Nov. 21, 1961 R. J. JACKSON ET AL 3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Filed March 16, 1959 6 Sheets-Sheet 1

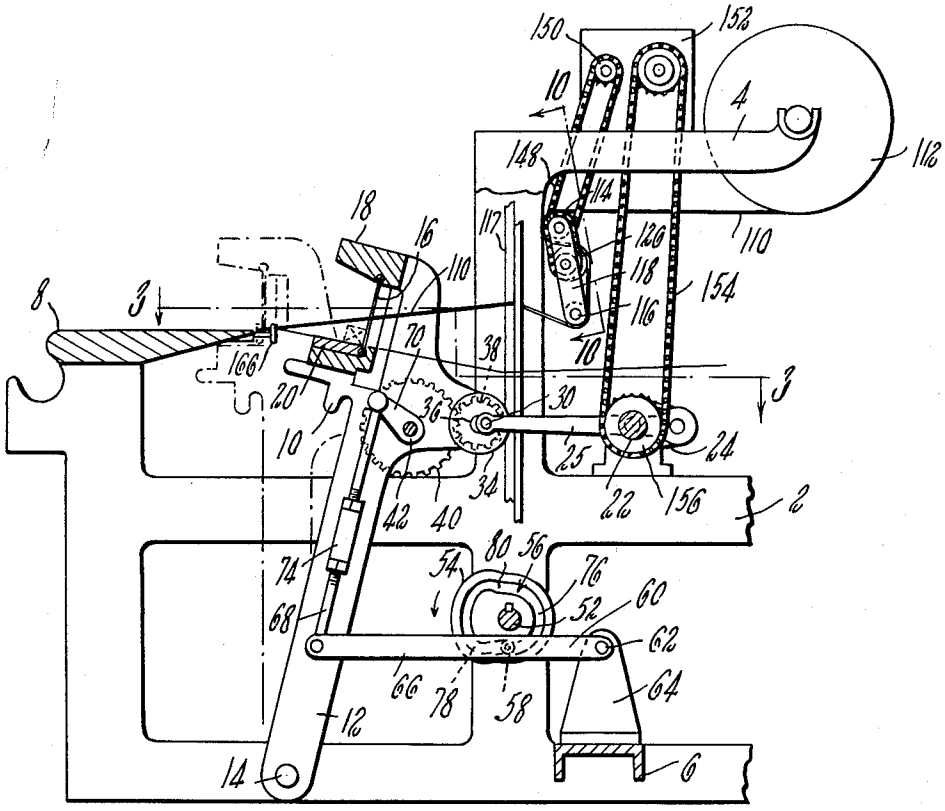


Fig. 1.

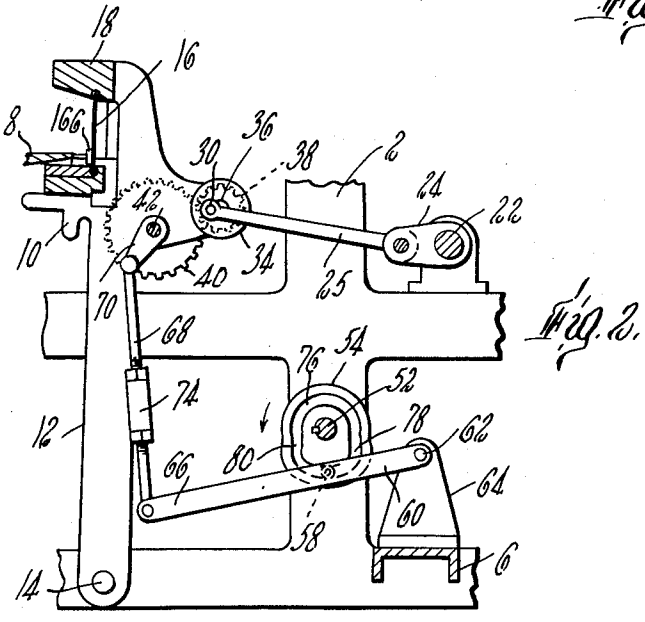


Fig. 2.

Nov. 21, 1961 R. J. JACKSON ET AL 3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Filed March 16, 1959 6 Sheets-Sheet 2

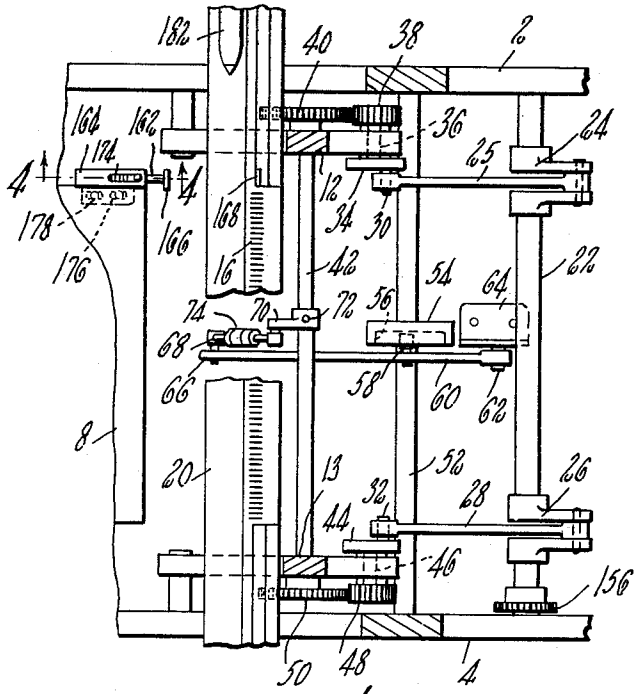


Fig. 3.

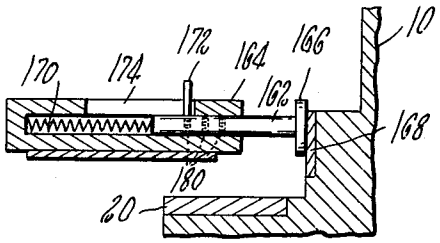


Fig. 4.

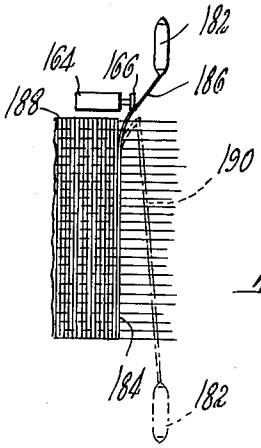


Fig. 5.

Nov. 21, 1961 R. J. JACKSON ET AL 3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Filed March 16, 1959 6 Sheets-Sheet 3

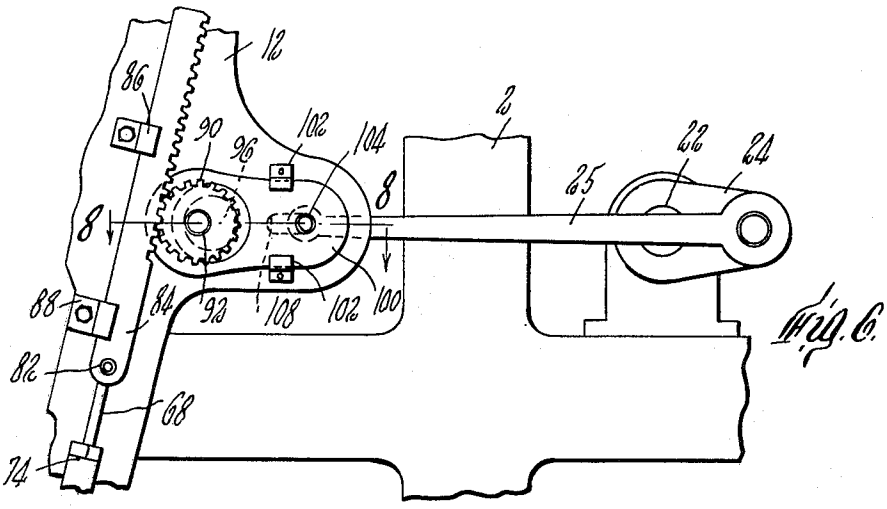


Fig. 6.

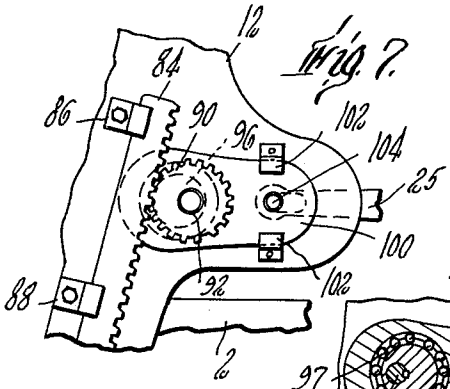


Fig. 7.

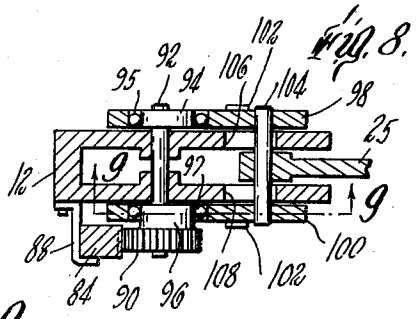


Fig. 8.

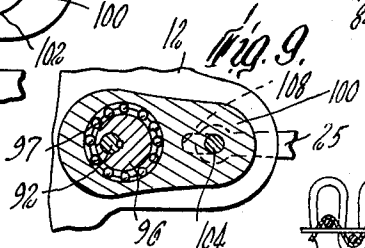


Fig. 9.

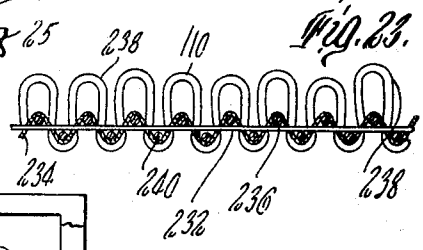


Fig. 23.

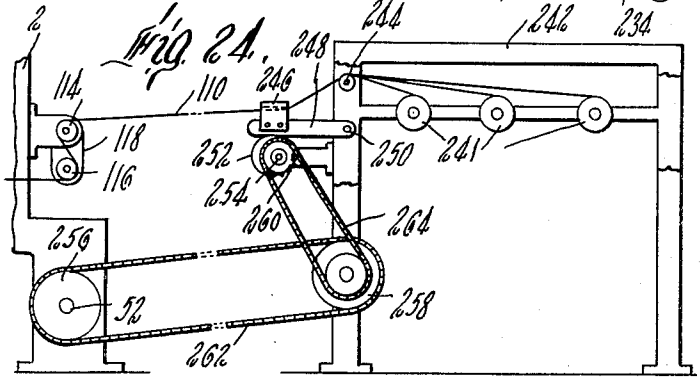


Fig. 24.

Nov. 21, 1961 R. J. JACKSON ET AL 3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Filed March 16, 1959 6 Sheets-Sheet 4

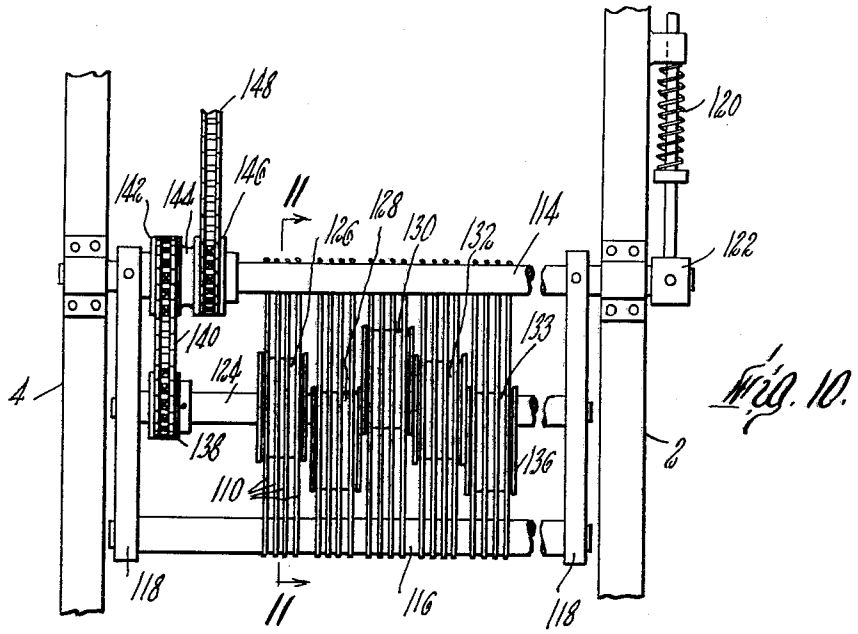


Fig. 10.

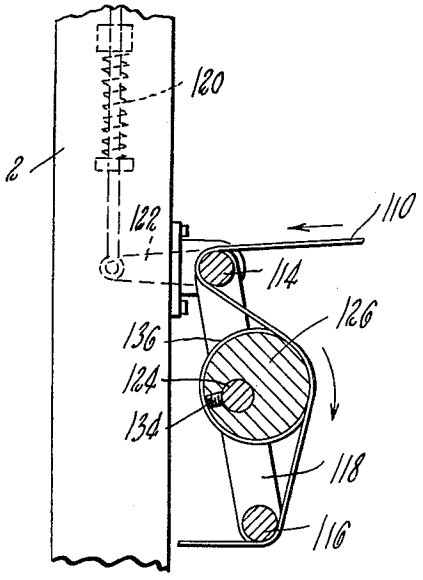


Fig. 11.

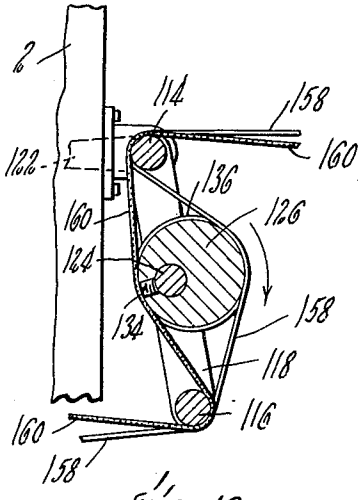


Fig. 12.

Nov. 21, 1961 R. J. JACKSON ET AL 3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Filed March 16, 1959 6 Sheets-Sheet 5

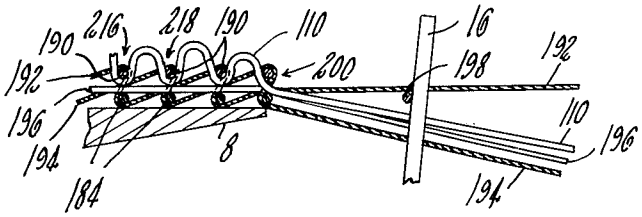


Fig. 13.

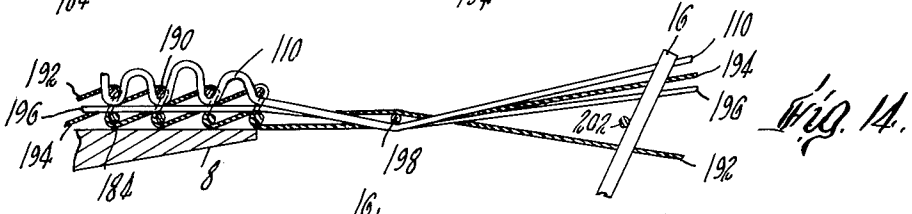


Fig. 14.

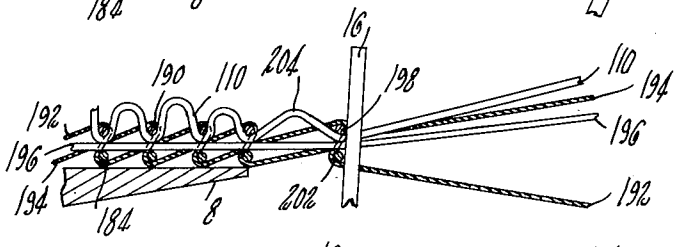


Fig. 15.

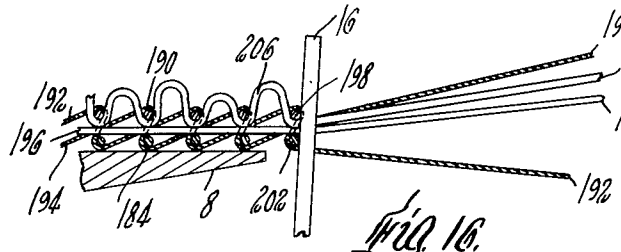


Fig. 16.

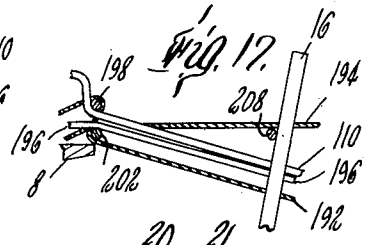


Fig. 17.

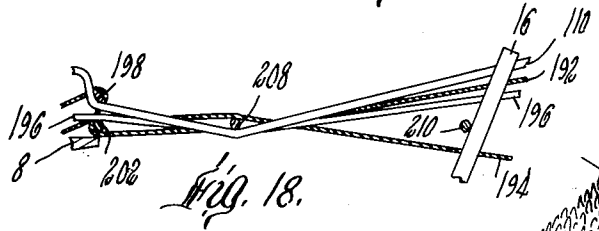


Fig. 18.

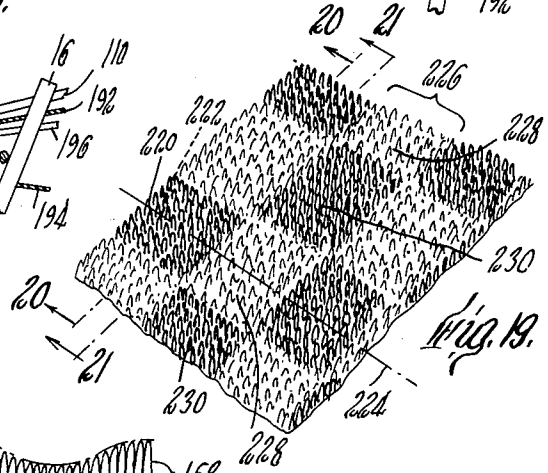


Fig. 19.

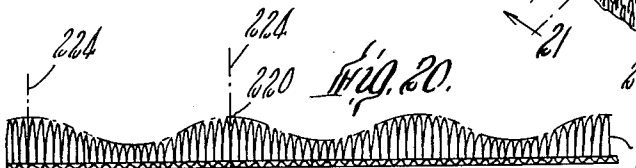


Fig. 20.

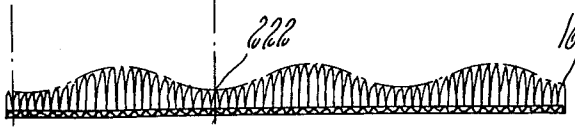


Fig. 21.

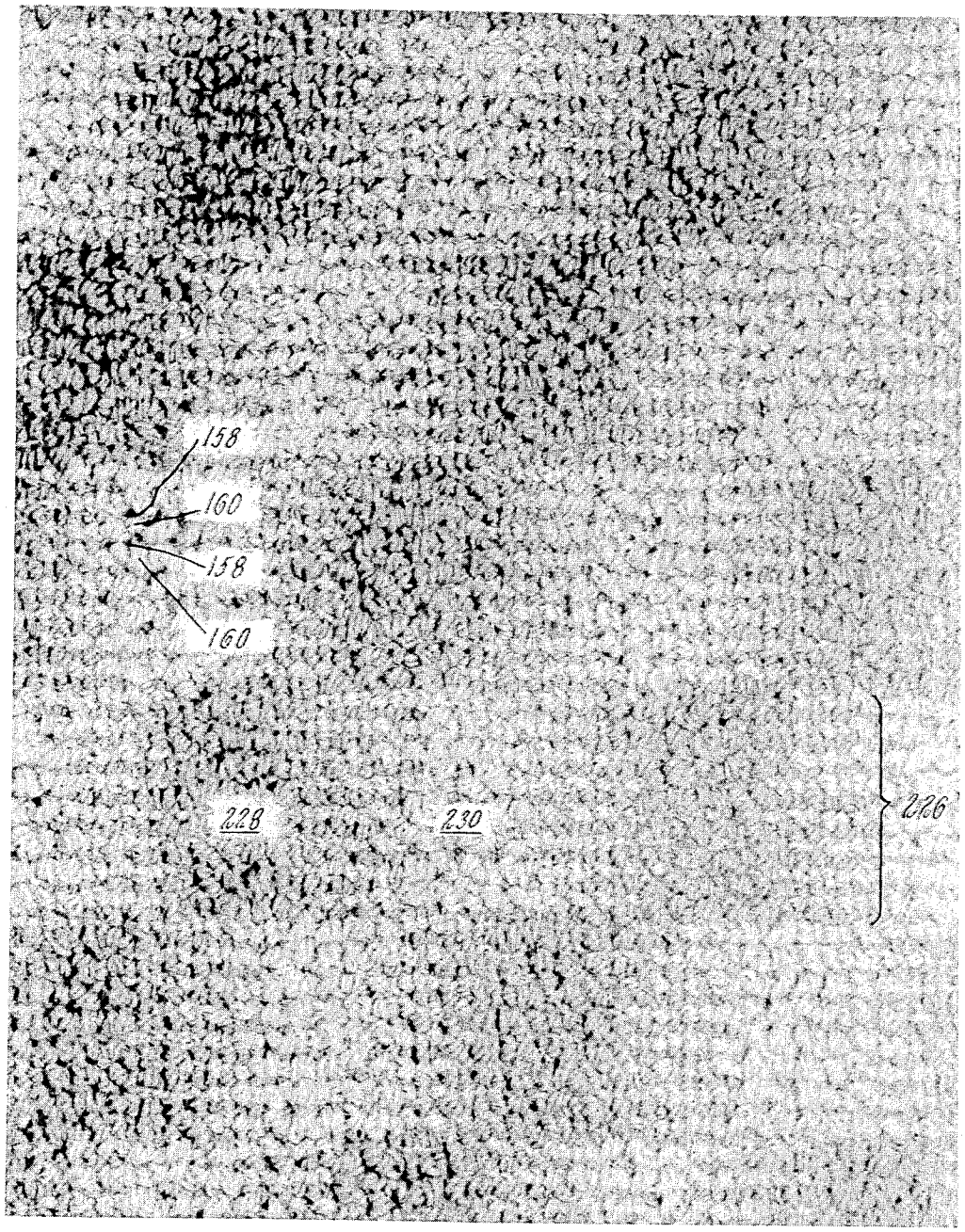


Fig. 32.

United States Patent Office 3,009,485
Patented Nov. 21, 1961

3,009,485

METHOD AND APPARATUS FOR MAKING PATTERNED ROUGH TEXTURED PILE FABRIC FLOOR COVERING

Robert J. Jackson, Hazardville, and Raymond J. Carrigan, Thompsonville, Conn., assignors to Bigelow-Sanford, Inc., Thompsonville, Conn., a corporation of Delaware

Filed Mar. 16, 1959, Ser. No. 799,541
8 Claims. (Cl. 139—25)

The present invention relates to pile fabric floor covering and more particularly to a rough-textured, patterned woven pile fabric floor covering and a method and apparatus for manufacturing the same.

An object of the invention is to provide an effective method whereby a rough-textured loop-piled fabric floor covering woven on a modified carpet loom without the use of the conventional pile wires can be provided with a pattern produced by differences in the lengths, or heights, of the loops.

A further object of the invention is to provide a modified carpet loom and method for the weaving of loop-pile carpet wherein the height of the pile loops varies haphazardly, or at random, within controllable limits, to give an overall rough surface texture and wherein a pattern due to further variation of pile height between different areas of the carpet can be produced.

A further object of the invention is to provide a loop pile fabric floor covering having a novel and attractive over-all rough-textured pile surface formed by pile loops of irregular random heights within a controllable range of heights and a surface pattern, of different height loops or different color loops, or both, superposed on the random loop heights.

The invention is in the nature of an improvement on the invention of our copending application, Serial No. 852,546, filed November 12, 1959 as a continuation-in-part of application Serial No. 823,757, filed June 29, 1959 as a continuation-in-part of application Serial No. 749,205, filed July 17, 1958, said applications Serial Nos. 823,757 and 749,205 now abandoned. According to the present invention, the carpet is provided with a pattern due to differences in loop heights. In the carpet of said applications the height of the pile loops varies from loop to loop in a wholly random or haphazard manner, within a small controllable range of heights. This same random height variation is present in the carpet of the present invention and in addition the height of the loops is further varied, in accordance with a pattern, from place to place in the carpet surface to provide a pattern due to difference in loop height, the carpet having a rough-textured pile surface due to the random height variation. Further, in accordance with the present invention, the patterned height variation may be so arranged as to produce a pattern due to differences in the appearance of the pile at different places in the pile surface, e.g., difference in color.

The pile floor covering comprises a backing formed from wefts, binder warp yarns and stuffer warp yarns, which may be a backing construction such as in the well known velvet or Wilton carpet woven on a pile wire loom, or an Axminster type backing, the wefts lying in two planes, above and below the stuffer warp yarns, and being bound against the stuffer warp yarns by binder warp yarns passing about the wefts. The pile surface is formed by pile warp yarns which rise above the upper wefts as pile loops, which, if desired, can be sheared to form pile tufts, and which are of different heights in accordance with a pattern. The haphazard or random pile height variation extends throughout the pile face, the difference in height due to this variation being slight but sufficient to be clearly apparent, say a difference of the order of ⅛ inch, or more

or less, with loops of random intermediate heights between the highest and lowest and with an entirely random or haphazard distribution of such heights among all the pile loops forming the pile face, providing a novel and attractive rough-textured and patterned pile surface.

We make this novel pile fabric by forming a first shed of the warp yarns, including the stuffer warp yarns, the pile warp yarns and the binder warp yarns, inserting a first weft in the shed and beating-up this weft less than the full distance to the weaving point or fell of the fabric so that this weft throughout its extent between the selvages is left between the warp yarns at an appreciable and substantially uniform distance from the fell of the fabric. While the first weft is so spaced from the fell, a second shed is formed in which the positions of binder warp yarns which in the first shed were in a different plane from the stuffer warp yarns are reversed to the other plane of the shed. The stuffer warp yarns and pile warp yarns also are reversed so that at least certain pile warp yarns are in different shed-lines or planes in the first and second sheds and therefore extend between the wefts inserted in these sheds. A second weft is inserted into this second shed. The second weft is then beaten up completely to the fell of the fabric and the first weft is carried ahead of it, also to the fell of the fabric. Due to the change of binder warp yarns and pile warp yarns between the first and second sheds, pile warp yarns lie between the two wefts and as the second weft approaches the first weft, in its beat-up travel, the two wefts are constrained toward each other by binder warp yarns, causing pile warp yarns to be pinched between the two wefts so that these pile yarns are pushed forward by the wefts in their beat up travel, causing the portions of such pile warp yarns between the fell and the wefts to buckle upwardly to form a row of pile loops. The loops so produced differ at random in height.

In accordance with the invention, we selectively vary the tension in the pile warp yarns supplied to the sheds, in accordance with a pattern. At any particular beat of the lay, different pile warp yarns may be under different tensions and each pile warp yarn may be under different tensions at different beats. We have found that such variation of tension will vary the height of the loops formed by the procedure just described to produce a pattern of higher and lower loop heights superposed on the random loop heights. The loops so formed in pile warp yarns which are under greater tension are lower than the loops formed at the same time in the pile warp yarns which are under lesser tension.

The method of the invention may be carried out on a carpet loom generally similar to the conventional carpet looms but modified so that the lay in its forward motion on alternate beats is checked at a predetermined point short of the fell of the fabric to give only a partial beat up; but is not so checked in its forward motion on the intermediate beats, and modified in accordance with the invention by the addition of means for selectively varying the tension in the individual pile warp yarns in accordance with a pattern. Mechanism is provided for assuring disposition of the partially beaten up wefts at a uniform, or substantially uniform, distance from the fell along their entire length between the selvages. The customary pile wires and the pile wire motion are not required and may, if present, be omitted from the loom.

Other objects, features and advantages of the invention will become apparent from the following detailed description of one particular, presently preferred, embodiment of the same in which reference is made to the accompanying drawings, wherein:

FIG. 1 is a vertical longitudinal sectional view of a carpet loom embodying the invention, showing the lay in full lines in its rearward position and in dot-dash lines in its fully forward position;

FIG. 2 is similar to FIG. 1 but shows the lay in its forward position at the end of a partial beat up;

FIG. 3 is a horizontal sectional view taken on lines **3—3** of FIG. 1;

FIG. 4 is a detail vertical longitudinal sectional view taken on line **4—4** of FIG. 3;

FIG. 5 is a schematic view in plan illustrating the manner of operation of a weft-positioning device;

FIG. 6 is a fragmentary vertical sectional view, corresponding to a part of FIG. 1 but showing a modification of the lay operating mechanism;

FIG. 7 is a view similar to FIG. 6 but showing the parts in a different position;

FIG. 8 is a horizontal sectional view taken on the line **8—8** of FIG. 6;

FIG. 9 is a vertical sectional view taken on line **9—9** of FIG. 8;

FIG. 10 is a detail sectional view to an enlarged scale taken on line **10—10** of FIG. 1;

FIG. 11 is a detail sectional view taken on line **11—11** of FIG. 10;

FIG. 12 is a view similar to FIG. 11 but showing an alternative way of threading in the pile warp yarns;

FIGS. 13 through 18 are diagrammatic warpwise sectional views through the fabric, shed and reed illustrating successive positions of the warp yarns, wefts and reed during one cycle of the weaving operation;

FIG. 19 is a perspective view of the fabric, after weaving;

FIG. 20 is a vertical warpwise sectional view on line **20—20** of FIG. 19;

FIG. 21 is a vertical warpwise sectional view on line **21—21** of FIG. 19;

FIG. 22 is a photographic plan view of the pile face of a fabric of the invention;

FIG. 23 is a warpwise sectional view of a modified weave; and

FIG. 24 shows a modified tension control means.

Referring to the drawings, we have shown so much only of a conventional velvet carpet loom as is necessary to show the relationship of the structural features of the loom of the present invention thereto. The loom comprises side frames **2** and **4** interconnected by cross girths **6** (one only is shown) to provide the main frame on which the various loom operating parts are supported. At the forward end of the loom a breast beam **8** extends between the side frames **2** and **4**, supporting the woven fabric as it is advanced thereover from the weaving point or fell by the conventional take-up roll (not shown). A lay **10** is supported on the conventional lay swords **12, 13**, each sword being pivoted on the loom frame, as at **14**, for oscillatory movement back and forth about a common axis. The reed **16** is carried on the lay between the reed cap **18** and the lay bed, being clamped to the latter by the reed clamp **20** which affords a raceway for the shuttle which inserts the wefts into the warp sheds.

It will be understood that although a shuttle is employed in the particular loom described, the wefts may be inserted by the use of a needle, as is well known in the carpet weaving art, and although the particular loom shown and described is a velvet carpet loom, the loom may instead be any pile wire type of carpet loom, such as a jacquard carpet loom (without employing the jacquard apparatus), or an Axminster type loom with modifications which will be obvious to those skilled in the art in view of the disclosure herein.

Oscillatory movement of the lay forwardly to beat up a weft and rearwardly to permit insertion of the next weft is effected by means of the crankshaft **22** extending between the side frames **2, 4** and having a crank **24** connected to the lay sword **12** by a pitman **25** and a crank **26** connected to the lay sword **13** by a pitman **28**. The parts thus far described are conventional.

The wristpins **30, 32** with which the pitmans engage, are adjustable on the lay swords for movement closer to

or farther away from the crank shaft **22** to, in effect, change the effective throw of the cranks **24, 26** and thus alter the length of the travel of the lay so that the lay makes only a partial beat-up on alternate forward movements and makes a full beat-up on the intermediate forward movements. One suitable mechanism for accomplishing this motion of the lay is shown in FIGS. 1, 2 and 3 and another suitable mechanism for this purpose is shown in FIGS. 6, 7, 8 and 9, but it will be understood that various other means may be employed for this purpose in combination with conventional loom parts.

Referring to FIGS. 1, 2 and 3, the wristpin **30** is mounted eccentrically on an eccentric disk **34** which is fast to and supported by a shaft **36** passing through and journaled in the lay sword **12**. Fast on the other end of shaft **36** is a pinion **38**. The pinion **38** is adapted to be oscillated about its axis through an angle of about 180° to change the position of the wristpin **30** with respect to the lay, and thus the effective throw of the crank **24**, by means of a spur gear **40** fast on the outer end of a shaft **42** which extends between and is journaled in the lay swords. Similar mechanism is provided at the other side of the loom for oscillating the wristpin **32**, comprising eccentric disk **44**, shaft **46**, pinion **48** and the spur gear **50** fast on shaft **42**.

The shaft **42** (and spur gears **40, 50**) is rocked in timed relation with the beats of the lay by mechanism now to be described. On the picker shaft **52**, a conventional shaft in tapestry and velvet carpet looms, is fixed for rotation with the shaft a face cam **54** having a cam track **56**. The cam track **56** guides a cam follower roller **58** extending sidewise from a lever **60** pivoted at **62** on the stationary bracket **64** carried on a cross girth **6**. The opposite end **66** of lever **60** is connected through a pull rod **68** to a crank **70** fixed on shaft **42** but rotatably adjustable thereon, as by loosening and resetting of the set screw **72** (FIG. 3). The pull rod **68** is adjustable in length, as by means of a turnbuckle **74**.

The picker shaft **52** rotates at half the speed of the crank shaft **22**. The cam **54** is so shaped that it produces the described alternate full and partial forward beats of the lay. The cam is also so shaped as to cause the effective throw of the cranks **24, 26** to be shortened during a forward motion of the lay and lengthened during a return motion of the lay, so that the component of motion imparted to the lay by change of position of the wristpins **30, 32** is subtractive rather than additive to the motion imparted to the lay by the cranks **24, 26** and the motion of the lay thus eased. For these purposes, the cam track **56** includes a semi-circular lobe **76**, a rise **78** and a fall **80**, the latter two portions of the cam track each extending through 90° of cam rotation.

In FIG. 1 the lay (full lines) is in its backward position, the wrist pins **30, 32** are in their position nearest the crank shaft **22** and the cam follower **58** lies at the junction of the semi-circular lobe **76** and the rise **78**. As the crank shaft **22** rotates counter-clockwise through 180° to the position of FIG. 2, the cam **54** rotataes counterclockwise through 90° to the position of FIG. 2, and the cam follower **58** passes over the rise **78** to depress lever **60** and oscillate the wrist pins **30, 32** into the position shown in FIG. 2, i.e., their position most remote from the crank shaft **22**. During this interval the lay is moved forwardly from its backward position, but, due to the motion of the wrist pins during this interval, the lay is arrested short of its fully-forward position and the reed beats the weft only part way to the fell of the fabric, to the position shown in FIG. 2.

During the second 180° of counter-clockwise rotation of the crank shaft **22** the lay is returned to its backward position and the cam **54** is rotated counter-clockwise 90°, moving the cam follower **58** over the fall **80** of the cam and lifting the lever **60**. Thus the wrist pins **30, 32** during this stroke will move into their position nearest to the crank shaft **22**. As this, in effect, lengthens the

throw of the cranks 24, 26 the lay motion added by the oscillation of the wrist pins is subtracted from the motion imparted to the lay by the cranks 24, 26.

During the third 180° of rotation of the crankshaft 22 the lay and reed again move forwardly. As the wristpins are in their position nearest the crankshaft and as the cam follower 58 is now passing along the circular portion 76 of the cam track and thus does not alter the position of the wristpins, the lay makes a full beat to the position shown in dot dash lines in FIG. 1.

During the fourth 180° of rotation of the crankshaft 22 the lay and reed are moved backwardly and the cam follower 58, again traveling along the circular portion 76 of the cam track, does not alter the position of the wrist pins 30, 32. The parts now have returned to their initial position of FIG. 1 (full lines) to complete a cycle of operation of the reed.

Referring now to the modification of FIGS. 6, 7, 8 and 9, the described motions of the lay in this modification also are produced through the crank shaft 22 and pitmans 25, 28 under the control of the cam 54, cam follower 58 and pull rod 68. The pull rod 68 is pivotally connected at 82 to a rack 84 which is slidable endwise of the lay sword 12 in fixed guides 86, 88 thereon. The cam 54 is so located on shaft 52 that the pull rod 68 is aligned with the rack 84. The rack 84 meshes with a pinion 90 fixed to a shaft 92 journaled for rotation in the lay sword 12. Fixed to the shaft 92 are two circular eccentric disks 94, 96 lying adjacent the side surfaces of the lay sword and respectively engaging, through ball bearings 95, 97, the plates 98, 100 which are movable in supports 102 on the lay sword. Plates 98, 100 are interconnected by wristpin 104 which passes through horizontally elongated openings 106, 108 in the sword. The wristpin 104 is the wristpin for the pitman 25.

Endwise movement of the rack 84 by pull rod 68 under the influence of the cam 54 causes oscillation of the pinion 90 through approximately 180° and with it of the eccentric disks 94, 96, thus moving the plates 98, 100 and with them the wristpin 104 to change the effective throw of crank 24, as in the case of the corresponding movement of wristpins 30, 32 in the modification of FIGS. 1, 2 and 3. A similar arrangement of cam 54, pull rod 68, rack, pinion, eccentric disks, and plates is provided on the other lay sword, 13, similarly cooperating with the pitman 28 and crank 26.

The pile warp 110 (FIG. 1) is supplied from a beam 112 supported on the side frames 2 and 4 at the top of the loom as appears in FIG. 1. From the beam 112 the pile warp passes forwardly to the weaving point over a whip roll and through the heddle eyes of the harnesses which may in general arrangement be conventional, for example as shown in Patent No. 1,840,855. Thus the pile warp 110 passes forwardly from the beam 112 over and forwardly of the shaft 114 (FIG. 11) and downwardly to whip roll 116. The pile yarns pass rearwardly of and below the whip roll 116 and thence forwardly through the pile heddle frame 117 and the reed 16 to the fell of the cloth. The whip roll 116 is mounted for rotation on the rocking arms 118, one at each side of the loom, which are mounted for swinging movement about the axis of shaft 114 carried on the loom frame, and are urged by springs 120, and arms 122 rigid with arms 118, to swing counterclockwise as seen in FIG. 11 to tend to move the whip roll 116 away from the weaving point. Thus the pile yarns are maintained under the desired tension determined by the springs 120. The whip roll arrangement so far described is conventional.

In accordance with the invention we provide means for selectively varying the tension in the pile yarns in accordance with a pattern. In the embodiment shown, a shaft 124 is mounted to extend between the arms 118 for rotation in bearings provided on the arms. The shaft 124 carries a series of rollers 126, 128, 130, 132 and 133 each having an eccentric bore through which the shaft 124 passes. Each roller is secured to the shaft 124 for rotation therewith by a set screw 134 set in a recess below the peripheral surface of the roller. The pile yarns pass over the peripheries of the rollers 126–133 and each roller may be provided with small flanges as at 136 to keep the yarns from slipping sidewise off the roller.

Shaft 124 is driven in timed relation with the weaving motions of the loom. The shaft may be driven by an independent drive, through a change-speed gear, but we prefer to take the drive from a moving part of the loom. In the embodiment shown, shaft 124 is provided with a sprocket 138 (FIG. 10) fixed thereon and driven by a chain 140 trained about a sprocket 142 fixed on a hub 144 to which also is fixed a sprocket 146. The sprocket 146 is driven by a chain 148 which passes upwardly and about a sprocket 150 (FIG. 1). The sprocket 150 is driven through a change-speed gear box 152 by the chain 154 which in turn is driven by a sprocket 156 fast on the crank shaft 22. It will be understood that the drive for the eccentric roller shaft 124 might equally well be taken from the picker shaft 52, or other moving part of the loom, appropriate adjustment in the speed ratio of the driving connections being made.

As the rollers 126–133 rotate they increase and then decrease the tension in the pile warps by deflecting the warps more and then less from a straight line in their passage from shaft 114 to whip roll 116. Thus the pile yarn 158 is under maximum tension as the high point of roller 126 engages it in the position shown in FIG. 12.

Some of the pile yarns may be passed over one side and other pile yarns over the other side of the rollers to produce various pattern variations. Thus, in FIG. 12 alternate pile yarns, as 158, are passed over the rearward faces of the rollers and the intermediate pile yarns 160 are passed over the front faces of the rollers, to cause the tension in the alternate yarns to be at a maximum when the tension in the intermediate yarns is at a minimum. The alternate yarns 158 may differ from the intermediate yarns 160 in appearance or other characteristic, for example, in color.

In the method of the invention the formation of the pile is dependent upon disposition of certain wefts at an appreciable distance from the fell following the beat up of these wefts. Customarily, the loom is timed so that the wefts are inserted when the reed is in or near its rearward position and thus the shuttle travels through the shed at some distance from the fell. The weft being inserted is bound in the selvage tightly against the fell on the side of the fabric at which the shuttle (or needle) enters and, accordingly, until it is fully beaten up, the weft does not extend straight across the fabric but lies at an inclination to the warp yarns, being at the fell at one selvage and spaced from the fell at the other selvage. Such oblique disposition of a weft which is to be partially beaten up would cause the pile loops formed nearer the weft end nearest the fell to be lower than loops formed farther from this end of the weft, introducing an objectionable disymmetry of pile height weftwise of the fabric. We overcome this difficulty by making provision for positioning of such wefts so that following the partial beat up the weft will extend across the fabric at the same distance from the fell throughout its length. Referring particularly to FIGS. 3, 4 and 5, at the left end of the breast beam 8 a plunger 162 is mounted for sliding movement in a housing 164 disposed slightly outwardly of the left selvage of the fabric. The plunger 162 is provided on its outer end with a head 166 having a flat face for engagement with an abutment 168 carried on the lay 10. The plunger 162 is urged outwardly of the housing 164, toward the lay, by a compression spring 170 and such outward movement of the plunger is limited by a stop pin 172 threaded into the plunger and extending upwardly through and guided in a slot 174 in the housing 164. The housing 164 and plunger 162 are bodily adjustable on the breast beam toward and from the lay by means of the slots 176 (FIG. 3), through which pass

bolts or machine screws **178** securing the housing to the breast beam **8**. The travel of the plunger in the housing is adjustable by selectively inserting the stop pin **172** into any one of a series of threaded holes **180**.

The operation of this weft positioning device is as follows: Referring to FIG. 5, in the loom and method illustrated, the lower weft shot is picked from the right hand side of the loom (lower side of FIG. 5), the shuttle **182** being received in the shuttle box on the left side, as shown in full lines, after it has laid the lower weft **184**. The beat up of the lower weft is a full beat-up so that the weft is carried to the fell of the fabric. As the lay moves forward for this full beat-up of the lower weft **184** of FIG. 5, the abutment **168** on the lay engages the portion **186** of the weft which extends from the selvage **188** to the shuttle and clamps it against the face of the head **166**. Continued forward motion of the lay to carry the weft to the fell is permitted by forward motion of the plunger **162** against the action of spring **170**. As the lay begins its backward movement, the spring **170** forces the plunger rearwardly to follow the lay so that the head **166** is maintained against the abutment **168** to continue to clamp the weft. The portion **186** of the weft, accordingly, is carried backward by the head **166** until the pin **172** reaches the end of its travel in the slot **174**, whereupon the head **166** comes to rest and the abutment **168** moves on, out of contact with the head and weft, leaving the weft portion **186** spaced rearwardly from the fell as shown in full lines in FIG. 5. The pin **172** is so positioned on the plunger **162** that the extreme rearward position of the head **166**, when it is at rest, is at least slightly rearwardly of (farther from the fell than) the partially beat up position of the upper weft. When the shuttle is next thrown, from left to right to its dotted position in FIG. 5, to lay the upper weft **190**, the left hand end of the upper weft at the selvage will not be in the fell as is conventional, but will be spaced rearwardly of the fell a distance at least as great as the spacing desired between the fell and this upper weft after it has been beaten-up to its initial beat-up position spaced appreciably from the fell. Accordingly, when the lay next beats forwardly in its partial beat-up of this upper weft **190** and returns to its rearward position it leaves the whole length of the weft, from selvage to selvage, spaced at a substantially uniform distance from the fell.

In weaving on the loom described the fabric of the particular preferred embodiment of the invention herein disclosed, we employ wefts, binder warp yarns, stuffer warp yarns, and pile warp yarns, the binder warp yarns being desirably divided into two series, each series controlled by a separate heddle. The stuffer warp yarns are shedded by a stuffer heddle and the pile yarns are controlled by a separate heddle. The stuffer and binder warp yarns are supplied from beams or a creel and are maintained under the conventional tensions long employed in velvet and tapestry weaving—the stuffer warp yarns being under somewhat more tension than the other warp yarns, as is well understood in the art. In FIG. 13 a first warp shed has been formed having in its upper plane the binder warp yarns **192** of the first series and in its lower plane the binder warp yarns **194** of the second series, the stuffer warp yarns **196** and the pile warp yarns **110**. A first weft **198** is picked into this shed, which weft, as it is above the stuffer warp yarns, will become an upper weft. The first weft **198** is beaten up as illustrated in FIG. 13, in which the reed **16** is shown at the end of its forward motion, in the relative position shown in FIG. 2, that is, in its forward position on a partial beat-up, having been arrested short of the fell **200** of the fabric, so that the first weft **198** is left after beat-up in a position an appreciable distance from the fell.

The first shed is then closed and the second shed, FIG. 14, is formed, containing in its lower plane the binder warp yarns **192** of the first series and in its upper plane, the pile warp yarns **110**, the stuffer warp yarns **196** and the binder warp yarns **194** of the second series. All of the warp yarns have been reversed from the positions they occupied in the first shed. A second weft **202** is inserted in the second shed. This weft, being below the stuffer warp yarns **196**, will become a lower weft. The reed **16** now beats forward in a full beat, carrying the weft **202** forward to the position shown in FIG. 15. Just before reaching the position of FIG. 15, the reed also engages the first weft **198**. Due to the reversal of the binder warp yarns **192** of the first series, between the first shed (FIG. 13) and the second shed (FIG. 14) the wefts **198**, **202** are constrained toward each other on their forward motion so that they pinch the pile warp yarns **110** between them and on continued forward movement draw the pile warp yarns forwardly, causing pile warp yarns lying between the fell and the partially beaten-up position of weft **198** in FIGS. 13 and 14 to buckle upwardly at **204** (FIG. 15) to form a row **206** of pile loops, FIG. 16. The stuffer warp yarns, also, are engaged between the wefts **198**, **202** but as they are under greater tension than are the pile warp yarns they are not drawn forward. The pile warp yarns, even when under substantially equal tensions, are not all drawn forward exactly equally, as we have found in practice, with the result that the loops in a weftwise row such as row **206** differ among themselves in height. Such difference in height between the lowest loop and the highest loops, may be of the order of ⅛", or more or less, and there are so produced, in each weftwise row, loops of various intermediate heights between the extremes. This height distribution is entirely at random and haphazard within each weftwise row and from row to row, and gives a rough-textured appearance to the pile surface of the fabric. In addition, the loops formed in yarns which are under appreciably greater tension, such as the yarns **158** passing over the high point of roller **126** (FIG. 12), are formed to a lesser length, or height, so that the variation in the tension in the pile warp yarns produced by rotation of the rollers **126**, **128**, **130**, **132** and **133** results in the production of long and short loops in the fabric in accordance with a pattern.

A third shed is then formed, as in FIG. 17, containing in its upper plane the binder warp yarns **194** of the second series and in its lower plane the binder warp yarns **192** of the first series, the stuffer warp yarns **196** and the pile warp yarns **110**. This shed is the same as the first shed, FIG. 13, except that the binder warp yarns of the two series are reversed, the yarns **192** of the first series being up in the shed of FIG. 13 and down in the shed of FIG. 17. A third weft **208** (FIG. 17) is inserted in the third shed and beat forward as in FIG. 13 to a distance appreciably short of the fell.

A fourth shed is then formed, FIG. 18, containing in its lower plane the binder warp yarns **194** of the second series and in its upper plane the pile warp yarns **110**, the stuffer warp yarns **196**, and the binder warp yarns **192** of the first series. This shed is identical with the second shed, FIG. 14, except that the binder warp yarns of the two series are reversed, that is, the binder warp yarns **192** of the first series which were down in the second shed are up in the fourth shed and the binder warp yarns **194** of the second series which were up in the second shed are down in the fourth shed. A lower weft **210** is picked into the fourth shed. As the reed **16** beats forward on its fourth beat, which is a full beat, the lower weft **210** and the upper weft **208** are forced toward each other to pinch and carry forward with them the pile warp yarns which lie between them, in the same manner as occurred on the second beat-up, as in FIGS. 14, 15 and 16, and producing two kinds of inequalities in the height of the loops so produced, as described in connection with the second beat-up.

The foregoing shedding, weft inserting and beating-up operations form a complete weaving cycle, with four

rotations of the crankshaft 22 and two rotations of cam 54. It will be observed that in this specific embodiment the position of the stuffer and of the pile warp yarns in the shed is changed following each beat-up but the binder warp yarns are changed only following alternate beat-ups, i.e., following the insertion and beating-up of the upper weft shots.

The result of this method of weaving is a patterned and rough-textured pile fabric floor covering of the construction illustrated at the left hand side of FIG. 13, the yarns in that figure being shown somewhat more widely separated than in the actual fabric for purposes of illustration. The fabric comprises the stuffer warp yarns **196**, the pile warp yarns **110**, the binder warp yarns **192** and **194** and the wefts **184**, **190**. The wefts are in pairs, whereof each pair comprises the upper weft **190** lying above the stuffer warp yarns **196** and the lower weft **184** lying below the stuffer warp yarns and approximately immediately below the upper weft with which it is paired. The binder warp yarns are in two series **192** and **194**, the binder warp yarns **192** of the first series passing above the upper weft **190** of alternate pairs **216** of wefts and thence directly between the two wefts of the pair and thence beneath the lower weft **184** of the pair. The binder warp yarns of this series pass between the upper and lower wefts of the intermediate pairs **218** of wefts. Correspondingly, the binder warp yarns **194** of the second series pass, as shown, between the upper and lower wefts of the alternate pairs **216**, above the upper wefts **190** of the intermediate pairs **218**, between the wefts of the intermediate pairs and below the lower weft **184** of the intermediate pairs. The pile warps **110** in this embodiment are woven under all of the upper wefts **190** and extend upwardly between adjacent upper wefts to form rows of pile loops which differ among themselves in height in accordance with the pattern produced by the variation of pile warp tension, with a further over-all random height variation superposed on the patterned height variation.

The pile surface of the pile fabric produced by the particular arrangement of FIG. 12 is shown in FIGS. 19, 20, 21 and 22. The alternate pile yarns **158** and the intermediate pile yarns **160** are of different appearance, in this instance of contrasting colors, and are threaded over opposite sides of the rollers **126–133**. All the pile yarns contain warpwise rows of loops, as in FIGS. 20 and 21, which gradually change in height from low to high and back to low. The highest loops **220** in alternate yarns **158** and the lowest loops **222** in the intermediate yarns are disposed along the same weftwise lines **224**; the lowest loops in the alternate yarns similarly lying in the same weftwise rows with the highest loops in the intermediate yarns. The higher loops spread out weftwise to cover and obscure the adjoining lower loops in the neighboring rows. The yarns which are controlled by the same roller form strips or stripes **226** in which blocks or areas **228** of higher loops of one color pile yarn alternate with blocks or areas **230** of higher loops of the other color yarn so that a color pattern as well as a pattern of higher and lower loops is provided. In addition, the lowest loop height produced by the rollers **126–133** (and the highest loop height as well) differs slightly from loop to loop and from yarn to yarn in a wholly random fashion so that there is a random slight variation in loop height distributed over the entire pile face, and superposed on the patterned and controlled height variation produced by the rollers, resulting in a rough-textured pile surface.

The height of the highest pile loop is determined by the spacing between the fell of the fabric and the position of the reed when it is in its forwardmost position on a partial beat-up. The highest pile loops will be of a height approximately one-half this distance of the reed from the fell, which distance we refer to herein as an "appreciable" distance, meaning a distance sufficient to produce a useful pile height.

The general level of height of the pile is controllable by varying this partial beat-up distance. This variation may be made by adjusting the length of the pull rod **68** by means of the turnbuckle **74** to change the amount by which movement of the wristpins from their forwardmost to their rearwardmost position changes the effective throw of the cranks **24**, **26**. The same result may be accomplished by changing the position of the crank **70** on the shaft **42** by loosening the set screw **72**, rotating the crank on the shaft as desired, and resetting the set screw. The pile height also may be adjusted by replacing the eccentric disks **34**, **44** with disks having wristpins set at different eccentricities, and we prefer this method of adjustment.

Many variations from the particular method and apparatus described may be made within the scope of the invention. For example, the construction of the fabric backing may be different from that shown. Thus, the pile yarns may be woven through to the back of the fabric, passing beneath the lower wefts which then serve as the holding wefts, as illustrated in FIG. 23. In this figure, the pile warp yarns appear at **110**, the stuffer warp yarns at **232** and the binder warp yarns at **234**. The pile yarns are raised over each upper weft **236**, to form the pile loops **238**, and pass beneath each of the lower wefts **240**. In weaving this fabric, all of the pile warp yarns **110**, together with all of the binder warp yarns **234**, are in the upper line of the shed and the stuffer warp yarns **232** are in the lower line of the shed, when an upper weft **236** is picked. The upper weft is given a partial beat-up, as in FIG. 13, and the shed is then changed to reverse all of the warp yarns, i.e., to place the pile warp yarns **110** and the binder warp yarns **234** in the lower line of the shed and the stuffer warp yarns **232** in the upper line of the shed, whereupon a lower weft **240** is picked. The lower weft is then beaten-up fully into the fell of the fabric, as in FIGS. 14, 15 and 16, together with the immediately preceding upper weft, the two wefts grasping the pile warp yarns between them to form a pile loop **238**.

The rollers may be made much narrower than those illustrated and increased in number, for example to provide a roller for each two pile yarns, or for each pile yarn, to provide the possibility of controlling the pattern in the pile face at each pair of pile yarns or at each pile yarn and at every pick. The rollers may be of other shapes than the circular shape shown.

Other means than that described may be employed to periodically vary the tension in the pile yarns. Referring to FIG. 24, the pile warp **110** may be supplied from packages **241** in a creel **242**, each yarn passing from its package over a guide bar **244** and through an opening in a weight **246** pivoted on an arm **248** which in turn is pivoted at **250** on the creel **242**. The tensions in the pile yarns may be varied by means of rotary cams **252**, one for each arm **248**, mounted on a shaft **254**. The shaft **254** is driven in timed relation with the weaving motions of the loom, for example from the picker shaft **52** through suitable sprockets **256**, **258** and **260** and chains **262** and **264**. As the cams **252** rotate they raise and lower the weights **246** and thus vary the tension in the pile yarns.

The novel fabric disclosed herein is claimed in our copending divisional application Serial No. 847,605, filed October 20, 1959 as a result of a requirement of restriction herein under title 35, United States Code, section 121.

Accordingly, as different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific fabric, processes and apparatus disclosed except as defined in the appended claims.

We claim:

1. The method of weaving a patterned pile fabric floor covering which comprises forming from pile warp yarns, binder warp yarns and stuffer warp yarns a first shed having warp yarns in an upper plane and warp yarns in a lower plane including pile warp yarns in one of said planes and binder warp yarns in the other of said planes, inserting a first weft in said first warp shed, beating-up said

first weft to an initial beat up position spaced appreciably from the fell of the fabric, reversing said warp yarns to form a second warp shed wherein each of said warp yarns which in said first shed was in an upper plane is in a lower plane, and vice-versa, inserting a second weft in said second shed and beating-up said second weft and with it said first weft to the fell of the fabric, said wefts during their joint beat up travel gripping pile warp yarns between them and bending pile warp yarn thereof lying between said initial beat up position and the fell upwardly into a first weftwise row of pile loops, some of said gripped pile warp yarns being under appreciably greater tension than others of said gripped pile warp yarns in accordance with a pattern, and repeating said shed-forming, weft inserting and beating up operations to form a succeeding weftwise row of pile loops with others of said pile warp yarns than said some of said pile warp yarns being, while gripped and being beaten up, under appreciably greater tension than others of the pile warp yarns, whereby the pile loops of each of said weftwise rows formed in the gripped pile warp yarns which are under greater tension are shorter than the pile loops of each of said weftwise rows formed in the gripped pile warp yarns which are under lesser tension, and at least some of said pile warp yarns contain loops of different heights in said first and said succeeding weftwise rows.

2. The method of weaving a patterned pile fabric floor covering which comprises forming a first shed having warp yarns in an upper plane and warp yarns in a lower plane including pile warp yarns in one of said planes, stuffer warp yarns in one of said planes, a first series of binder warp yarns in one of said planes and a second series of binder warp yarns in the other of said planes, inserting a first weft in said first warp shed, beating-up said first weft to an initial beat up position spaced appreciably from the fell of the fabric, reversing said warp yarns to form a second warp shed wherein each of said warp yarns which in said first shed was in an upper plane is in a lower plane, and vice-versa, inserting a second weft in said second shed and beating-up said second weft and with it said first weft to the fell of the fabric, said wefts during their joint beat up travel gripping pile warp yarns between them and bending pile warp yarn thereof lying between said initial beat up position and the fell upwardly into a first weftwise row of pile loops, some of said gripped pile warp yarns being under appreciably greater tension than others of said gripped pile warp yarns in accordance with a pattern, and repeating said shed-forming, weft inserting and beating up operations to form a succeeding weftwise row of pile loops with others of said pile warp yarns than said some of said pile warp yarns being, while gripped and being beaten up, under appreciably greater tension than others of the pile warp yarns, whereby the pile loops of each of said weftwise rows formed in the gripped pile warp yarns which are under greater tension are shorter than the pile loops of each of said weftwise rows formed in the gripped pile warp yarns which are under lesser tension, and at least some of said pile warp yarns contain loops of different heights in said first and said succeeding weftwise rows.

3. The method of weaving a patterned pile fabric floor covering which comprises forming a first shed having warp yarns in an upper plane and warp yarns in a lower plane including pile warp yarns and stuffer warp yarns in said lower plane and binder warp yarns in said upper plane, inserting a first weft in said first warp shed, beating-up said first weft to an initial beat up position spaced appreciably from the fell of the fabric, reversing said warp yarns to form a second warp shed having warp yarns in an upper plane and warp yarns in a lower plane including said pile warp yarns and said stuffer warp yarns in said upper plane and said binder warp yarns in said lower plane, inserting a second weft in said second shed and beating-up said second weft and with it said first weft to the fell of the fabric, said wefts during their joint beat up travel gripping pile warp yarns between them and bending pile warp yarn thereof lying between said initial beat up position and the fell upwardly into a first weftwise row of pile loops, some of said gripped pile warp yarns being under appreciably greater tension than others of said gripped pile warp yarns in accordance with a pattern, and repeating said shed-forming, weft inserting and beating up operations to form a succeeding weftwise row of pile loops with others of said pile warp yarns than said some of said pile warp yarns being, while gripped and being beaten up, under appreciably greater tension than others of the pile warp yarns, whereby the pile loops of each of said weftwise rows formed in the gripped pile warp yarns which are under greater tension are shorter than the pile loops of each of said weftwise rows formed in the gripped pile yarns which are under lesser tension, and at least some of said pile warp yarns contain loops of different heights in said first and said succeeding weftwise rows.

4. The method of weaving a patterned pile fabric floor covering having stuffer warp yarns, pairs of wefts whereof each pair comprises an upper weft lying above the stuffer warp yarns and a lower weft lying below the stuffer warp yarns and below and adjacent said upper weft, a first and a second series of binder warp yarns, and pile warp yarns woven under upper and above lower wefts and extending upwardly between adjacent upper wefts to form pile loops, which comprises forming a first shed having in its upper plane the binder warp yarns of said first series of binder warp yarns and having in its lower plane the binder warp yarns of said second series of binder warp yarns, stuffer warp yarns and at least certain of the pile warp yarns, inserting an upper weft in said first shed, beating-up said upper weft to an initial beat up position spaced appreciably from the fell of the fabric, forming a second warp shed having in its upper plane the binder warp yarns of said second series of binder warp yarns, stuffer warp yarns and said certain of the pile warp yarns, and having in its lower plane the binder warp yarns of said first series of binder warp yarns, inserting in said second shed a lower weft to be paired with said upper weft, beating-up said lower weft and with it said upper weft to the fell of the fabric, said upper and lower wefts during their joint beat up travel gripping said certain pile warp yarns between them and bending pile warp yarn thereof lying between said initial beat up position and the fell upwardly into a first weftwise row of pile loops, some of said certain pile warp yarns being under appreciably greater tension than others of said certain pile warp yarns in accordance with a pattern, and repeating said shed-forming, weft inserting and beating up operations to form a succeeding weftwise row of pile loops with others of said pile warp yarns than said some of said pile warp yarns being, while gripped and being beaten up, under appreciably greater tension than others of the pile warp yarns, whereby the pile loops of each of said weftwise rows formed in said pile warp yarns which are under greater tension are shorter than the pile loops of each of said weftwise rows formed in said pile warp yarns which are under lesser tension, and at least some of said pile warp yarns contain loops of different heights in said first and said succeeding weftwise rows.

5. The method of weaving a patterned pile fabric floor covering having stuffer warp yarns, pairs of wefts whereof each pair comprises an upper weft lying above the stuffer warp yarns and a lower weft lying below the stuffer warp yarns and below and adjacent said upper weft, a first and a second series of binder warp yarns, and pile warp yarns woven under the upper wefts extending upwardly between adjacent upper wefts to form pile loops, which comprises forming a first shed having in its upper plane the binder warp yarns of said first series of binder warp yarns and having in its lower plane the

stuffer warp yarns, the binder warp yarns of said second series of binder warp yarns and the pile warp yarns, inserting an upper weft in said first shed, beating-up said upper weft to an initial beat up position spaced appreciably from the fell of the fabric, forming a second shed having in its upper plane the stuffer warp yarns, the binder warp yarns of said second series of binder warp yarns and the pile warp yarns, certain of said pile warp yarns being under greater tension than others of said pile warp yarns, and said second shed having in its lower plane the binder warp yarns of said first series of binder warp yarns, inserting in said second shed the lower weft to be paired with said upper weft, beating-up said lower weft and with it said upper weft to the fell of the fabric, said upper and lower wefts during their joint beat up travel gripping between them said pile warp yarns and bending the portions of the pile warp yarns lying between said initial beat up position and the fell upwardly into a first weftwise row of pile loops of unequal heights, the pile loops of said weftwise row formed in the pile warp yarns which are under greater tension being shorter than the pile loops of said weftwise row formed in the pile warp yarns which are under lesser tension, forming a third shed having in its upper plane the binder warp yarns of said second series of binder warp yarns and having in its lower plane the stuffer warp yarns, the binder warp yarns of said first series of binder warp yarns and the pile warp yarns, inserting an upper weft in said third shed, beating-up said upper weft to an initial beat up position spaced appreciably from the fell of the fabric, forming a fourth shed having in its upper plane the stuffer warp yarns, the binder warp yarns of said first series of binder warp yarns and the pile warp yarns, altering the amount of tension in at least some of the pile warp yarns, in accordance with a pattern, from the amounts of tension which were in the respective pile warp yarns during said beat up of said lower weft, and said fourth shed having in its lower plane the binder warp yarns of said second series of binder warp yarns, inserting in said fourth shed the lower weft to be paired with said last inserted upper weft, beating-up said last inserted lower weft and with it said last inserted upper weft to the fell of the fabric as before to form a second weftwise row of pile loops of unequal heights, the pile loops of said second weftwise row formed in the pile warp yarns which are under greater tension being shorter than the pile loops of said second weftwise row formed in the pile warp yarns which are under lesser tension, and at least some of the pile warp yarns containing loops of different heights in said first and said second weftwise rows, and repeating said shedding, weft inserting, tension altering and beating-up operations to form said pile fabric.

6. A carpet loom comprising means for supplying to the weaving point stuffer warp yarns, pile warp yarns and binder warp yarns, mechanism for shedding the warp yarns, mechanism for inserting wefts in the sheds, a reed for beating up the wefts, means for oscillating the reed back and forth toward and from the fell of the fabric with a limited travel, to a point short of the fell of the fabric on alternate beats and a full travel, to the fell of the fabric, on the intermediate beats, and means for varying the tension in individual pile warp yarns between successive intermediate beats so that the tension in some of the pile warp yarns differs from the tension in other pile warp yarns during an intermediate beat and so that the tension in some of the pile warp yarns during one intermediate beat is different from what it is during another intermediate beat, in accordance with a pattern.

7. A carpet loom comprising means for supplying to the weaving point stuffer warp yarns, pile warp yarns and binder warp yarns, mechanism for shedding the warp yarns, mechanism for inserting wefts in the sheds, a reed for beating up the wefts, means for oscillating the reed back and forth toward and from the fell of the fabric with a limited travel, to a point short of the fell of the fabric on alternate beats and a full travel, to the fell of the fabric, on the intermediate beats, a plurality of eccentric rollers mounted on the loom in position to engage their peripheries against the pile warp yarns and means for rotating the rollers to vary the tension in the individual pile warp yarns between successive intermediate beats in accordance with a pattern.

8. A carpet loom comprising means for supplying to the weaving point stuffer warp yarns, pile warp yarns and binder warp yarns, mechanism for shedding the warp yarns, mechanism for inserting wefts in the sheds, a reed for beating up the wefts, means for oscillating the reed back and forth toward and from the fell of the fabric with a limited travel, to a point short of the fell of the fabric on alternate beats and a full travel, to the fell of the fabric, on the intermediate beats, a shaft disposed transversely of the pile warp yarns, a plurality of rollers mounted eccentrically on said shaft with their peripheries engaging alternate pile warp yarns on one side of the shaft and intermediate pile warp yarns on the other side of the shaft to increase the tension in the alternate pile warp yarns while simultaneously decreasing the tension in the intermediate pile warp yarns.

References Cited in the file of this patent

UNITED STATES PATENTS

577,981	Gilfillan	Mar. 2, 1897
936,310	Davidson	Oct. 12, 1909
1,593,851	Ryon	July 27, 1926
1,739,205	Blanchard	Dec. 10, 1929
2,299,004	Berg	Oct. 13, 1942
2,553,303	Crawford	May 15, 1951
2,625,956	Sippel	Jan. 20, 1953
2,709,461	Groat	May 31, 1955
2,714,399	Hoeselbarth	Aug. 2, 1955
2,715,921	Smiley	Aug. 23, 1955
2,741,270	Mills	Apr. 10, 1956

FOREIGN PATENTS

547,864	Great Britain	Sept. 15, 1942