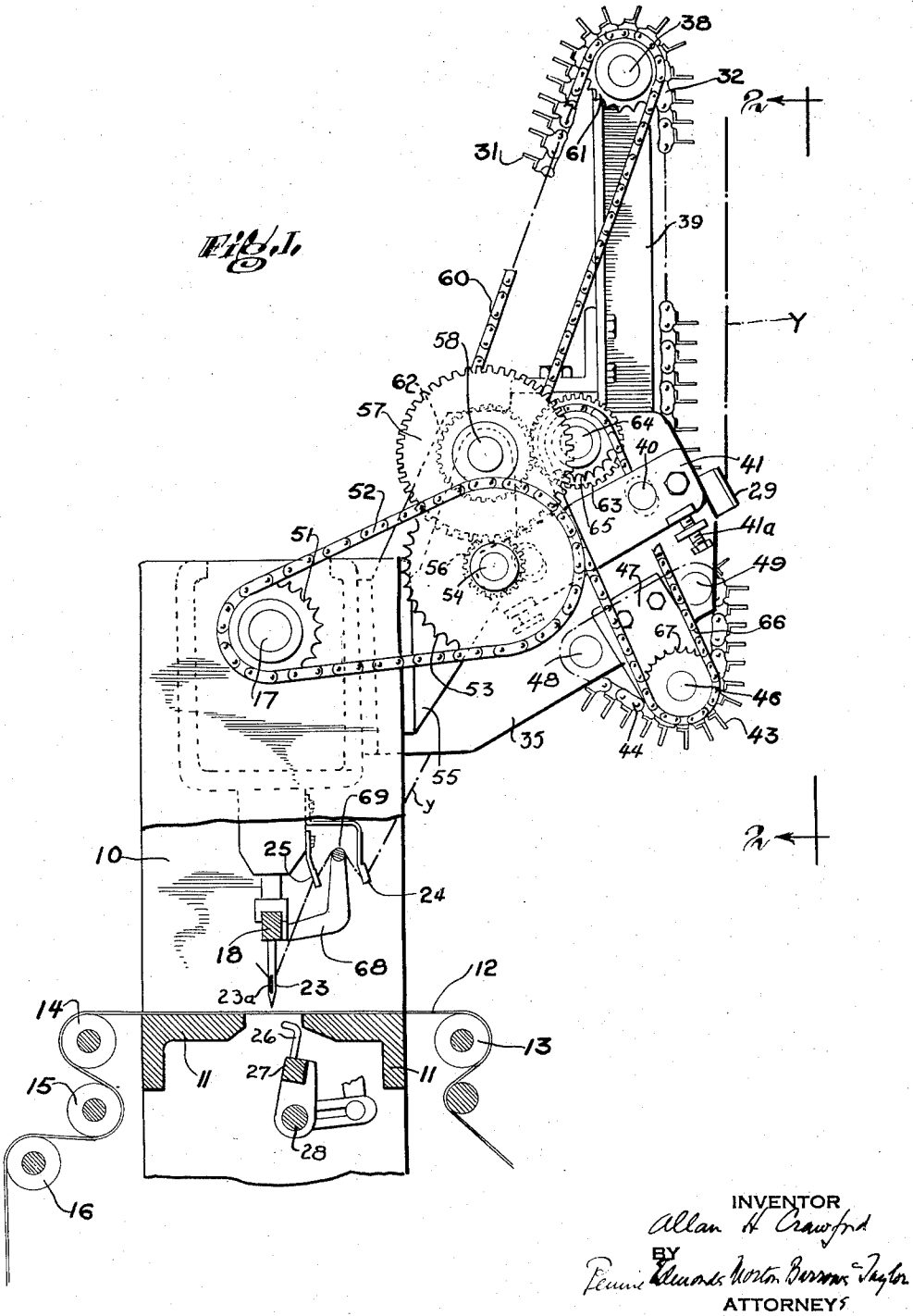
Sept. 23, 1958 A. H. CRAWFORD 2,853,034

METHOD OF MAKING PILE FABRICS WITH LOOPS OF DIFFERENT HEIGHT AND APPARATUS FOR PRACTICING THE METHOD

Filed Nov. 10, 1954 4 Sheets-Sheet 1

Fig. 1.



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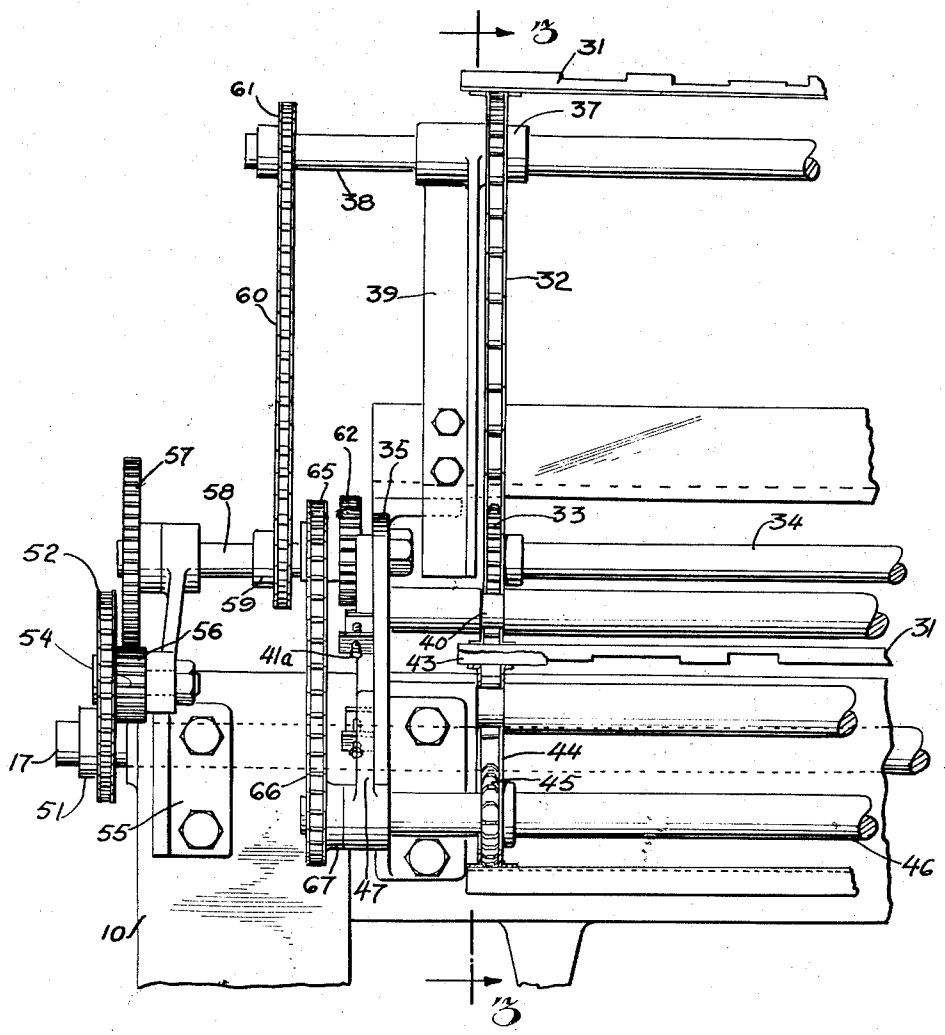

Fig. 2.

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Fig. 4.

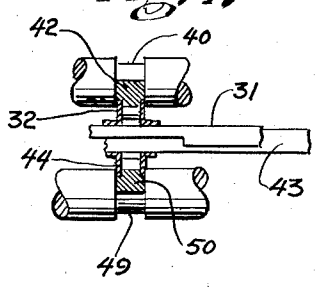

Fig. 3.

Fig. 8.

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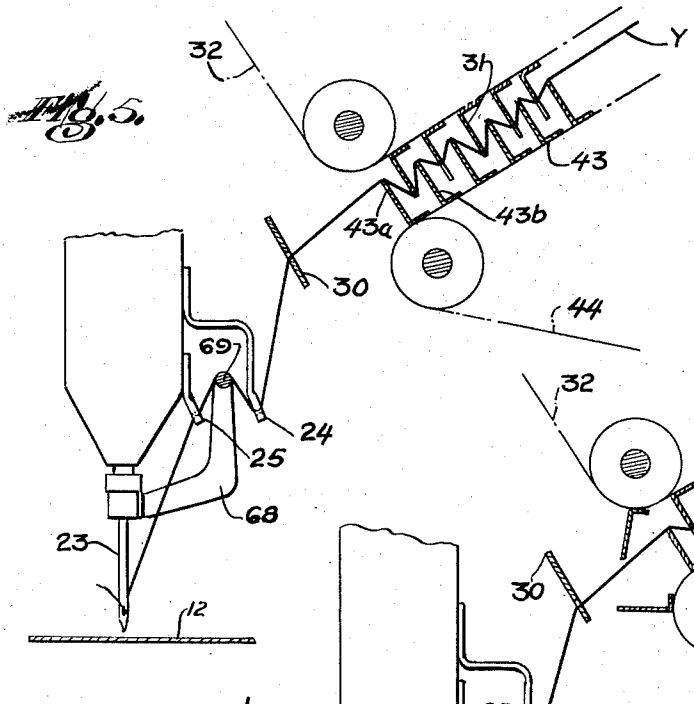
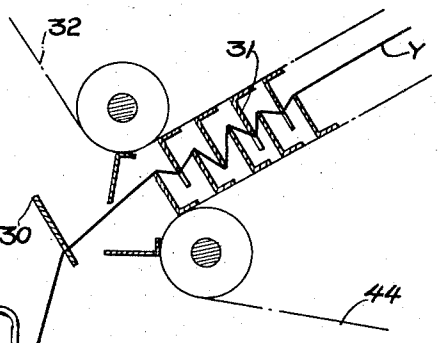


Fig. 5.



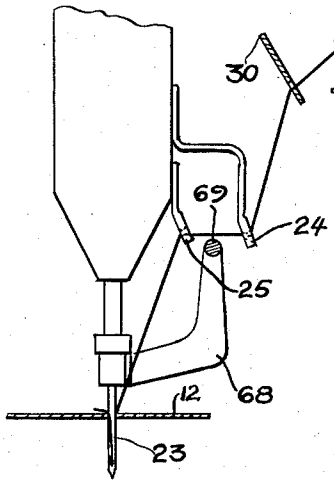


Fig. 6.

Fig. 7.

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2,853,034

METHOD OF MAKING PILE FABRICS WITH LOOPS OF DIFFERENT HEIGHT AND APPARATUS FOR PRACTICING THE METHOD

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Application November 10, 1954, Serial No. 468,030

15 Claims. (Cl. 112—79)

This invention relates to the production of pile fabrics of the type made by passing loops of pile yarn through a backing sheet by means of needles and is concerned more particularly with a novel method of making such fabrics, in which the pile loops of the individual yarns vary in height in accordance with a pattern. In addition to the method, the invention includes an apparatus, by which pile yarns can be fed to the pile-forming devices of fabric-producing machines at rates varying in accordance with a pattern, the apparatus being advantageously used in the practice of the method.

Tufted pile fabrics can be produced rapidly and at low cost on sewing machines of the multiple needle type used for tufting operations and some of the machines heretofore available have been equipped with means, by which the height of the loops can be varied. Such means have taken the form of devices for feeding the pile yarns to the needles and function to feed more or less yarn to the needles in accordance with the requirements of the pattern. The needles of the machine penetrate the fabric to a constant depth in the insertion of pile loops and, if a loop of less than maximum height is to be formed, the amount of yarn fed for the formation of the following loop of that yarn is insufficient for a loop of maximum height. The insertion of the second loop to the standard depth by its needles then results in yarn being withdrawn from the preceding loop, so that the loop first formed is reduced in height by an amount equal to the amount of yarn taken therefrom. The height of each loop in the fabric produced in the prior machines is thus determined by the amount of yarn fed for the formation of the succeeding loop of that yarn and the formation of a loop of less than maximum height is always accomplished by taking yarn from a loop previously inserted in the fabric.

The withdrawal of yarn from the loop of that yarn previously inserted through a backing sheet, as described, may cause a pucker in the backing sheet, especially if there is a knot in the yarn being withdrawn. Also, the withdrawal from an inserted loop of yarn containing a knot may result in the yarn being broken, after which no loops of the yarn will be formed until the break is repaired, since the loose end will be merely carried by its needle through the backing sheet and then withdrawn without being caught by the looper of the machine.

The method of the present invention when used in connection with a tufting machine makes possible the production of tufted loop pile fabrics, in which the height of each loop is under the control of a pattern and the loop assumes its final height upon complete retraction of the needle in the formation of the loop. The height of each loop depends upon the amount of yarn fed to the needle for the formation of the loop and the pattern controls the loop height directly instead of through the feeding of yarn for the succeeding loop of that yarn. Since no yarn is withdrawn from a previously inserted loop, the machine runs more smoothly than the prior machines and difficulties arising from knots in the pile yarns are avoided.

In the practice of the new method in conjunction with a tufting machine, the pile yarns are fed at rates varying in accordance with the requirements of a pattern and a supply of each yarn, which has been fed and lies between its needle and the feeding means, is stored during each upstroke of the needle. All the stored supplies contain the same length of yarn and they are all released when the needles move downward to penetrate the backing sheet and insert loops of the yarns through the sheet. During each cycle of operation of a needle, its yarn is being fed and the total amount of a yarn thus available to a needle for insertion of a loop is the length of a stored supply plus the length of the yarn so fed. During the upstroke of the needle after insertion of a loop, a second supply of the yarn is stored and, since the same length of yarn is always present in all the stored supplies, the length of a yarn, which is left as a loop in the backing sheet, is the length of the yarn fed during the needle cycle, in which the loop was inserted.

The apparatus forming a part of the invention may be employed in the feeding of yarns to the pile-forming devices of fabric-producing apparatus of various sorts and the apparatus affords close control of the amount of yarn fed for each pile-forming operation of the apparatus. Accordingly, by the use of the apparatus, the height of each loop throughout the fabric being produced is under control and may be varied as required by the pattern.

For a better understanding of the invention, reference may be made to the accompanying drawings, in which:

Figure 1 is a view in side elevation, with parts omitted, of a sewing machine for tufting purposes, which is equipped with the yarn feeding mechanism of the invention;

Figure 2 is an elevational view on the lines **2—2** of Fig. 1 with parts omitted;

Figure 3 is a sectional view on the line **3—3** of Fig. 2;

Figure 4 is a fragmentary sectional view on the line **4—4** of Fig. 3;

Figures 5 and 6 are diagrammatic views illustrating the operation of the yarn feeding and yarn storing means employed in the machine of the invention;

Figure 7 is a series of diagrams illustrating the insertion of loops through a backing sheet in the operation of a tufting machine equipped with the yarn feeding means of the invention; and

Figure 8 is a partial side elevational view of one of the pattern elements.

The tufting machine shown somewhat diagrammatically in the drawings comprises a frame structure **10** provided with a table **11**, over which the backing sheet **12** is advanced from a supply by means of rolls **13**, **14**, **15**, and **16**, some or all of which are driven. A shaft **17** mounted above the table and driven by suitable means reciprocates a needle bar **18** through suitable connections including a plurality of eccentric discs **19**, straps **20** encircling the discs, and push rods **21** connected to the straps and attached to the needle bar, the push rods being movable in guides **22**. The needle bar carries a plurality of needles **23**, and a pair of spaced guides **24**, **25** having eyes for each yarn Y travelling toward its needle are mounted on the push rod guides **22** opposite the needle.

Beneath the table, a plurality of loopers **26**, one for each needle, are mounted on a bar **27** carried by arms on a rock shaft **28**. As the needles pass loops of the pile yarn through the backing sheet in the usual way, the loopers are swung to cause their hooks to enter the loops and hold them, when the needles are retracted and rise out of the fabric.

The yarns Y to be fed to the respective needles are drawn from packages in a creel and pass through a stationary guide **29** having an eye for each yarn. A second

stationary guide **30** with an eye for each yarn is mounted in alignment with guide **29** at a distance therefrom, and the yarns issuing from the eyes in guide **30** travel to respective guides **24**.

The yarns are drawn from the supplies by the new feeding apparatus, which includes an upper endless series of pattern elements **31** extending the full width of the sheet of yarns travelling from guide **29** to guide **30**. The pattern elements are mounted on two or more chains **32**, which are trained about sprocket wheels **33** on shaft **34** journalled in brackets **35** attached to the housing **36** for the main drive shaft **17** of the machine. The chains also pass about sprocket wheels **37** on a shaft **38** journalled in bearings in extensions **39** from the brackets **35** and about idler pulleys on shafts **40** journalled in bearings on plates **41** (Fig. 1) mounted on brackets **35**. Plates **41** can be adjusted relative to brackets **35** by screws **41***a* to keep chains **32** taut, and the plates carry rails **42**, which back up the stretches of the chains between shafts **40** and extend substantially parallel to a line between the eyes of guides **29**, **30**.

A second set of pattern elements **43** extending the full width of the sheet of yarns are mounted on chains **44** passing about sprocket wheels **45** on a shaft **46** journalled in extensions **47** from brackets **35**. The chains **44** are also trained about idler pulleys on shafts **48**, **49** journalled in bearings on brackets **35**. The stretches of chains **44** between the idlers on shafts **48**, **49** are backed up by rails **50**, which extend parallel to a line connecting the eyes in guides **29**, **30**.

The main drive shaft **17** carries a sprocket wheel **51** connected by a chain **52** to a sprocket wheel **53** on a stud **54** mounted on a bracket **55** attached to the frame **10** of the sewing machine. The stud carries a pinion **56** fast to sprocket wheel **53** and meshing with a gear **57** on a shaft **58** journalled in bearings in brackets **55** and **35**. Shaft **58** carries a sprocket wheel **59** connected by a chain **60** to a sprocket wheel **61** on shaft **38** and shaft **58** also carries a gear **62** meshing with a gear **63** on a stud **64** attached to one of the brackets **35**. A sprocket wheel **65** fast to gear **63** on stud **64** is connected by a chain **66** to a sprocket wheel **67** on shaft **46**.

The pattern elements **31** and **43** are wires of L-section, of which the bases are connected to the outer faces of links of chains **32** and **44**, respectively. The wires on the stretches of the chains backed up by rails **42** and **50** are staggered and their free edges are partially intermeshed, so that they subject the yarns in the sheet between guides **29** and **30** to lateral deviation and cause the yarn to assume the form of waves. The length of a yarn extending from a wire of the **43** series past a wire of the **31** series to the next wire of the **43** series constitutes one feed increment or wave of the yarn and the yarns in the sheet between guides **29** and **30** are formed into such a number of waves that the wires of the two series grip the yarns sufficiently to draw them from their packages and feed them to the needles as the chains **32** and **44** are driven. For each reciprocation of the needles, the chains advance by the distance between adjacent wires thereon, so that a feed increment of each yarn equal to the length of a wave of the yarn is fed to the needles for each reciprocation thereof. A feed increment of each yarn is thus fed to its needle for the formation of a single pile loop.

The yarns forming successive feed increments are laterally deviated by amounts corresponding to the heights of successive pile elements in a longitudinal row in the fabric to be produced and the yarns forming transversely aligned increments across the pattern sheet are deviated by different amounts determined by the pattern. The varying lateral deviation of the yarns as described with resultant variation in the individual feed increments or waves is produced by forming the wires of the **31** or **43** series or both of varying height throughout their length, although ordinarily the wires of the longer series **31** only are so formed. A typical pattern wire **31** is shown in Fig. 8 of the drawing as having sections marked *a*, *b*, *c*, *d*, *e*, etc., which are of uniform width and are engageable with individual pile yarns. Each section of a wire may be considered to be a pattern element and each wire is thus an assembly of individual pattern elements lying in a row transverse to the direction of feeding movement of the yarns. The sections differ in height in accordance with the pattern to be produced in the fabric and the length of yarn in each wave extending between a pair of wires of the **43** series depends on the height of the section of wire **31**, which engages the yarn between the wires **43**. Accordingly, when the section of the wire **31** in contact with the yarn is relatively high like the area *a*, Fig. 8, the length of the yarn in the wave will be long, whereas, if the effective section is low like area *e*, the length of the wave will be short. The length of yarn required for formation of a normal loop by a needle is that in a wave of maximum size.

Lengths of the yarns leaving the guide **30** and passing through guides **24** and **25** on their way to the needles are periodically stored and, for this purpose, the needle bar is provided with brackets **68** carrying a deflecting element in the form of a bar **69** engageable with the yarns between the guides **24** and **25**. The deflecting bar **69** is so positioned relative to the needle bar that, when the needles are in their lowermost positions, the bar **69** lies slightly spaced from the portions of the yarns lying in a straight line between the eyes of guides **24** and **25**, or barely makes contact with those portions of the yarns. When the needle bar rises to retract the needles from the backing sheet, the deflecting bar engages the yarns between guides **24** and **25** and deflects them from a straight line between the eyes of guides **24**, **25**. The difference in length between a yarn so deflected and a yarn travelling in a straight line between guides **24**, **25** is a stored supply of the yarn. When the needle bar descends to cause the needles to penetrate the backing sheet, the deflecting bar moves downward with the needle bar to release the stored supplies of the yarns.

In the operation of the machine, the yarns drawn from the supplies are threaded through the eyes in guide **29** and between those pattern wires of the two series **31** and **43**, which are in effective position between the rails **42** and **50**. The yarns are then passed through the eyes of guides **30** and **24**, over the top of the deflecting bar **69**, and then through the eyes of guide **25**, after which the yarns are threaded through their respective needles **23**.

The action of the needles and the deflecting bar is illustrated in the diagrams of Fig. 7, of which diagram I shows a needle **23**, which has penetrated the backing sheet **12** and is at the bottom of its downstroke. As the needle moves down, the deflecting bar **69** moves down with it to release the stored supply of yarn previously raised over the bar between guides **24** and **25**. Also, during each needle cycle, the feeding means are operating to feed yarn, so that yarn so fed is available to the needle as it penetrates the fabric. When the needle completes its downstroke, the looper enters the loop of yarn inserted by the needle and holds the inserted loop L_1 momentarily as the needle rises. Simultaneously with the retraction of the needle, the bar **69** rises to store a second supply of the yarn by deflecting it from its straight path between guides **24**, **25** and, since the bar **69** always rises to the same height, the length of yarn in the stored supplies is always the same. Accordingly, the net length of yarn available for each loop is the length of yarn fed during the needle cycle, in which the loop was formed.

As shown in diagram II, Fig. 7, the length of yarn fed during the needle cycle, in which L_1 was formed, was sufficient to produce a loop of maximum length as determined wholly by the depth of penetration of the needle through the fabric. Accordingly, when the needle was retracted after formation of loop L_1, yarn was available

between the needle and the feeding means for storage of a supply without affecting the loop L_1.

Diagrams III and IV, Fig. 7, show the needle rising and yarn being stored by the action of bar **69**, after insertion of a loop L_2. The length of yarn fed during the needle cycle for this loop was not sufficient for a loop of maximum length and, as a consequence, in the downstroke of the needle, part of the yarn required for the loop was borrowed from the stored supply released as the needle moved down. Then, as the needle started up and the storage of the next supply began, the uncompleted loop was shortened by the difference between the length of the yarn fed and that required for a loop of maximum length. Loop L_2 was, accordingly, converted to loop L_3.

It will be seen from the foregoing that, in the operation of the feeding apparatus of the invention when utilized in connection with a tufting machine, the length of yarn available to each needle on each downstroke thereof is the length of yarn fed during the cycle of needle operation, in which the downstroke occurs, plus the length of yarn, which was taken up to form the stored supply during the preceding cycle and is let out during the downstroke. After insertion of a loop by the needle, another length of the yarn is taken up and stored during the upstroke of the needle. As the length of yarn taken up to form a stored supply and then let out is always the same, it will be apparent that the length of yarn in each completed loop is the length fed during the cycle of needle operation, in which the loop was inserted. When a loop of less than maximum height is to be inserted and the amount of yarn fed during the cycle of needle operation is insufficient to produce a loop of maximum height, the needle initially produces a loop of maximum height, but, when the yarn is taken up on the upstroke of the needle to form the stored supply, yarn is withdrawn from the loop and it becomes one of a height corresponding to the amount of yarn fed. The formation of a loop of less than maximum height thus involves the steps of inserting a loop of maximum height and then withdrawing yarn from it as a continuous operation. As the yarn is pulled from the loop while the needle hole in the fabric is of full size and before it has been closed by the next penetration of the fabric by the needle, the withdrawal of the yarn from the loop does not cause puckering of the fabric and there is little likelihood that the yarn will be broken, even if the length withdrawn contains a knot. The method and apparatus of the invention thus provide control of the height of every loop in the fabric while avoiding the possibility of breakage of the yarn withdrawn.

This application is related to my co-pending application Serial No. 445,007, filed July 22, 1954.

I claim:

1. An apparatus for feeding a plurality of yarns at rates varying in accordance with a varying pattern, which comprises flexible endless carriers, means for supporting the endless carriers with longitudinal stretches thereof lying opposed, a set of pattern members secured to each endless carrier and extending therefrom in spaced relation, the members of at least one set of pattern members differing from one another in accordance with the pattern, the pattern members of the respective endless carriers on said stretches intermeshing, means for guiding the yarns in side-by-side relation to pass between the opposed stretches of the carriers to be bent to wave form by the intermeshing pattern members on the stretches, means for advancing the carriers so that waves in the yarns successively are released at one end of said stretches and new increments of yarn simultaneously are pulled between the pattern members carried by the flexible carriers at the other end of said stretches to be bent to wave form, and means for alternately taking up and letting out constant lengths of the yarns including the lengths of the yarns in the waves released from between the pattern members on said stretches.

2. The apparatus of claim 1, in which the means for alternately taking up and letting out lengths of the yarn perform a cycle of operations while the carriers advance by the distance between a pair of adjacent pattern members on one carrier.

3. The apparatus of claim 1, in which each pattern member is continuous and extends entirely across the group of yarns.

4. The apparatus of claim 1, in which the pattern members of at least one set differ from one another in height along their lengths.

5. The apparatus of claim 1, in which the pattern members are flat wires secured to the carriers to project outwardly therefrom.

6. The apparatus of claim 1, in which the means for taking up and letting out lengths of the yarns include spaced guides for the yarns and a reciprocating member extending transverse to the yarns between the guides and operating alternately to engage and deflect the yarns from their direct path from one guide to the other and to release the yarns.

7. A method of making a pile fabric which comprises advancing a backing sheet, feeding varying lengths of yarn toward a storage zone defined by spaced guides through which the yarn passes, withdrawing the yarn from the storage zone and inserting it through the backing sheet to form a loop of predetermined length, laterally deviating the yarn between said guides by a fixed amount, the yarn required by the deviation being, in some instances, greater than the length of yarn fed toward the zone, and, in such instances, drawing, during the deviation, the deficiency from the loop just formed.

8. A method of making a pile fabric which comprises advancing a backing sheet, withdrawing yarn from a storage zone and inserting it through the backing sheet to form a loop, repeating said steps to form the pile fabric, feeding increments of yarn of varying lengths from a source of supply towards the storage zone, laterally deviating the yarn from a direct path between its point of entry into and point of withdrawal from the storage zone by a fixed amount during each loop forming operation, such deviation being into the storage zone and providing a supply of yarn therein, utilizing successive increments of yarn fed toward the storage zone for successive deviations into the storage zone, and drawing such additional yarn as is required for a deviation from the loop inserted through the backing sheet immediately prior to such deviation.

9. A method of making a pile fabric, which comprises carrying out a cycle made up of the steps of advancing a backing sheet, feeding from a source of supply a length of yarn controlled in accordance with a pattern, taking up in a storage zone a fixed length of yarn so fed, and withdrawing a fixed length of yarn from the storage zone and inserting it through the backing sheet to form a loop, and repeating the cycle indefinitely to form a fabric, the fixed lengths of yarn taken up in the storage zone being uniform in successive cycles and the controlled lengths of yarn fed in successive cycles varying in length with certain controlled lengths of yarn being shorter than the fixed lengths taken up, the taking up in storage of a fixed length of yarn in a cycle, in which the controlled length of yarn fed is shorter than said fixed length, causing yarn to be drawn from the loop inserted through the backing sheet in that cycle.

10. The method of claim 9, in which the uniform fixed lengths of yarn taken up in the storage zone in successive cycles are at least as long as the longest controlled lengths of yarn fed.

11. The method of claim 9, in which the fixed lengths of yarn withdrawn from the storage zone and inserted through the backing sheet to form loops are of uniform length throughout the cycles.

12. The method of claim 9, in which the fixed length of yarn is taken up in the storage zone by being laterally deviated from a direct path between its point of entry into and its point of withdrawal from the storage zone, the lateral deviation of the yarn being the same and the

fixed lengths of yarn taken up in the storage zone being uniform in successive cycles.

13. A method of making a pile fabric, which comprises carrying out a cycle made up of the steps of advancing a backing sheet, taking up in a storage zone a fixed length of yarn, supplying the yarn to be taken up in the storage zone by holding and advancing toward said zone a length of yarn drawn from a source of supply with a plurality of successive feed increments thereof laterally deviated by varying amounts corresponding to the heights of successive pile elements in a longitudinal row in the fabric to be produced, successively releasing the leading feed increment of said held length of yarn for introduction into the storage zone and simultaneously with said release adding another feed increment drawn from the source of supply to said held length of yarn at the trailing end thereof, withdrawing a fixed length of yarn from the storage zone and inserting it through the backing sheet to form a loop, and repeating the cycle indefinitely to form a fabric, the fixed lengths of yarn taken up in the storage zone being uniform in successive cycles, and certain feed increments of the laterally deviated length of yarn being shorter than the fixed lengths taken up, the taking up in the storage zone of a fixed length of yarn in a cycle, in which the released feed increment is shorter than said fixed length, causing yarn to be drawn from the loop inserted through the backing sheet in that cycle.

14. A method of making a pile fabric, which comprises carrying out a cycle made up of the steps of advancing a backing sheet, taking up in a storage zone fixed lengths of a plurality of yarns, supplying the yarns to be taken up in the storage zone by simultaneously holding and advancing toward said zone lengths of the yarns drawn from a source of supply with a plurality of successive feed increments thereof laterally deviated by varying amounts corresponding to the heights of successive pile elements in a longitudinal row in the fabric to be produced and with transversely-aligned feed increments of the yarns deviated by varying amounts determined by a pattern, the yarns lying side-by-side while held and being advanced toward the storage zone, successively releasing the leading feed increments of said held lengths of yarns for introduction into the storage zone, and simultaneously with said release of the leading feed increments of the yarns adding another feed increment of each yarn drawn from the source of supply to said held lengths of yarns at the trailing end thereof, and withdrawing fixed lengths of the yarns from the storage zone and inserting them through the backing sheet to form loops, and repeating the cycle indefinitely to form a fabric, the fixed lengths of yarns taken up in the storage zone being uniform in successive cycles, and certain feed increments of the laterally deviated lengths of yarn being shorter than the fixed lengths taken up, the taking up in the storage zone of fixed lengths of yarns in a cycle, in which the released feed increment is shorter than said fixed lengths, causing yarns to be drawn from the loops inserted through the backing sheet in that cycle.

15. A method of making a pile fabric, which comprises carrying out a cycle made up of the steps of advancing a backing sheet, taking up in a storage zone fixed lengths of a plurality of yarns, supplying the yarns to be taken up in the storage zone by forming a plurality of yarns into a sheet with the yarns lying side-by-side, engaging lengths of the yarns in said sheet from opposite sides along spaced lines extending transversely of the yarns, and bending the engaged lengths of yarns to the form of a plurality of waves varying in amplitude both with and along the respective yarns, moving the bent yarns simultaneously toward the storage zone, successively releasing the leading waves of all of the yarns simultaneously, and simultaneously with the releasing of the leading waves of each yarn, engaging a new section of each yarn and bending it to wave form, withdrawing fixed lengths of the yarns from the storage zone and inserting them through the backing sheet to form loops, and repeating the cycle indefinitely to form a fabric, the fixed lengths of yarns taken up in the storage zone being uniform in successive cycles, and the length of certain of the yarns in at least some of the released waves being shorter than the fixed lengths taken up in the storage zone, the taking up in the storage zone of a fixed length of any yarn in a cycle, in which the length of the released section of such yarn is shorter than said fixed length, causing yarn to be drawn from the loop of that yarn inserted through the backing sheet in that cycle.

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