Feb. 26, 1957 J. E. SMITH 2,782,905

PATTERN TUFTING DEVICE FOR PILE FABRICS

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FIG. 1.

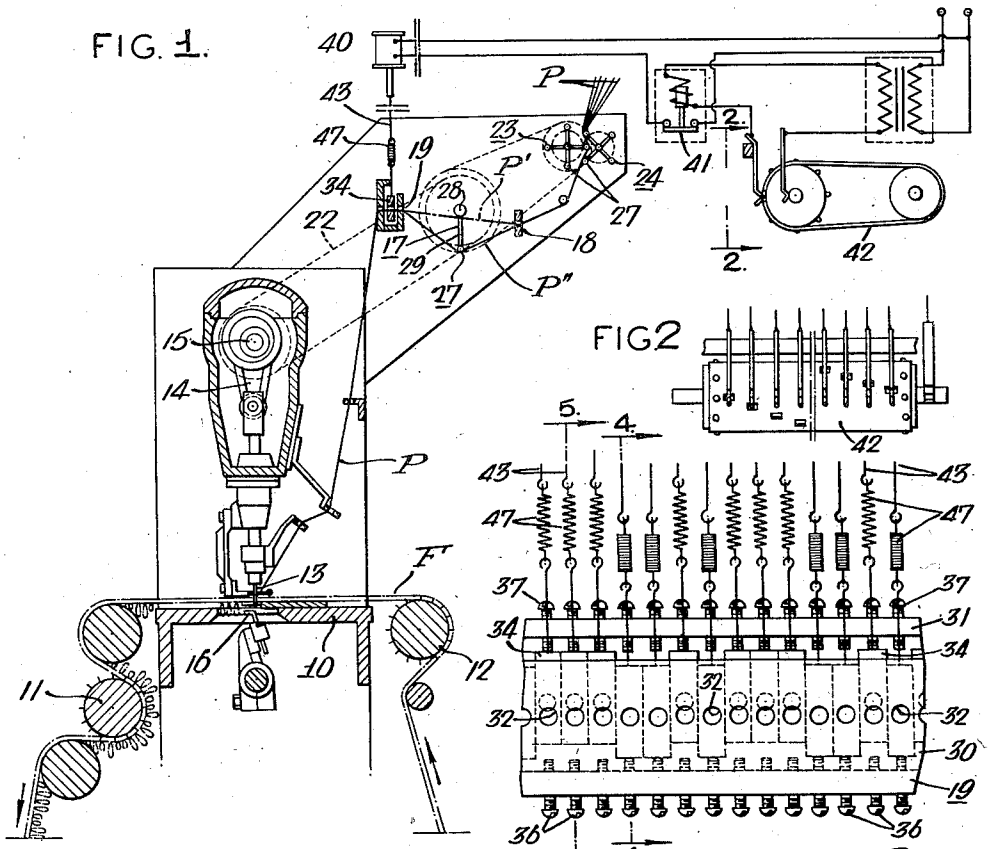


FIG2

FIG.3.

FIG. 4.

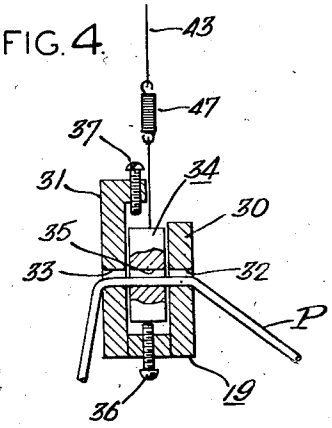
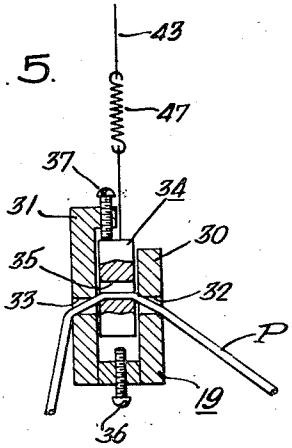


FIG. 5.



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FIG. 6.

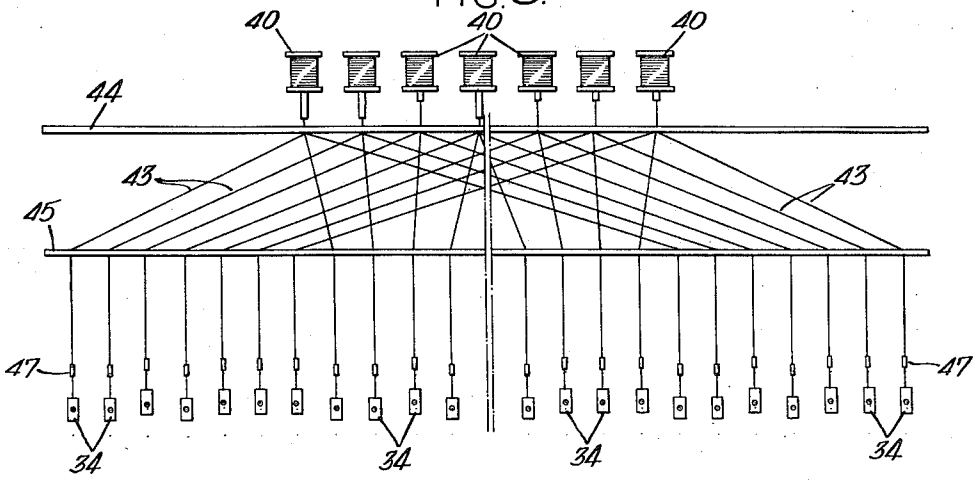


FIG. 7.

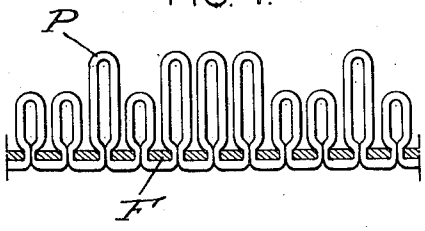


FIG. 8.

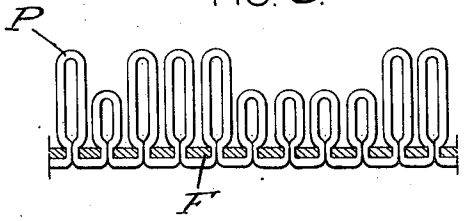


FIG. 9.

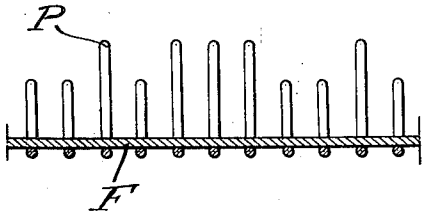
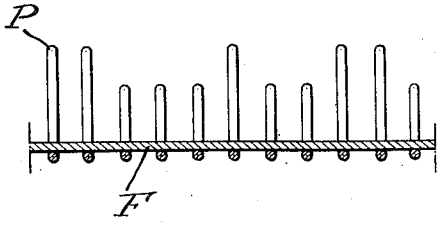


FIG. 10.



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FIG. 11.

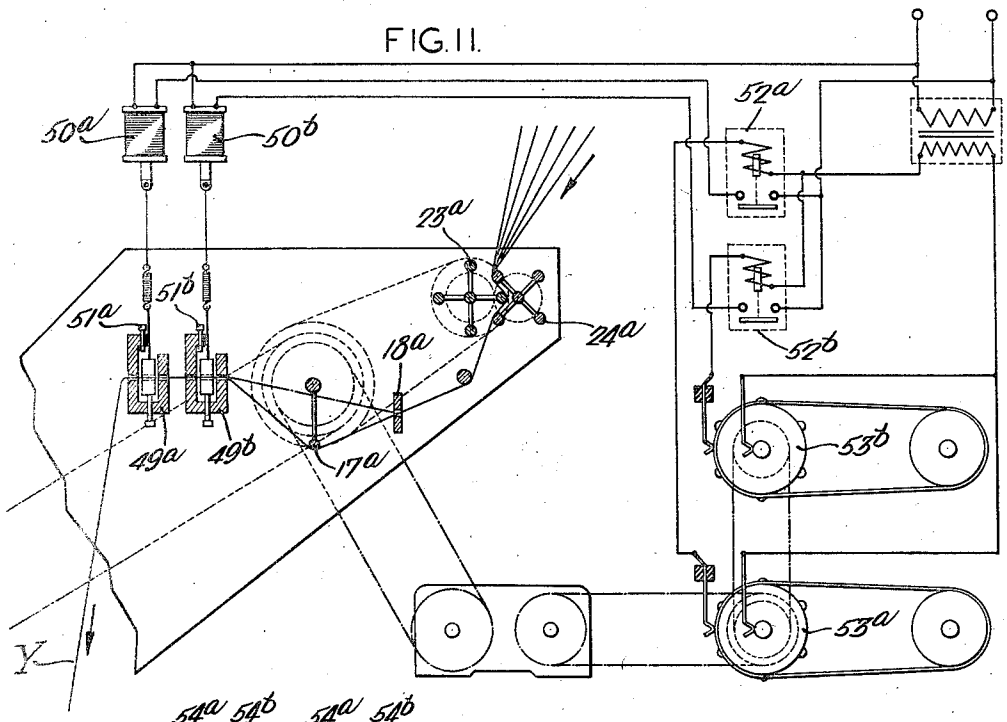


FIG. 13.

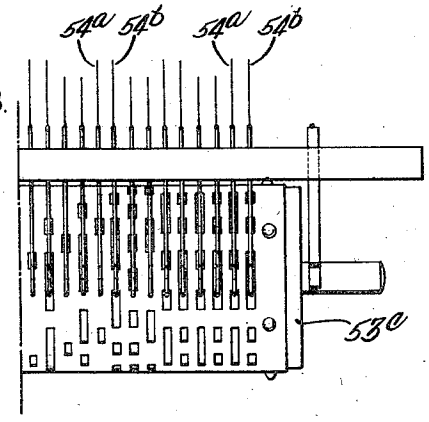


FIG. 12.

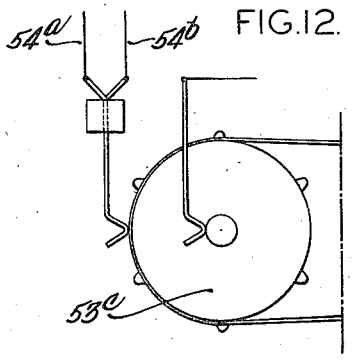


FIG. 14.

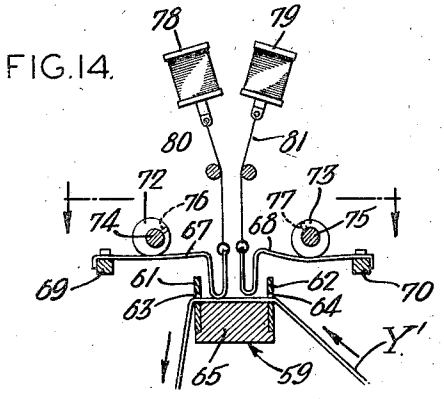
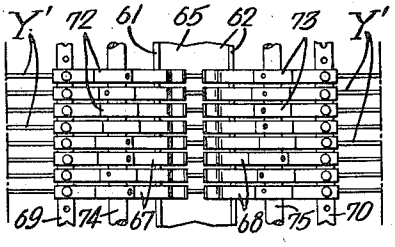


FIG. 15.



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PATTERN TUFTING DEVICE FOR PILE FABRICS

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Application March 5, 1956, Serial No. 569,308

8 Claims. (Cl. 203—200)

The present invention relates to apparatus for producing a variable height pile in pile fabrics and more particularly to control mechanism for varying the rate at which individual ends of pile yarn are supplied to the pile-forming means of tufting machines and similar apparatus, and is an improvement upon the apparatus shown and described in my copending application, Serial No. 464,588, filed October 25, 1954. This application is a continuation-in-part of my application, Serial No. 504,981, filed April 29, 1955, and now abandoned.

In the manufacture of conventional tufted fabrics, the pile surface is formed with uniform pile heights by means of a bank of tufting needles which are adapted to insert a row of pile loops into a base fabric. A let off roll extends the full width of the tufting machine to feed pile yarn to the tufting needles which penetrate the base fabric to a uniform depth when inserting the loops therein. Because of this, it has not been possible to produce a variable pile height in conventional tufted fabrics.

With the ever-increasing use of tufted fabrics for floor covering and the like, it is desirable to provide means for producing variations in the pile height of the finished fabric in order to produce an embossed or carved pile surface effect. An embossed pile surface produces a fabric having striking characteristics which are unobtainable with printed or plain pile patterns.

The prior methods for producing embossed surface effects on tufted pile fabrics involve the use of complicated mechanisms which are disposed along the feed roll to control the feed of the individual pile yarns. These mechanisms are space-consuming and it is, therefore, difficult to obtain the desired regulation of the height of the individual pile loops across the full width of the fabric.

In addition to the difficulty in obtaining the desired regulation of the individual pile loops, the prior mechanisms are difficult to regulate to obtain the desired pattern effect on the pile surface. To obtain the desired pattern, the designer must have an intimate knowledge of the function of the control apparatus in order to properly adjust the regulating devices of the mechanisms to produce the desired effect.

In my aforementioned co-pending application, I have shown and described one type of apparatus for accomplishing pile height control for individual yarn ends. In that application the operation of a yarn beater or feeding element is combined with variably positioned needles to control the rate of feed of the pile yarn to the tufting machine, such control being affected for individual ends of yarn within each repeat of a given pattern.

Certain elements of the above mentioned apparatus are modified and combined in the present invention with other elements to provide for more positive feed of yarn to the needles and more accurate regulation of pile height.

Broadly, the present invention comprises means for feeding predetermined lengths of yarn upon each cycle of the needles combined with individual tensioning means selectively operable to control the amount of yarn fed

to selected needles in accordance with a predetermined pattern.

With the foregoing in mind, it is a primary object of the present invention to produce a novel apparatus for feeding the pile yarn to the loop-forming mechanism of a tufting machine in variable lengths to produce a pile surface of varying height in the finished fabric.

Another object is to provide control apparatus which is easily regulated and set up to provide the desired pattern without the necessity for intimate knowledge of the operating characteristics of the apparatus by the designer.

A further object is to provide control apparatus which can be readily changed to produce a different pattern effect.

Still another object is to provide improved pile yarn control apparatus of simple construction which is entirely effective and efficient in operation and use.

A still further object is to provide an apparatus capable of controlling individual ends of yarn across a given row length to effect the production of floral or non-geometric patterns or the like.

The above and other objects of the invention and the various features and details of the construction and operation thereof are more fully set forth hereinafter with reference to the accompanying drawings in which:

Fig. 1 illustrates a tufting machine embodying control apparatus made in accordance with the present invention;

Fig. 2 is a fragmentary sectional view taken on the line 2—2 of Fig. 1 showing the pattern control elements employed in the device;

Fig. 3 is an enlarged sectional view taken on the line 3—3 of Fig. 1;

Figs. 4 and 5 are sectional views taken on the lines 4—4 and 5—5 respectively of Fig. 3;

Fig. 6 is a diagrammatic representation showing an arrangement for controlling the individual pile yarns;

Figs. 7 and 8 illustrate two laterally adjacent warpwise sectional views of the fabric produced by the machine and method shown and described herein showing pile effects which may be obtained by the present invention;

Figs. 9 and 10 illustrate two consecutively adjacent weftwise sectional views of the fabric produced by the machine and method shown and described herein showing pile effects which may be obtained by the present invention.

Fig. 11 is a fragmentary view similar to Fig. 1 showing a modified embodiment of the present invention;

Fig. 12 is a fragmentary view showing a further modification of the pattern control device which may be employed with the apparatus shown in Fig. 11;

Fig. 13 is a front elevation of the device shown in Fig. 12;

Fig. 14 is a section showing a modified apparatus for controlling the pile yarn within the scope of the present invention; and,

Fig. 15 is a section taken on the line 15—15 of Fig. 14.

The invention may be applied to the formation of any pile fabric in which the pile yarn is fed to the base fabric substantially independently of the formation of the base fabric; but, for the purposes of illustration, the present embodiment of the invention is shown and described in conjunction with a conventional tufting machine.

The present invention provides means for selectively controlling the tension on the pile yarns individually. By applying minimum tension on the yarns, a maximum feed of the pile yarns is obtained. Similarly, by applying maximum tension on the pile yarns, a minimum feed of the pile yarns is obtained. In accordance with a modification of the invention, intermediate tensions are provided which afford intermediate rates of feed, as more fully described hereinafter.

Referring more particularly to the drawings, in the tufting machine shown in Fig. 1, the ground fabric F is fed across the bed 10 of the machine by pin rollers 11 and 12. The pile surface is formed by loops which are inserted into the ground fabric F by a bank of needles 13 mounted for vertical oscillation relative to the bed 10. The needles are oscillated by a crank mechanism indicated generally at 14 and driven by an eccentric shaft 15. The base fabric F is driven intermittently and the bank of needles 13 inserts full rows of loops at successive equally spaced intervals along the length of the fabric. The needles 13 move in unison and penetrate the fabric F to a given distance below the bed 10 of the tufting machine, so that upon each reciprocation of the needles, a row of loops of uniform height is formed in the base fabric F. The latching mechanism for retaining the pile loops in the fabric F upon withdrawal of the needles 13 is conventional, for example, as shown at 16. The pile yarn P is fed to the needles by a rotatable yarn beater 17 disposed between spaced yarn guides 18 and 19. The yarn beater 17 is continuously driven, for example by a chain drive indicated at 22. Rotation of the beater engages and displaces the yarn from the straight line path indicated at P' to the angular path indicated at P'', thereby feeding a length of yarn equal to the difference in length between the path P' and P''. The yarn is fed from the creel since the tension or drag on the yarn at the guide 18 is substantially less than the tension or drag at the tensioning guide 19.

To insure that the yarn is relatively tensionless at the guide 18, a pair of cooperating yarn pullers 23 and 24 are positioned intermediate the guide 18 and the creel (not shown). The yarn pullers rotate at a faster speed than the beater 17, so that when the beater 17 exerts tension on the yarn P, the cooperating pullers 23 and 24 operate to supply yarn in a relatively tension-free condition to the guide 18. When the beater 17 is disengaged from the yarn, and the yarn is slack at the guide 18, the pullers 23 and 24 do not advance the yarn from the creel. In operation, the yarn beater 17 draws a quantity of yarn equal to the length required to form a loop of maximum height through the base fabric F.

In the present instance, the yarn beater and pullers 17, 23 and 24 comprises beater rods 27 extending the full width of the tufting machine and engaging all of the pile yarns passing to the needles. In the instance of the beater 17, the beater rod is mounted for movement in a cylindrical path intersecting the path of travel of the yarn between the guides 18 and 19. To this end, the beater rod is mounted on a rotary shaft 28 positioned above the path of the yarn by means of a plurality of struts or spacer members 29 extending radially from the shaft 28. The beater 17 is driven in synchronism with the tufting needles, so that it passes through its lower limit position when the previously inserted loops are retained in their maximum position by the latching mechanism 16, and is in the upper position or portion of the cycle when the needles are inserting the next row of tufts into the base fabric F. Thus, as the beater rod 27 is displaced from its upper to its lower limit position, it engages the yarn intermediate the guides 18 and 19 and withdraws a selected quantity of yarn from the creel. During the travel of the beater rod from its lower limit position of the cycle, it is disengaged from the yarn and the slack caused by the disengagement may be taken up by the needle as it inserts the yarn into the base fabric.

In accordance with the present invention, means is provided to vary the amount of yarn drawn from the beater 17 by the needles 13 during their insertion through the base fabric F. When lesser lengths of yarn are drawn by the needles from the creel, the remaining length necessary to form a loop of maximum height is drawn or robbed from the loop formed in the immediately preceding row of pile in the base fabric F. Thus, the loop in the preceding row is shortened to provide a low pile therein.

The present invention provides a variation in the feed of yarn from the creel by varying the tension in the yarn intermediate the needles 13 and the beater 17. Thus, when the tension in the yarn at the tensioning guide 19 is substantially less than the tension in the yarn between the needle and the loop formed in the immediately preceding row of pile, the needle in forming a new loop draws the yarn through the guide 19. On the other hand, when the tension at the guide 19 is substantially more than the tension between the needle and the preceding formed loop, the yarn is drawn from the preceding formed loop. When the tension at the guide 19 is substantially equal to the tension between the needle and the previously formed loop, yarn is drawn equally from the guide 19 and from the preceding loop.

In the first instance set forth above, a loop of maximum height is formed by the needle, leaving a loop of maximum height in the preceding row. In the second instance, a loop of maximum height is formed by the needles, completely eliminating the loop formed in the preceding row. In the third instance, a loop of maximum height is formed by the needle, and the loop in the preceding row is reduced in height by approximately one half. By regulating the tension at the guide 19, it is therefore possible to control the height of the loop formed in the preceding row.

In accordance with the present invention, means is provided to vary the tension at the guide 19 between a tensionless condition, and a tensioned condition approximating the tension in the yarn between the needle and the loop of the preceding row of loops. Although the two limit positions are described respectively as tensionless and tensioned conditions, it is to be understood that in the tensionless condition, there is a sufficient tension in the yarn at the guide 19 to cause the base portion of the yarn between adjacent loops to lie snugly against the base fabric. By further increasing the tension in the "tensionless" condition, it is possible to pull back a portion of the preceding loop to provide a maximum pile height less than the maximum penetration of the needles. In a similar manner, the tensioned position may be regulated to provide any selected height of low pile.

The tension regulating device is embodied in the tensioning guide 19. To this end, the guide is formed by a pair of spaced plates 30, 31. The plates are provided with a series of registering apertures 32 and 33 respectively. A plug element 34 is mounted intermediate the plates 30, 31 and is formed with a pot-eye 35 for passing the pile yarn P. The plug 34 is vertically displaceable between lower and upper limit positions shown in Figs. 4 and 5 respectively. In the lower limit position, the pot-eye 35 is in substantial registry with the apertures 32 and 33 to exert a minimum tension in the pile yarn P as it passes through the guide member 19. In the opposite limit position, as shown in Fig. 5, the pot-eye 35 is only in partial registry with the apertures 32, 33 to exert maximum tension on the pile yarn P. A set screw is provided at 36 to adjust the lower limit position of the plug 34 to provide the desired minimum tension; and a set screw is provided at 37 to regulate the upper limit position of the plug 34 and thereby regulate the maximum tension at the guide 19. Each pile yarn is threaded through the pot-eye of an individual plug member 34, so that each pile yarn is susceptible of individual control.

It should be noted that the plug 34 is maintained in a given position for as long as the yarn passing through the guide 19 is forming loops of a given height. The position of the plug changes only when it is desired to change the height of loops being formed in the pile yarn.

In order to control the positioning of the plug 34 so as to cause loops of selected heights to be formed in the

fabric F in accordance with a predetermined pattern, a series of solenoids 40 is provided, each of which, when energized, raises selected plugs 34 to the upper position, and when subsequently de-energized, allows the plugs to return to the lower position. As shown schematically in Fig. 1, energization and de-energization of the solenoid 40 is controlled by means of a low-energy relay 41 which, in turn, is controlled by a conventional rotary belt contact selector 42 set up according to a predetermined pattern.

Figure 6 diagrammatically illustrates one type of arrangement of the control mechanism for carrying out the present invention. In practice, one solenoid 40 will be provided to control the positioning of each individual plug 34 within each repeat of a selected pattern weftwise of the fabric. The illustration, by way of example, shows seven plugs 34 in each repeat of the pattern beginning at the left side thereof. Assuming these seven plugs to comprise one complete pattern, it may be seen that every eighth plug is controlled by the same solenoid 40 through wires 43 directed through guides 44 and 45 so as to provide identical repeats of the pattern weftwise of the fabric. The wires 43 are connected to the plugs 34 through a spring 47. With normal settings of the set screws 36 and 37, the plug moves a fraction of an inch, whereas the solenoids 40 have strokes of two or three inches. Thus, the springs 47 compensate for the differences in the movements of the two elements. It is contemplated that for coarser patterns, each solenoid 40 may control two or more plugs 34 in each repeat of the pattern weftwise of the fabric.

Figures 7 and 8 illustrate two consecutively adjacent warpwise sections through a pile fabric which may be produced by means of the present invention and illustrates the flexibility of control of each individual warpwise pile loop that can be accomplished thereby.

Figures 9 and 10 illustrate two consecutively adjacent weftwise sections through a pile fabric which may be produced by means of the present invention and further illustrates the flexibility of control over each weftwise pile loop that can be accomplished thereby.

Figures 11 to 15 inclusive show means for obtaining four different heights of pile. In these instances, each pile yarn is controlled by two tension devices arranged in series. Each tension device is selectively operable to exert minimum or maximum tension on the yarn. The maximum tension applied by each device is different, and the series relationship of the devices adds the tension of the two devices. In this manner, when both devices provide minimum tension, high pile is formed; when both tension devices provide maximum tension, low pile is formed; and when one of the two tension devices applies maximum tension and the other applies minimum tension, either high, intermediate or low intermediate pile is formed, depending on which of the tension devices is actuated.

Referring now to Fig. 11, the yarn Y is fed from a creel (not shown) by a yarn puller 17*a* and a cooperating pair of yarn pullers 23*a* and 24*a* through a guide 18*a* in the manner described above in connection with Fig. 1. Instead of a single guide 19 embodying a tension device, two tension devices 49*a* and 49*b* control the yarn. Each of the tension devices 49*a* and 49*b* is constructed similarly to the tension device 19. The tension device 49*a* is actuated by a solenoid 50*a*, and the tension device 49*b* is actuated by a solenoid 50*b*. In the illustrated position, each of the devices 49*a* and 49*b* apply minimum tension to the yarn Y passing through the device. However, when the device 49*a* is actuated, it applies a greater tension on the yarn than does the device 49*b* when it is actuated. This is accomplished by adjusting the set screws 51*a* and 51*b* respectively to different positions. Thus, as pointed out above, four different tensions are available by selectively energizing the solenoids 50*a* and 50*b*. The solenoids 50*a* and 50*b* are energized respectively by low energy relays 52*a* and 52*b*. The solenoids, in turn, are respectively energized by two conventional rotary belt contact selectors 53*a* and 53*b*. Of course, other pattern control devices may be employed.

Figures 12 and 13 illustrate a modification wherein a single rotary belt contact selector 53*c* controls the supply of current to the conductors 54*a* and 54*b* respectively, leading to the solenoids 50*a* and 50*b*. Since there are two solenoids for each separately acting pile yarn Y, there are two relays and two conductors leading from the control device for each pile yarn which is controlled separately.

Figures 14 and 15 illustrated a modified form of tension device embodying the present invention. In the present instance, the tensioning guide 19 is replaced by a tension device 59. The tension device 59 comprises a pair of guide plates 61 and 62 having pot-eyes 63 and 64 therein respectively. The yarn is threaded through the pot-eyes as shown in Fig. 14 and travels over a spacer block 65 mounted between the guide plates 61 and 62. Preferably, the spacer block 65 is formed of porcelain or another material highly resistant to frictional erosion by the pile yarns.

Means is provided to exert tension on the individual yarns in the form of spring fingers 67 and 68 mounted to bear against each individual pile yarn. As shown, the fingers are fixed in supports 69 and 70 and are biased against the yarn Y'. When biased against the yarn, the fingers provide a predetermined drag or tension on the yarn. Means is provided to insure that all of the fingers 67 exert a uniform given tension on the yarns, and all of the fingers 68 exert a uniform greater tension on the yarns. To this end, each of the fingers is engaged by an eccentric cam 72 or 73 which are keyed to fixed shafts 74 and 75 by set screws 76 and 77 respectively. By adjusting the cams angularly on the fixed shaft 74, the differences in the resilience of the individual spring fingers is compensated for.

Means is provided to relieve the tension applied by the fingers 67 and 68, in the form of solenoids 78 and 79, which are connected to the fingers as indicated at 80 and 81. Thus, when it is desired to form pile of maximum height, minimum tension is applied to the yarn by de-energizing both of the solenoids 78 and 79; to form intermediate high pile, the solenoid 78 is de-energized, to form low intermediate pile, the solenoid 79 is de-energized, and the solenoid 78 is energized; and to form minimum height pile, both solenoids 78 and 79 are de-energized. Thus, by selectively controlling the solenoids 78 and 79 for each pile yarn, four different pile heights may be obtained. The control of the solenoids may be affected in the manner illustrated in Figs. 11 and 12, but of course, other pattern control devices may be employed.

Thus, it is seen that the present invention affords pile height control apparatus wherein the operation of a yarn beater and pullers or other feeding element is combined with variably positioned tension elements to control the tension and thereby the rate of feed of the pile yarn to the tufting machine, such control being effected for individual ends of yarn within each repeat of a given pattern.

While particular embodiments of the present invention have been herein illustrated and described, it is not intended to limit the invention to such disclosure, but changes and modifications may be made therein and thereto, as defined in the appended claims, without departing from the invention.

I claim:

1. In pile yarn control apparatus, a yarn guide device having tensioning means for the individual yarns operable selectively between positions providing minimum and maximum tensions respectively, and means to supply lengths of yarns to said guide device in a relatively tensionless condition, said guide device comprising a fixed guide member having aperture means therein for passing each of said yarns, a movable member for each yarn cooperable with said fixed guide member and engageable with said yarn, and selectively operable means for each of said movable members to displace the same between

a first position to exert a minimum tension on said yarn and a second position to exert a maximum tension on said yarn, said supply means comprising a yarn beater mounted for rotation in a cylindrical path intersecting the yarn path to said guide device, and a pair of inter-engaging yarn pullers mounted for rotation to engage the yarn in said path and advance the same when tensioned.

2. A device according to claim 1 wherein said movable member for each yarn has a pot-eye therein for passing said yarn, and wherein further each of said movable members in its first position disposes said pot-eye in registry with said aperture means to exert a minimum tension on said yarn, and in its second position disposes said pot-eye out of registry with said aperture means to exert a maximum tension on said yarn; said selectively operable means comprising a solenoid, a connection between the core of said solenoid and said movable member, and means to selectively energize said solenoid to displace the core between first and movable limit positions, said connection positioning said second member in its first position when the core is in its first position, and positioning said movable member in its second position when said core is in its second position.

3. A device according to claim 2 wherein said connection includes a resilient element extendable to compensate for the differences in the distances between the first and second positions of said solenoid and said movable member.

4. A device according to claim 1 wherein said movable member comprises a resilient finger element operable in its first position to afford untensioned free travel of the yarn, and operable in its second position to pinch the yarn and restrain its travel to provide maximum tension.

5. A device according to claim 4 wherein said selectively operable means comprises a solenoid, a connection between the core of said solenoid and said movable member, and means to selectively energize said solenoid to displace the core between first and movable limit positions, said connections positioning said movable member in its first position when the core is in its first position and positioning said movable member in its second position when said core is in its second position.

6. In pile yarn control apparatus, tensioning means for the individual yarns operable selectively between positions providing minimum and maximum tensions respectively, comprising a pair of spaced fixed guide plates, each having a series of apertures therein for passing each of said yarns, the corresponding apertures in the plates

being in registry, a spacer block intermediate said guide plates adjacent said apertures to underlie the yarn passing through said apertures, a spring finger for each yarn fixedly mounted at one end adjacent said plates and projecting into engagement with said yarns at its other end, and selectively operable means for each of said fingers to displace said other end between a first position in which said finger is displaced out of engagement with said yarn to exert a minimum tension on said yarn, and a second position in which said finger is biased into engagement with said yarn to pinch the same between said finger and said spacer block to thereby exert a maximum tension on said yarn.

7. Apparatus according to claim 6 including a fixed shaft overlying said finger elements, cam elements rotatable on said shaft and engaging said finger elements intermediate the ends thereof to bias the same into engagement with the yarns, and means to lock said cam elements at a predetermined angular position on said shaft.

8. In pile yarn control apparatus, tensioning means for the individual yarns comprising a first tensioning element for each yarn engaging said yarn, and selectively operable means for said first tensioning element to displace the same between a first position to exert a minimum tension on said yarn, and a second position to exert a given maximum tension on said yarn, a second tensioning element for each yarn engaging said yarn adjacent said first tensioning element, and selectively operable means for each of said second tensioning elements to displace the same between a first position to exert a minimum tension on said yarn and a second position to exert a second given maximum tension on said yarn greater than said first given maximum tension, and control means for said first and second selectively operable means to control the condition of tension on said yarn among four conditions: a minimum tension condition wherein said two selectively operable means are disposed in their first position, a low intermediate tension condition wherein said first selectively operable means is in its second position, and said second selectively operable means is in its first position, and a high intermediate tension wherein first selectively operable means is disposed in its first position and said second selectively operable means is disposed in its second position, and a maximum tension condition wherein both said first and second selectively operable means are disposed in their second positions.

No references cited.