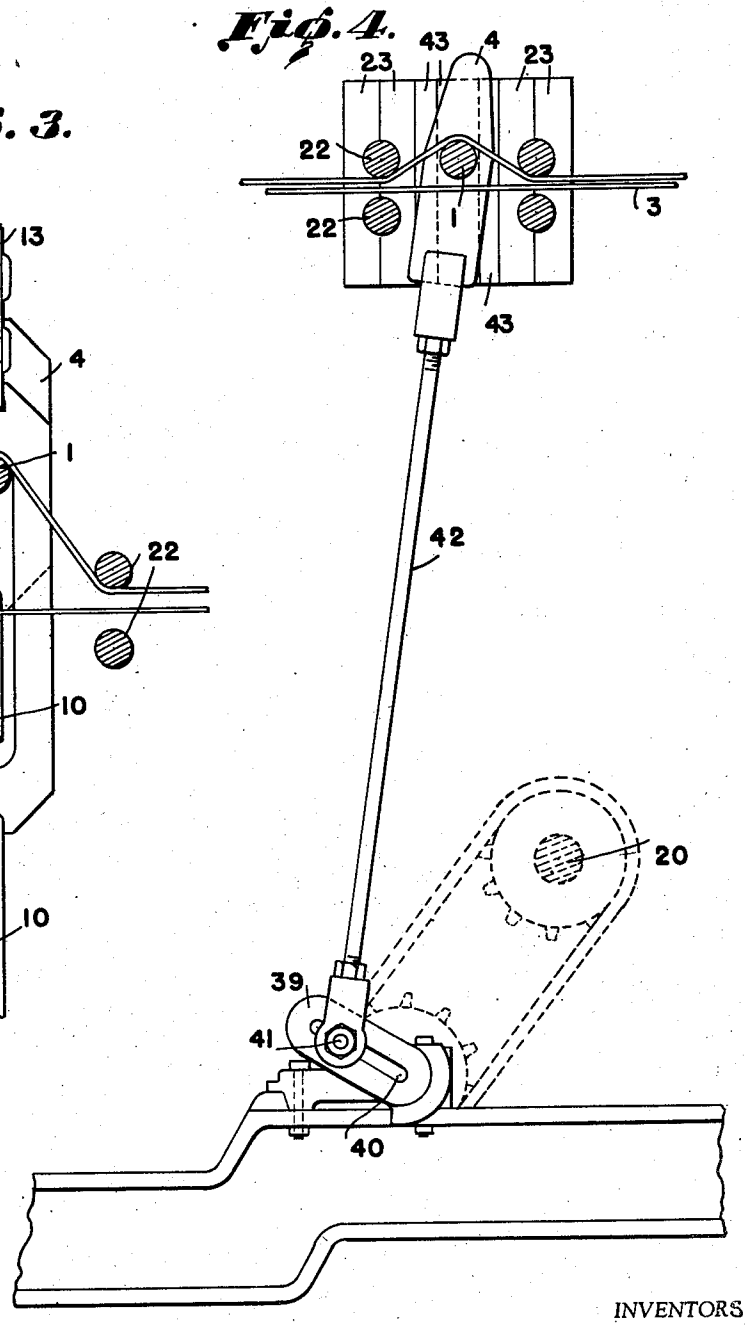


Fig. 4.



INVENTORS
M. MAYER JR.
G. J. KYAME

BY L. M. Mantell

ATTORNEY

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ATTACHMENT FOR WEAVING HIGH DENSITY FABRICS

Mayer Mayer, Jr., and George J. Kyame, New Orleans, La., assignors to the United States of America as represented by the Secretary of Agriculture

Application April 24, 1951, Serial No. 222,726

4 Claims. (Cl. 139—97)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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The invention herein described may be manufactured and used by or for the Government of the United States of America for governmental purposes throughout the world without the payment to us of any royalty thereon.

This invention relates to weaving. More particularly it provides a new method of weaving which produces fabrics having a smoother look and feel than those produced by the processes of weaving heretofore known. The new method is capable of producing denser fabrics than can be produced by the processes of weaving heretofore employed. In addition, the invention provides an apparatus which is capable of mechanically weaving by the new method, and which is suitable for mounting upon any loom.

It is old in the loom art to produce special effects in cloth by applying variable tensions to the warp yarns during weaving. For example, a "cover" may be produced on the cloth if the warp yarns forming one of the shed layers are given a greater tension than the remaining yarns as the lay beats up. The means heretofore used for obtaining the added tension in the warp yarns are varied. Frequently the tension is obtained, to a certain extent, by raising the whip roll and the sand roll or breast beam, but these methods are not always satisfactory or practical. For over twenty years it has been known that "cover" could be obtained by attaching to a loom an apparatus embodying a bar extending transversely across the warp strands, close to the shed harnesses, which bar deflected from their normal approach to the shed harnesses the warp strands, at the time they are pulled into shed layers by the harnesses. However, while by such means, for certain weave patterns, all of the warp strands are, in the consecutive deflecting motions of the bar, deflected by the bar; different additional tension is applied to part of the warp strands to which additional tension is applied. For example, since the shed harnesses are arranged in banks and some banks are closer to the deflecting bar the warp strands running through the closest banks of the shed harnesses receive the greatest additional tension for a given distance of deflection.

In the above and other means heretofore used for applying variable tension to the warp yarns during the weaving, the resultant fabrics occasionally had a greater density than would have been obtained in the absence of the application of the additional tension. However, the majority of the fabrics so produced were characterized by their lack of uniformity which was the purpose for which the tension was varied. In addition,

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the increase in fabric density was slight because the occasional variation in the tension resulted only in an occasional closer packing of the threads into the fell.

We have found that if during the process of weaving, the warp strands are divided into two groups each of which contain half of the total number of strands as well as half of the strands passing through each two consecutive dents in the reed, and an additional tension is intermittently applied substantially uniformly upon all of the strands in one group and then upon all of the strands in the other group, with additional tension being applied at the moment of extreme beatup and at least partially released between beats, and with the additional tension being applied so that the warp strands approach the shed harnesses without substantial deviation from the normal warp line; the fabrics produced are unobviously and advantageously different from fabrics of the same composition produced by the same loom without such a synchronized uniform application of intermittent additional tension.

In contrast to the fabrics produced by the application of variable tensions during weaving, as heretofore practiced; the fabrics produced by the synchronized uniform application of intermittent additional tension (i. e. produced as described in the preceding paragraph) have a smoother look and feel than do fabrics of the same composition woven by the methods heretofore known.

In addition, the density of fabrics woven with a synchronized uniform application of intermittent additional tension is not solely dependent upon the mechanical limitations of the weaving equipment (as is the case in the methods of weaving heretofore employed), but is governed substantially completely by the physical characteristics of the yarn and cloth construction. Particularly when the maximum application of additional tension is synchronized to occur at the instant of extreme beatup; fabrics of abnormally high density can be produced. Such fabrics without chemical treatment or coatings of any kind, are highly resistant to penetration by liquids or gases.

Among the objects of the present invention is the provision of an apparatus which can be attached to any loom, and when so attached, is capable of accomplishing the synchronized uniform application of intermittent additional tension.

Other objects and advantages of the present invention will be apparent to those skilled in the

art from the following description, illustrations, and examples of embodiments of the invention.

Fig. 1 is an oblique view showing the components of the attachment and their location relative to each other and to the loom.

Figures 2*a*, 2*b* and 2*c* are general schematic views of the attachment in the neutral position and in two successive beatup positions.

Fig. 3 is a schematic view showing how the stroke of the warp tensioning member can be reduced.

Fig. 4 is a plan view showing another means for actuating the warp tensioning member.

In the preferred embodiment, Fig. 1, a push bar 1, preferably one having rounded top and bottom edges, separates warp 16 into two layers, 2 and 3, respectively. Each of the layers contains half of the total number of warp strands and half of the strands passing through any two consecutive dents in the reed. A loading member such as loading bar 4, which is a smooth flat plate having a centrally located aperture, which is preferably one which closely fits the push bar and restricts its vertical motion, yet permits free passage of said push bar therethrough, is fitted on push bar 1. The overall length of plate 4 is preferably such that it extends as far above and below the push bar as is necessary to prevent linking members, such as 12, from contacting the warp, i. e. layers 2 or 3. A slotted member, such as slotted bar 5 is fitted around push bar 1. Member 5 is a smooth flat plate which is slotted to receive push bar 1. The overall length of the slot is at least twice the total vertical distance traversed by the push bar plus the vertical dimension of the bar. The lower ends of said members 4 and 5 terminate in adjustable connecting members, such as threaded connecting rods 10 which screw into one end of turnbuckles 11, while the upper ends terminate in connecting members, such as chain connecting links 12. Flexible members, such as chains 13 supported from idler sprockets 14 which are rotatably attached to superstructure 15, are connected to links 12 thereby positively linking members 4 and 5 to each other. Attached to the lower ends of turnbuckles 11 are connecting rods 17 which, in turn, are pivotally attached to one end of actuating members, such as levers 8 and 9. The other ends of said levers are pivotally attached to supports such as 18 which are fitted to a support mount such as 19. Cams 6 and 7 are rigidly mounted on the loom camshaft 20 and make contact with cam follower rolls 21 on levers 8 and 9, to transmit power from said camshaft to said levers. Spaced compensator bars 22 are clamped in clamps 23 supported by brackets 24. Mounted on clamps 23 are push bar guides 25 which limit the lateral movement of push bar 1.

The loom is preferably powered by a single motor in the conventional manner, and in such an embodiment, camshaft 20, shuttle harnesses 30 and lay sword 34 move synchronously and the relative time of occurrence of their various functional motions is adjustable in the conventional manner. In a particularly preferred embodiment of the present invention the harnesses are adjusted to form a closed shed at the moment of extreme beatup of lay sword 34 and cams 6 and 7 are positioned so that push bar 1 applies the maximum additional tension to one shed layer at the same moment, and applies such tension to the other shed layer at the instant the reed is in the extreme beatup position on the next stroke of the lay sword.

In placing the attachment on a loom, a particularly suitable arrangement is one which will permit loading push bar 1 (via load members 4) to be at, or as near as possible to, the so-called "quarter points," i. e. one quarter the distance from each end of said bar.

As shown in Fig. 2*a*, warp 16 is threaded through the loom in the conventional manner: from the warp beam 26 over whip roll 28, through drop wires 29, harnesses 30, and reed 31 to the fell 32 of the woven fabric 33. The presence of the attachment on the loom does not in any way interfere with the threading up operation since it is so designed that those parts which would interfere can be readily dismantled and reassembled after the warp is in place. Thus, with the warp in place, compensator bars 22 are clamped in position, one over and one under the warp, and loading members 4 and 5 are brought up through the warp in line with chains 13, and connected thereto through links 12. Warp 16 is then separated into two sheets to form shed layers 2 and 3 in the immediate vicinity of the aforementioned members 4 and 5. Push bar 1 is inserted between said shed layers and through members 4 and 5. Guides 25 are then installed.

It is essential that one half of the warp strands passing through any two adjacent dents of the reed be put in the same layer of warp strands passing above or below push bar 1. All of the strands passing through a given dent may be in the same layer, thus, the groups in alternate dents of reed 31 will all be in the same shed layer and will subsequently be on the same side of the push bar. A particularly preferred arrangement for the weaving of an oxfold or plain fabric is to have half of the strands passing through each dent in the reed in the same layer above or below push bar 1.

Cams 6 and 7 are preferably set 180° out of phase with each other, and are adjusted so that push bar 1 reaches its extreme position, either upward or downward, when loom lay sword 34 is at its extreme forward or beatup position. Although the cams shown are circular and rotate eccentrically, they need not be so limited. Other cam shapes can be used provided they impart to said push bar one upward and one downward stroke with each revolution of loom camshaft 20.

In Fig. 2*a*, the cams 6, 7, and levers 8, 9, are shown in the neutral position, in which case, push bar 1 preferably exerts no pressure on either shed layer 2 or 3. Lay sword 34 is in its rearmost position and harnesses 30 have formed a shed 35 through which shuttle 36 is traveling to insert weft thread 37. As the loom operates, lay sword 34 advances causing reed 31 to push weft 37 toward fell 32 of fabric 33. Meanwhile, cams 6 are pushing levers 8 downward causing push bar 1 to exert pressure on shed layer 3 thereby placing the warp strands in said shed layer under extreme tension.

At this time shed layer 2 is preferably completely relaxed as shown in Fig. 2*b*. As lay sword 34 reaches its forwardmost position, reed 31 beats weft 37 into fabric 33. Weft 37 thus forces the slackened warp strands in shed layer 2 over or under the previously picked weft thread. As the loom operation continues, lay sword 34 retracts, cams 7 push down on levers 9 which, through the depending action of loading members 5 and chains 13, return push bar 1 to its neutral position. Harnesses 30 form a reversed shed 35 and shuttle 36 returns therethrough to insert another pick (weft 37).

As lever 9 continues downward it preferably

causes push bar 1 to leave shed layer 3 and produce tension in shed layer 2 as shown in Fig. 2c. The tightening of said shed layer draws the previously mentioned overriding or underriding weft thread into the plane of the fabric, while the new weft 37 forces warp strands from shed 3 over or under the pick just described. Lay sword 34 again retracts, lever 8 moves downward pulling push bar 1 to its neutral position, harnesses 30 form a normal shed, and the above described cycle is ready to repeat.

Compensator bars 22 are placed in close proximity to drop wires 29 and prevent any substantial movement of the warp out of the plane of the normal warp line. Another important function of said compensator bars is to reduce the amount of vertical movement of push bar 1 required to develop a given amount of tension in the warp shed layers. Thus, while not always necessary, it is desirable to have a second pair of such compensators on the opposite side of the push bar; this arrangement is shown in Fig. 3.

The amount of stroke of push bar 1 required for weaving a high density fabric is dependent on the physical characteristics of the yarn used and on the fabric construction. Turnbuckles 11 allow the regulation of said stroke by controlling the amount of slack in chain linkage 13, thus permitting the utilization of the total throw of cams 6 and 7, or any fractional part thereof. Springs 27 take up the slack in chains 13 thereby maintaining the vertical alignment of loading members 4 and 5 and preventing warp damage which would otherwise occur if load members 4 and 5 are free to slip around.

The invention is not limited to the particular apparatus described above. For example, load members 4 and associated cams, levers, etc. may be positioned so as to apply load to push bar 1 at its extremities or any other intermediate points without deviating from the spirit of the invention. The same may be said for slotted member 5. A further variation would consist in making such arrangements as to cause slotted member 5 to function outside the confines of warp 16, in which case said load member would be omitted and chain 13 would be extended to join corresponding connecting rod 10.

Another modification of the invention is shown in Fig. 4. In this arrangement cranks 39, fixed to the ends of jackshaft 40 are driven from loom camshaft 20 through suitable driving means such as a gear train, chain and sprocket drive, etc. Crankpins 41, adjustably mounted on cranks 39, actuate connecting rods 42 which terminate in load members 4. The vertical component of the rotary motion of crankpins 41 is transmitted by connecting rods 42 to load members 4 and hence to push bar 1. Guides 43, similar to guides 25 in the preferred embodiment, restrict push bar 1 to vertical motion only.

Tests have proven that our invention utilizes to the fullest extent the compressibility of the yarn. For example, in the case of the first fabric listed in Table I below, attempts were made to put in more than 72 picks per inch with the attachment providing synchronized uniform application of intermittent additional tension, i. e., to put in 76 and 78 picks. But in each case, pick counts made on the fabrics after weaving revealed that they contained, as recorded, not more than 72 picks per inch. This indicates that the limit of compressibility of the yarn was reached at 72 picks per inch. Without said attachment on the loom it was found that with gears for the production of more than 56 picks per inch, the operation resulted in an abnormal number of end breaks, thus in impractical operation.

Data so obtained for typical fabric constructions are given in the following table; the yarns used were cotton yarns and were woven into an Oxford pattern. In the weavings conducted in accordance with the process of the invention the two groups containing half the total warp strands also contained half of the warp strands passing through each dent in the reed, the maximum additional tension was applied and the harnesses formed a closed shed, at the instant of extreme beatup.

Table I

Warp yarn	Ends per inch	Weft yarn	Maximum picks per in. obtainable		
			Without attachment	With attachment	Percent increase
34s/2 ply	124	22s/2 ply	56	72	28.6
15s/5 ply	49	15s/3 ply	26	36	38.5
30s/2 ply	124	30s/2 ply	56	72	28.6

The high density fabrics woven by the process of our invention are extremely resistant to penetration by liquids or gases as may be seen in Table II, which gives data for the permeabilities of the above fabrics having the maximum density weavable with and without the use of our invention.

Table II

Fabric No.	Invention used	State	Thread count: Warp, Threads	Thread count: Filling, per in.	Weight, oz./sq. yd.	Thickness, In.	Air permeability,[1] Min.	Water permeability,[2] Ml.
1	No	Gray	124	56	9.26	.0184	9.05	1,146
	Yes	do	124	72	10.16	.0171	32.82	15.9
	No	Finished	128	56	9.37	.0171	9.70	1,845
	Yes	do	130	70	10.20	.0164	28.07	108
2	No	Gray	124	53	9.00	.0181	11.43	249
	Yes	do	126	68	10.34	.0173	42.35	4.2
	No	Finished	128	53	9.05	.0162	10.47	1,965
	Yes	do	130	67	10.24	.0161	30.28	103
3	No	Gray	122	53.5	9.03	.0175	10.80	265
	Yes	do	122	70.6	10.47	.0168	58.50	0.14
	No	Finished	124	53	8.86	.0164	8.45	1,391
	Yes	do	122	71	10.34	.0159	32.47	8.5

[1] Time required for 300 cc. of air under constant pressure to pass through an orifice covered with the fabric.

[2] Volume of water leaking through an 8 x 8 inch fabric sample subjected to the hydrostatic pressure of a water column of constant height for 5 minutes.

A plain weave cotton fabric composed of warp yarn of 36^s/2 and weft yarn of 18^s/2 was woven with 64 picks per inch in accordance with the process of the invention in the same manner as the above fabrics. The fabric was subjected to the ASTM drop penetration test (the amount of leakage, in 3 hours, through a fabric mounted on a 45° angle under a constant stream of water from a shower head 8 ft. above the fabric), leakages of 8 ccs. and 0 cc. were observed in tests of the untreated fabric. Under the ASTM Suter hydrostatic head test, a head of 74.7 cm. was required to cause the first three drops to form on the opposite side of the fabric.

The above fabric was mildew proofed in the conventional manner (causing its hydrostatic head test to increase to 76.5 cm.) and was exposed for two months to the semi-tropical weather in the vicinity of New Orleans, La. When the exposed fabric was again subjected to the ASTM Suter hydrostatic head test, a head of 91.3 cm. was required to cause the first three drops to appear. The ASTM drop penetration test resulted in no penetration. The impermeability properties of the fabric had markedly improved upon weathering.

Having thus described our invention, we claim:

1. In a loom having a warp beam, whip roll, drop wires, shuttle harnesses, shuttle lay sword and reed provided with dents, and a loom camshaft for operating movable parts, the apparatus comprising: a horizontal push bar slidably mounted so that it is free to move in a vertical direction, but not in a horizontal direction, and positioned behind the drop wires so that it divides the warp strands into two groups each containing half of the total number of strands and half of the strands passing through each consecutive two dents in the reed; two elongated flat loading bars centrally pierced to receive and hold said push bar, so that the push bar is free to move horizontally but not vertically with respect to the loading bars, positioned with their width parallel to the warp strands and extending above and below said strands further than said loading bars move; a chain passing from each of said load bars over an idler sprocket mounted on a loom superstructure to an elongated slotted flat bar positioned with its width paralleling the fiber strands and slotted to accommodate the travel of the push bar; cam actuated levers pivotally attached to the said loading and slotted bars through adjustable rigid connecting members and mounted below the loom cam shaft; cams rigidly attached to the loom camshaft positioned to lower one of said levers the same distance the other is allowed to rise; and horizontal guide bars rigidly mounted above and below the warp strands in both of the aforesaid groups and mounted between the said push bar and the drop wires so that all of the warp strands are held substantially in the plane of the normal warp line.

2. In a loom having the standard loom parts comprising whip roll, shuttle harnesses, lay sword and reed provided with dents, the apparatus which comprises: a vertically movable horizontal push bar dividing the warp strands into two groups each containing half of the total number of strands and half of the strands passing through every two consecutive dents in the reed; a cam driven push bar actuating mechanism arranged to raise and lower the push bar so that the warp strands passing above and below the push bar are respectively deflected as the reed reaches each extreme beatup position; and two horizontal bars rigidly mounted transversely above and below the warp strands and positioned between the push bar and the drop wires so that the deflection imparted to the warp strands does not deflect the strands from the plane of the normal warp line as they pass forward along the loom.

3. The apparatus of claim 2 with the cam driven push bar actuating mechanism synchronized with the loom functions so that the push bar reaches its maximum vertical travel and the harnesses position the shed layers substantially in parallel at the instant of extreme beatup.

4. The apparatus of claim 2 in which two horizontal bars rigidly mounted transversely above and below the warp strands are positioned between the push bar and the whip roll in addition to the two horizontal bars positioned between the push bar and drop wires.

MAYER MAYER, JR.
GEORGE J. KYAME.

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