United States Patent [19]

Bondi

[11] **3,847,692**

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[54] **METHOD AND APPARATUS FOR MAKING PILE FABRICS FROM A BLOCK OF PILE YARNS**

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[73] Assignee: **Fieldcrest Mills, Inc.,** Eden, N.C.

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[21] Appl. No.: **363,832**

Related U.S. Application Data

[63] Continuation-in-part of Ser. Nos. 54,751, July 14, 1970, abandoned, and Ser. No. 316,740, Dec. 20, 1972.

[30] **Foreign Application Priority Data**

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Dec. 12, 1969 Italy 25744/69

[52] **U.S. Cl.** **156/72,** 156/148, 156/204, 156/226, 156/227, 156/251, 156/435, 156/459, 156/474, 156/516

[51] **Int. Cl.** **B32b 5/00,** B32b 31/12, B32b 31/18

[58] **Field of Search** ..... 156/72, 148, 177, 204, 156/226, 251, 297, 435, 459, 474, 516, 227; 28/72 R

[56] **References Cited**

UNITED STATES PATENTS

3,673,048	6/1972	Gidge	156/510
3,580,761	5/1971	Boultinghouse	156/72
3,390,034	6/1968	Hull	156/72
3,359,147	12/1967	Miller	156/72
3,325,324	6/1967	Schmidt et al.	156/72
2,788,835	4/1957	Brookes	156/72
2,516,559	7/1950	Fuhrhop et al.	156/72
2,491,258	12/1949	Fuhrhop et al.	156/72
3,085,922	4/1963	Koller	156/435

FOREIGN PATENTS OR APPLICATIONS

1,040,286	8/1966	Great Britain	156/72
1,047,382	11/1966	Great Britain	156/72
790,498	2/1958	Great Britain	156/72
496,165	10/1950	Belgium	156/72
140,288	5/1953	Sweden	156/72
332,070	8/1903	France	156/254

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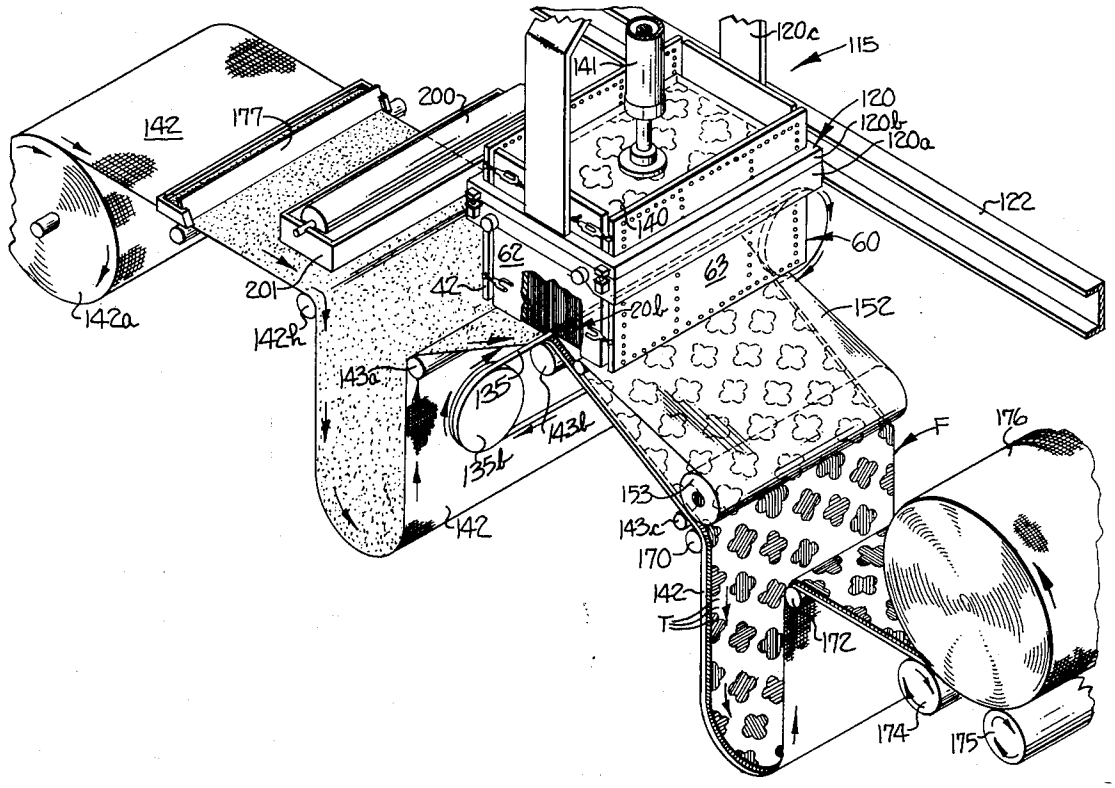
Attorney, Agent, or Firm—Parrott, Bell, Seltzer, Park & Gibson

[57] **ABSTRACT**

A method and apparatus for making pile fabrics, such as carpets, rugs and the like, ultizing a block of substantially parallel pile yarns in an open-ended container, wherein the pile yarns are incrementally fed from the container parallel to their axes in successive increments of an amount equal to the desired length of pile. Following each successive incremental feeding of the pile yarns from the container, they are progressively severed transversely of their axes while being progressively deposited onto an adhesive-coated backing to connect the severed pile yarns to the backing and while the backing is being advanced relative to the block of pile yarns.

42 Claims, 14 Drawing Figures



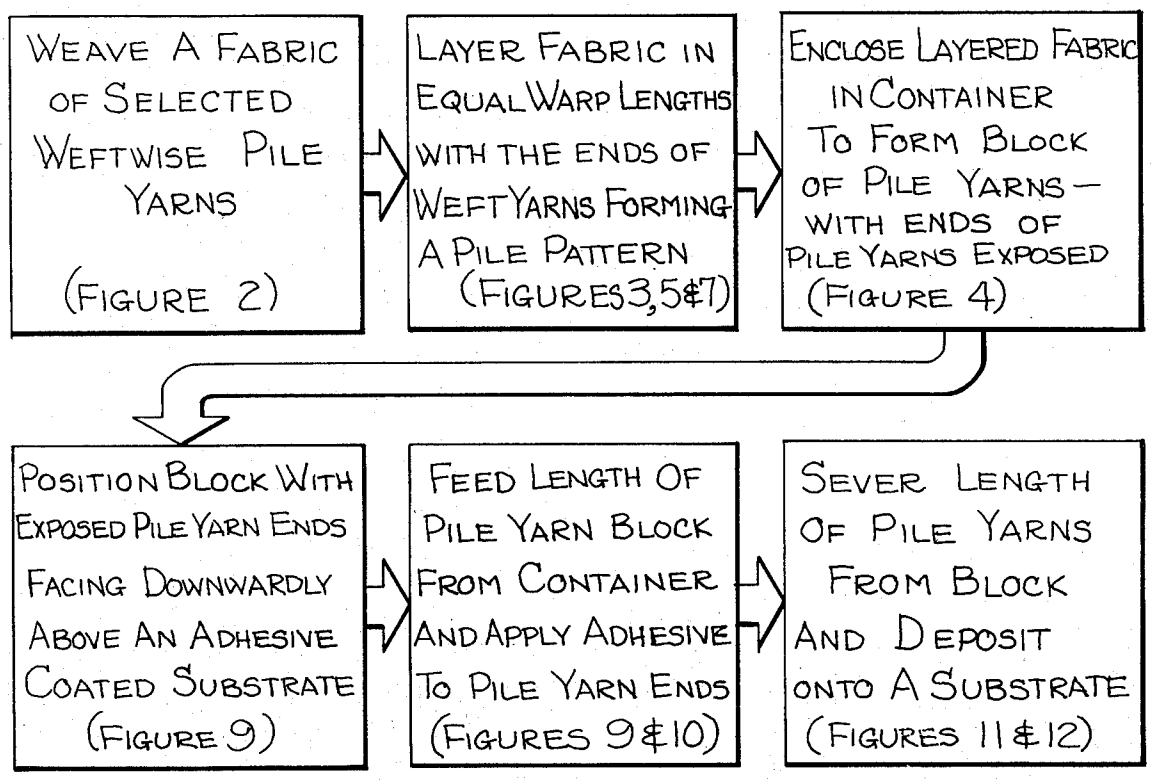

WEAVE A FABRIC OF SELECTED WEFTWISE PILE YARNS (FIGURE 2)
LAYER FABRIC IN EQUAL WARP LENGTHS WITH THE ENDS OF WEFT YARNS FORMING A PILE PATTERN (FIGURES 3, 5 & 7)
ENCLOSE LAYERED FABRIC IN CONTAINER TO FORM BLOCK OF PILE YARNS — WITH ENDS OF PILE YARNS EXPOSED (FIGURE 4)
POSITION BLOCK WITH EXPOSED PILE YARN ENDS FACING DOWNWARDLY ABOVE AN ADHESIVE COATED SUBSTRATE (FIGURE 9)
FEED LENGTH OF PILE YARN BLOCK FROM CONTAINER AND APPLY ADHESIVE TO PILE YARN ENDS (FIGURES 9 & 10)
SEVER LENGTH OF PILE YARNS FROM BLOCK AND DEPOSIT ONTO A SUBSTRATE (FIGURES 11 & 12)

Fig-1

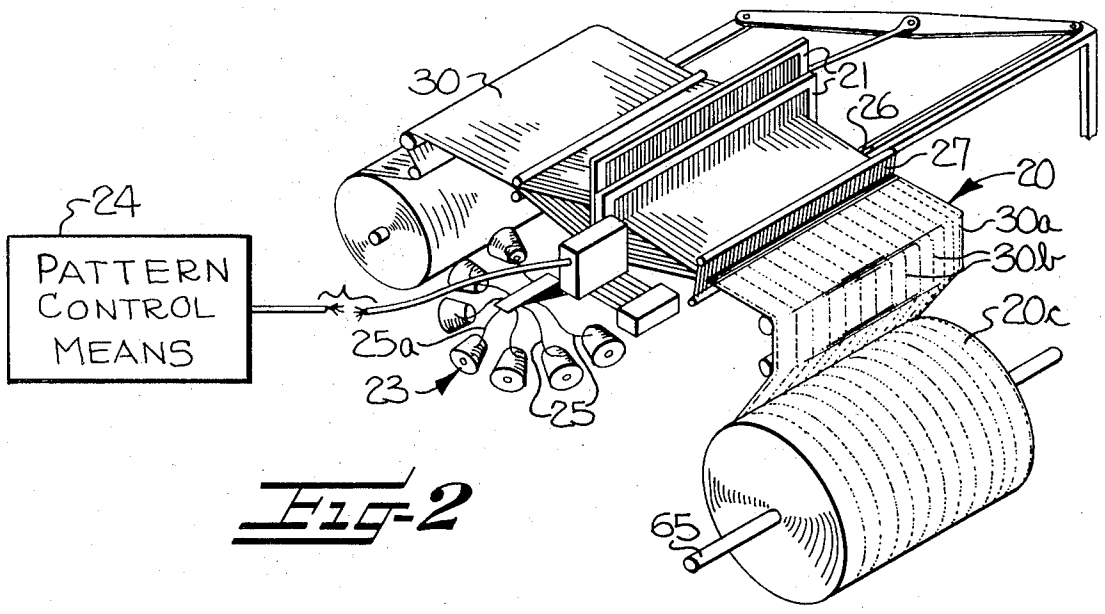
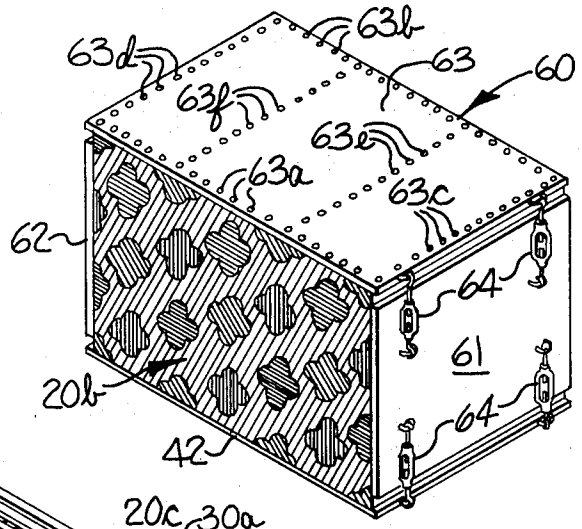

24
PATTERN CONTROL MEANS
30
21
26
27
20
30a
30b
20c
25a
23
25
65

Fig-2

Fig-4


63d
63b
63
60
63f
63e
63a
63c
62
64
61
20b
64
42

102
110
101
107
103
106
105
100
100a
20c
30a
74
70
73
71
72
65
20
30b
83
75
80
85
81
20b
82
40
41
42
50
45
87
86
43

Fig-3

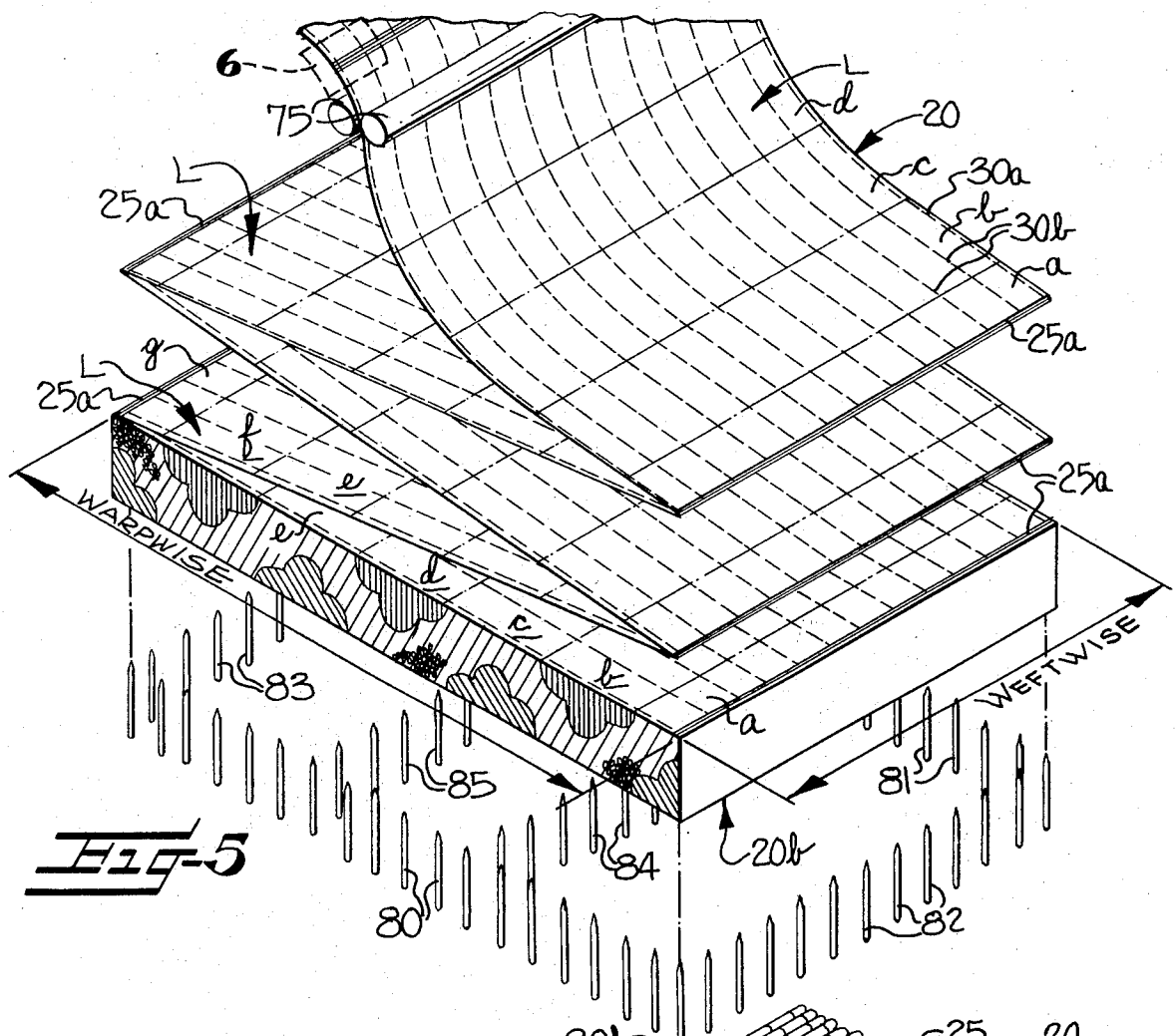

6
75
L
d
20
c
30a
b
30b
a
25a
L
25a
g
L
25a
f
e
WARPWISE
e
d
c
b
a
25a
WEFTWISE
83
85
81
84
20b
80
82

Fig-5

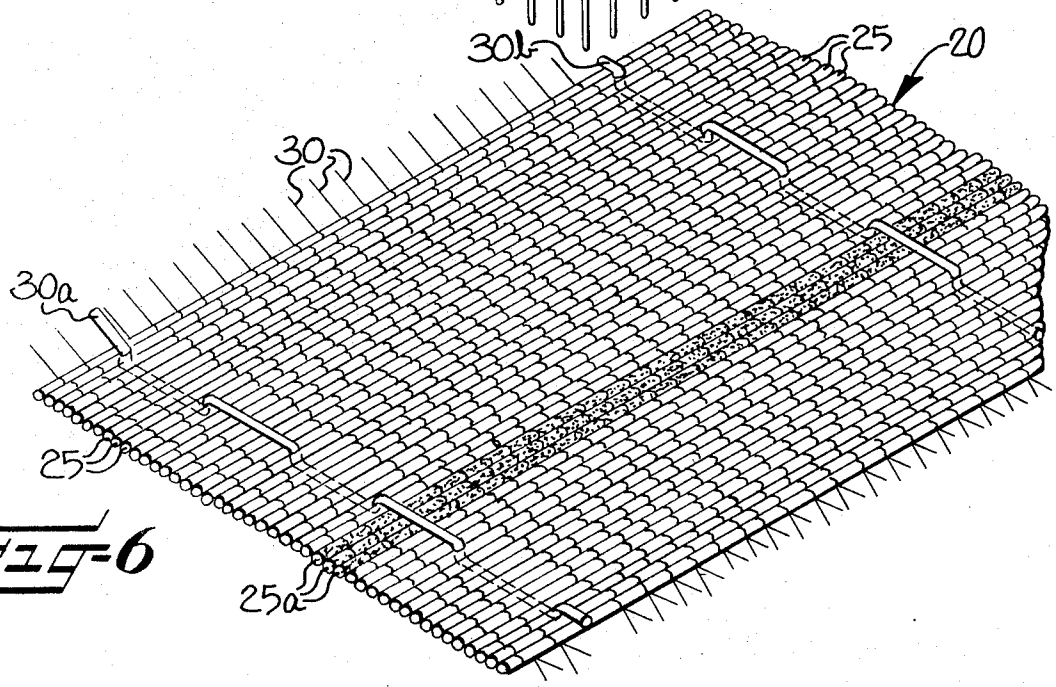

30b
25
20
30
30a
25
25a

Fig-6

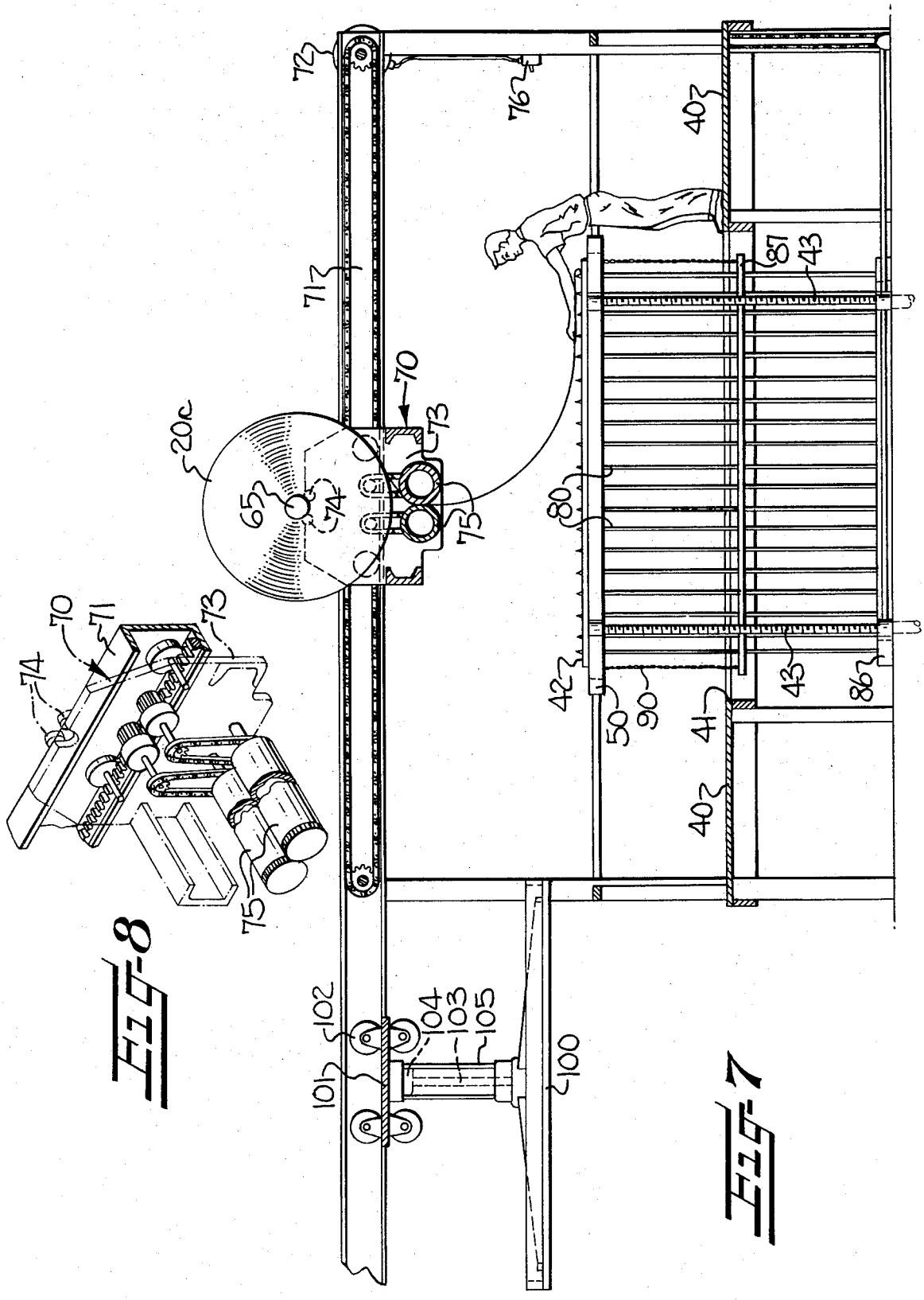

72
76
40
71
87
43
70
73
20c
65
74
75
80
42
50
90
41
86
102
104
103
105
101
100

FIG-8

FIG-7

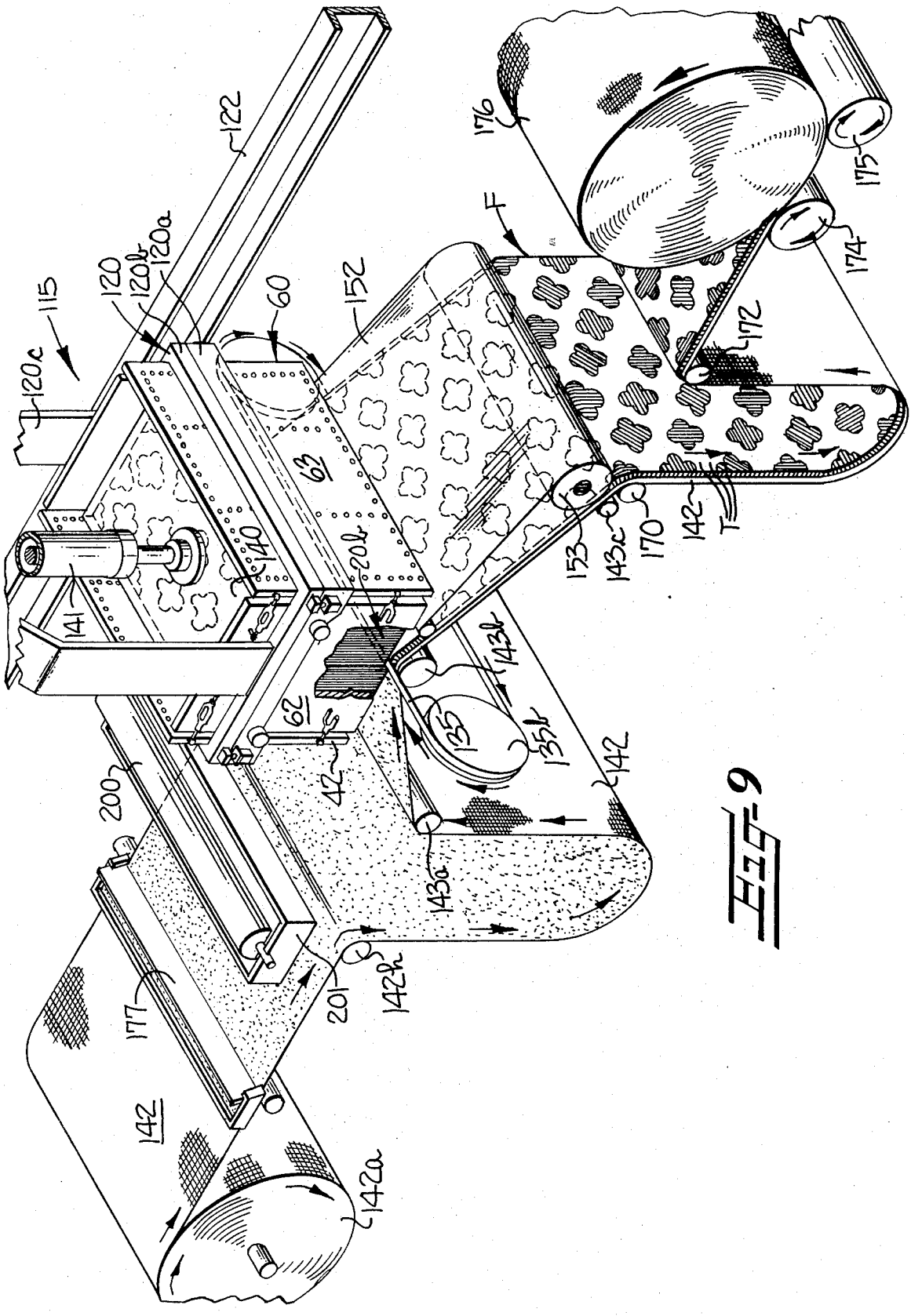

122
120
120b
120a
115
120c
60
152
176
175
F
174
172
63
140
141
20b
153
143c
170
142
T
143b
135
135b
62
42
200
142
143a
142b
201
177
142
142a

Fig. 9

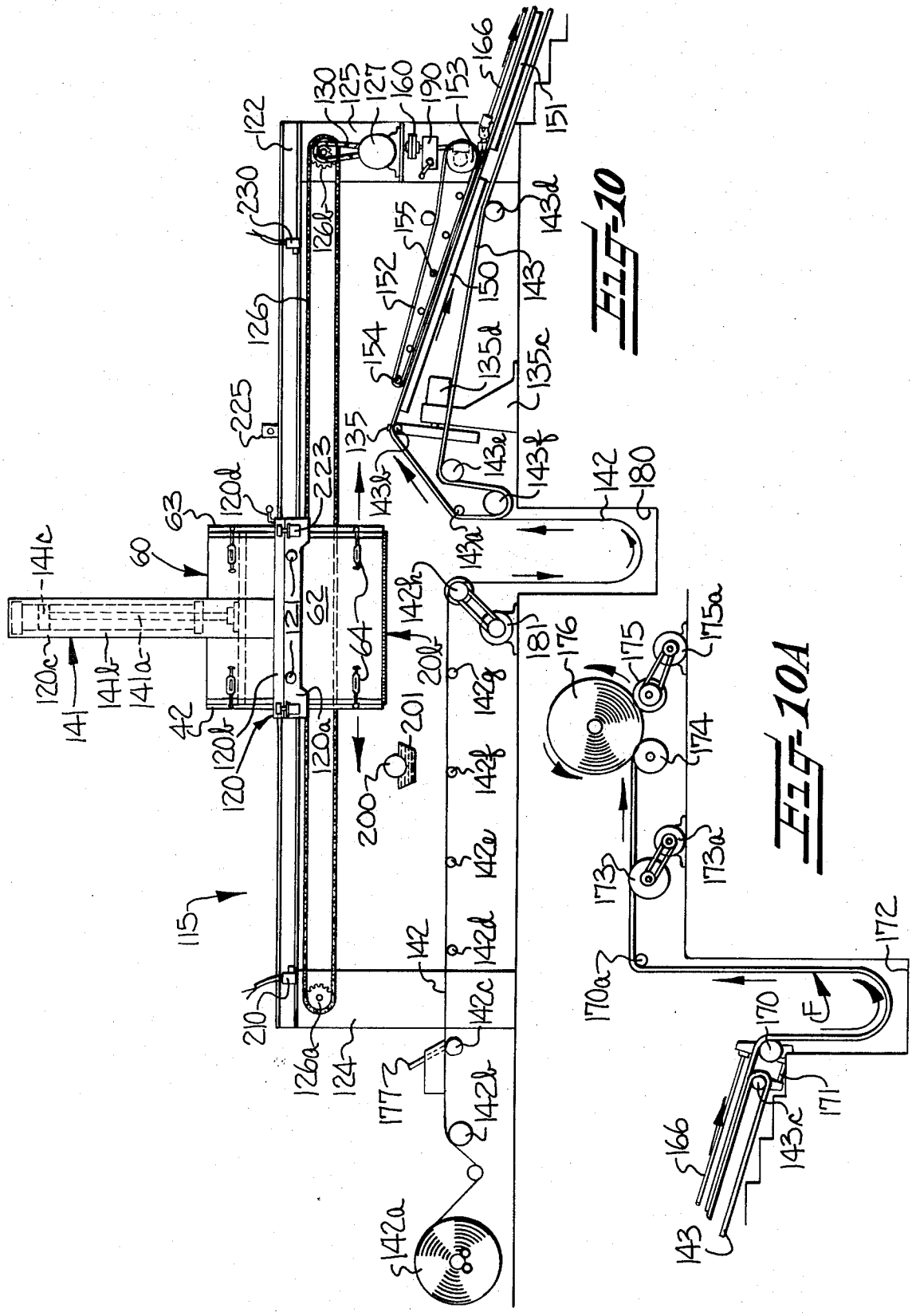


FIG-10
FIG-10A

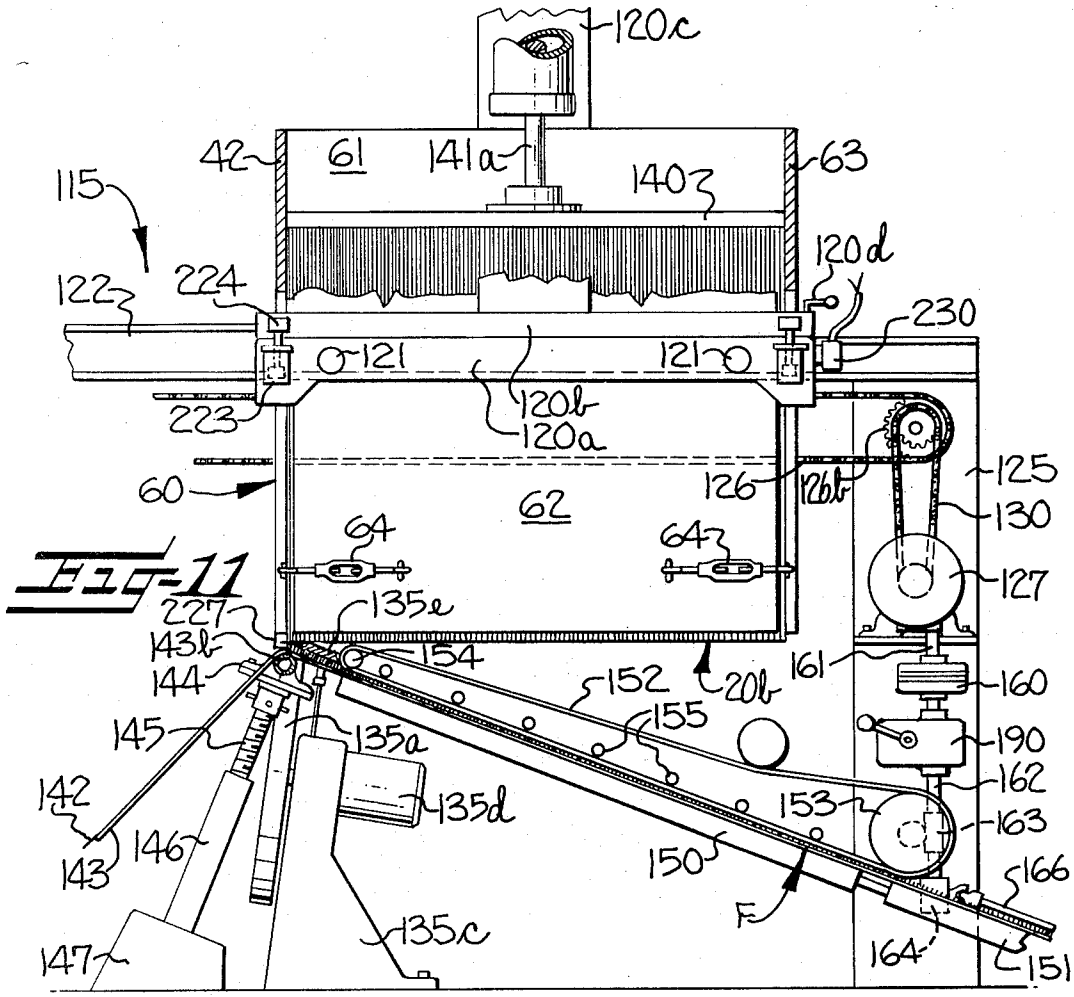

120c
42
61
141a
140
63
115
120d
122
224
230
121
121
120b
120a
223
60
62
126
126b
125
130
64
64
127
227
135e
143b
154
144
152
20b
161
160
145
135a
155
190
142
135d
153
162
146
163
143
150
166
F
147
135c
164
151

Fig-11

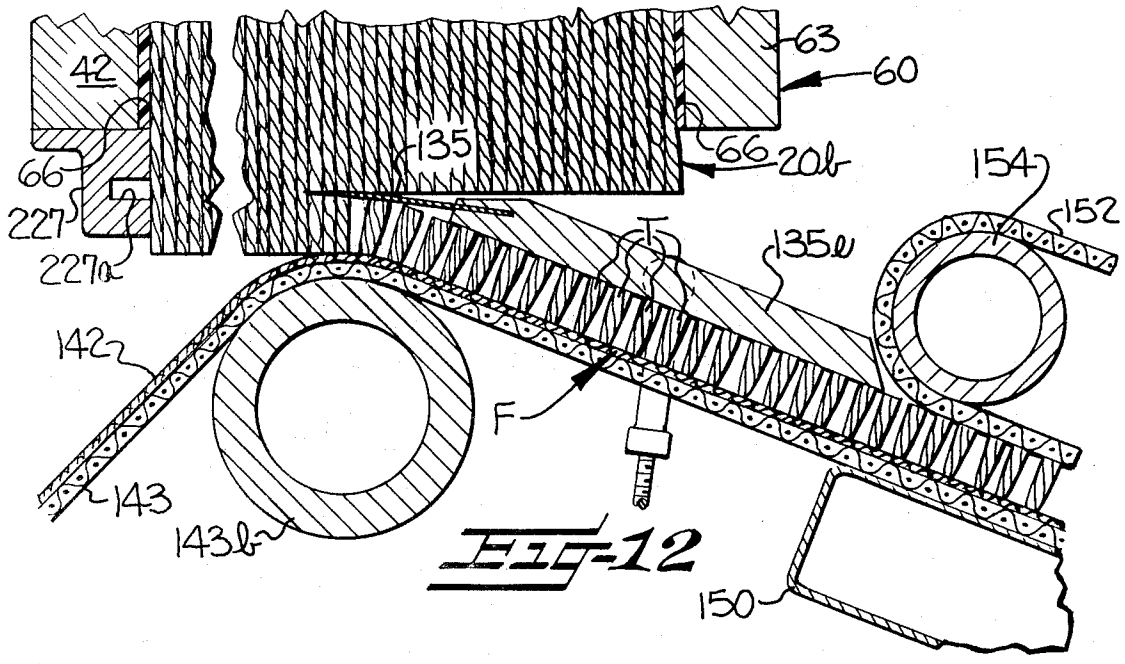

42
63
60
135
66
66
20b
154
227
152
227a
135e
T
142
F
143
143b
150

Fig-12

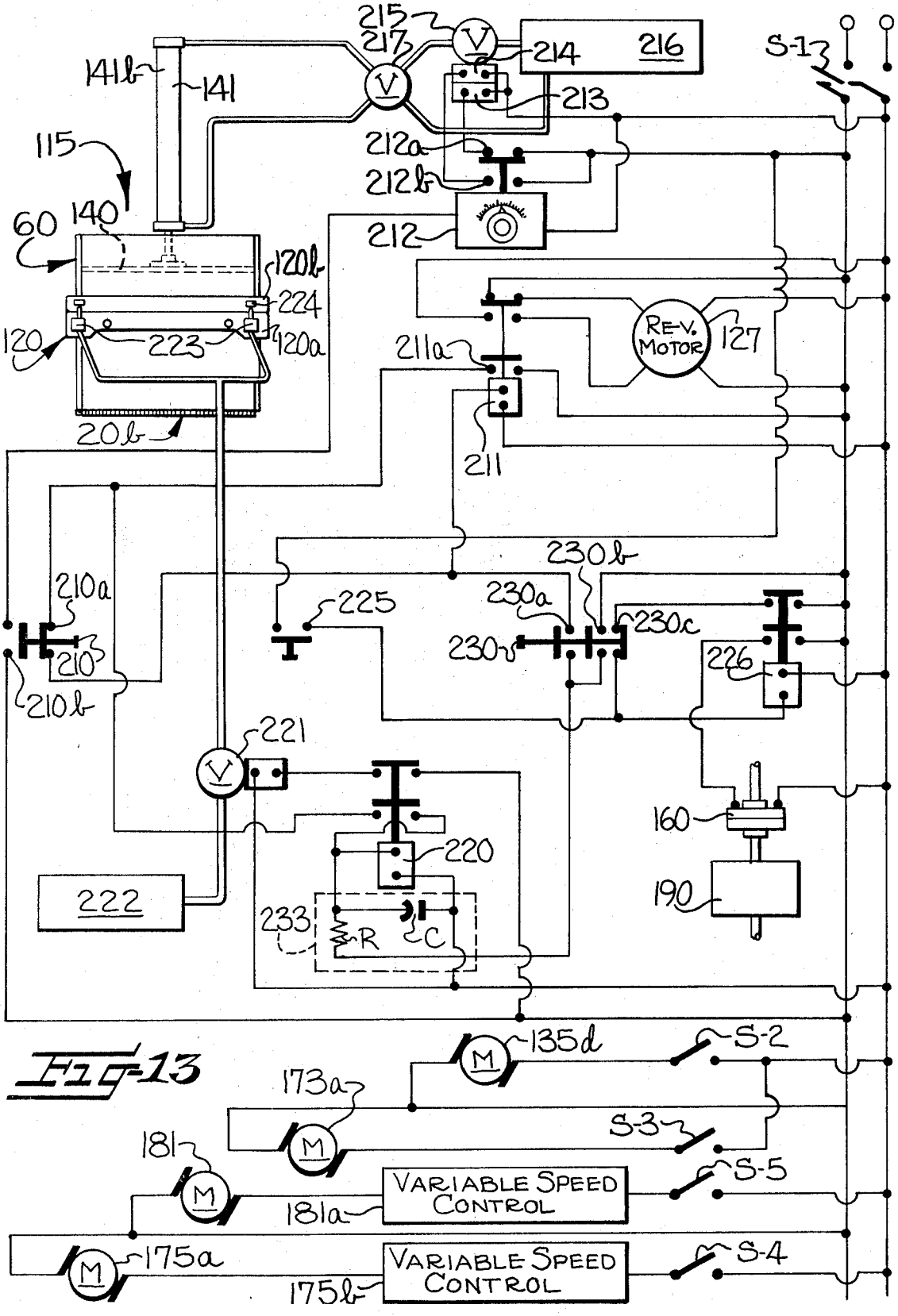

215
217
214
216
S-1
141b
141
213
115
212a
212b
60
140
212
120b
224
120
223
120a
RE-V. MOTOR
127
211a
20b
211
230b
210a
225
230a
230c
230
210
226
210b
221
160
220
190
222
233
R
C
135d
S-2
173a
S-3
181
S-5
VARIABLE SPEED CONTROL
181a
175a
S-4
VARIABLE SPEED CONTROL
175b

FIG-13

METHOD AND APPARATUS FOR MAKING PILE FABRICS FROM A BLOCK OF PILE YARNS

This application is a continuation-in-part of my copending application Ser. No. 54,751, filed July 14, 1970, now abandoned and entitled A METHOD AND EQUIPMENT FOR PRODUCING CARPETS WITH WELDED OR GLUED PILE, AND CARPETS THEREBY PRODUCED, and this application also is a continuation-in-part of my copending application Ser. No. 316,740, filed Dec. 20, 1972, and entitled METHOD OF PRODUCING PATTERNED BLOCKS OF PILE YARNS IN MAKING PATTERNED PILE FABRICS.

Various methods and apparatuses have been proposed heretofore for producing patterned blocks of pile yarns and utilizing such blocks for making pile fabrics by anchoring the ends of the pile yarns together, either by means of an adhesive or by melting of the ends of the pile yarns, or by adhesively or fusibly securing the ends of the pile yarns to a suitable backing or substrate and then severing a slice of the pile yarns from the yarn block. Various such methods and apparatuses are disclosed in British Pat. No. 662,531, published Dec. 5, 1951, British Pat. No. 732,980, published July 6, 1955, British Pat. No. 1,040,286, published Aug. 24, 1966, and U.S. Pat. Nos. 2,438,156; 2,491,258; 3,359,147 and 3,673,048, for example. The methods and apparatuses proposed in these prior art patents, as well as any other methods and apparatuses proposed heretofore within applicant's knowledge, have presented many problems and difficulties which could not be effectively overcome to such extent as to permit feasible, economical and practical production-line techniques in the manufacture of pile fabrics, especially pile fabrics having highly intricate pattern designs in the pile surface thereof. Also, such prior art methods and apparatuses have not permitted readily obtaining variations in density of the pile in the various pile fabrics produced in accordance with the teachings of the known prior art.

It is therefore the primary object of this invention to provide an improved method and apparatus for making pile fabrics in which the principle of severing pile tufts from a block of pile yarns is adopted, but which improved method and apparatus is more efficient and more economical than any prior art methods or apparatuses of which I am aware.

It is a more specific object of this invention to provide an improved method and apparatus for making pile fabrics, such as carpets, rugs and the like, from a block of substantially parallel pile yarns in an open-ended container, and wherein the pile yarns are fed parallel to their axes from the container in successive increments of an amount equal to the desired length of pile and are progressively severed transversely of their axes following each successive incremental feeding of the pile yarns from the container, and also wherein the severed pile yarns are progressively deposited onto an adhesive-coated backing to connect the severed pile yarns to the backing while the backing is being advanced relative to the block of pile yarns.

According to the preferred specific embodiment of the invention, a patterned block of pile yarns is formed by weaving a plurality of weftwise pile yarns of different colors in a predetermined patterned order and then forming a compact stack of layers of the woven fabric by moving the same back and forth and folding the same along identifying weft yarns previously woven into the fabric. The compact stack of folded fabric is then enclosed in an open-ended container to form a confined block of pile yarns with the ends of the pile yarns exposed and forming a composite pattern at an open end of the container. The container then is positioned on a suitable carriage equipped with means for incrementally feeding the block of pile yarns from the open end of the container in successive increments of an amount in accordance with the desired length of pile and also mounted so as to move the container forwardly in a predetermined path transversely of the pile yarn axes while moving the container into cooperating relation with a severing means. The severing means is arranged to progressively sever the ends of the pile yarns during forward movement of the container so as to form tufts of the pile yarns. The apparatus also is provided with means for advancing an adhesive-coated backing forwardly past and adjacent the severing means and the pile yarn block during the severing of the pile yarns so that the tufts being formed are progressively deposited onto the backing and joined thereto during the severing of the pile yarns.

Some of the objects and advantages of the invention having been stated, others will appear as the description proceeds when taken in connection with the accompanying drawings, in which

FIG. **1** is a block diagram briefly setting forth steps according to the method of the present invention;

FIG. **2** is a schematic perpsective view of a loom for weaving a fabric of selected weftwise pile yarns used for forming the patterned yarn block of which the improved pile fabric is formed;

FIG. **3** is a schematic perspective view, with portions broken away, showing a preferred form of fabric layering apparatus for forming a cake or stack of superposed fabric layers constituting the patterned block of pile yarns employed in forming the pile fabric;

FIG. **4** is a schematic perspective view of a completed patterned block of pile yarns produced according to the present invention and wherein the layered stack of weftwise pile yarns is positioned in an open-ended container with corresponding ends of the pile yarns exposed so that they may be severed from the pile yarn block to form pile tufts therefrom;

FIG. **5** is a schematic partially exploded view of an upper portion of the stack of superposed fabric layers shown in FIG. **3**, for the purpose of illustrating various bands of contrasting or different colors or kinds of weftwise pile yarns in the fabric and also illustrating how the fabric layers may be impaled on restraining pins to ensure proper alignment of the successive layers in the stack being formed;

FIG. **6** is a greatly enlarged fragmentary view of the area **6** of FIG. **5**, showing a portion of one of the layers of fabric adjacent one side edge thereof;

FIG. **7** is a vertical sectional view substantially through the central longitudinal plane of the apparatus shown in FIG. **3**, but showing the position of a supporting work-table when starting the formation of a stack of superposed pile yarn fabric layers thereupon;

FIG. **8** is a fragmentary perspective view illustrating suitable mechanism for imparting reciprocatory motion to the roll of pile yarn fabric in the upper portion of FIG. **7**;

FIG. 9 is a schematic perspective view of the apparatus for progressively severing the pile yarns in the pile yarn block transversely of their axes while progressively depositing the severed pile yarns or tufts onto an advancing adhesive-coated backing to connect the severed pile yarns thereto;

FIGS. 10 and 10A are, collectively, a somewhat schematic longitudinal vertical sectional view through the apparatus shown in FIG. 9, but illustrating additional elements not shown in FIG. 9;

FIG. 11 is an enlarged schematic fragmentary elevation similar to the right-hand portion of FIG. 10, but showing the pile yarn block container in a different position from that shown in FIG. 10 to illustrate how the exposed lower ends of the pile yarns in the container are severed from the pile yarn block and deposited as cut pile tufts on the backing to form a pile fabric;

FIG. 12 is an enlarged fragmentary vertical sectional view similar to the central portion of FIG. 11, but showing more in detail how the pile tufts are progressively severed from the block of pile yarns and deposited on the backing to form the pile fabric thereform;

FIG. 13 is a schematic diagram of a suitable electrical circuit for controlling the operation of the pile fabric manufacturing apparatus shown in FIGS. 9–12;

FIG. 14 is a detail of some of the drive mechanism for imparting a stepwise forward movement to the backing in the course of each forward movement of the container;

FIG. 15 is a schematic view of a modified form of pile fabric manufacturing apparatus and is similar to FIG. 11, but shows means for heat-fusing the lower ends of the pile yarns during forward movement of the container and before the container reaches the severing means; and

FIGS. 16 and 17 are fragmentary views of typical pile fabrics which may be produced with the apparatus arranged as in FIG. 15.

Referring more specifically to the drawings, as illustrated in the block diagram of FIG. 1, the essential steps involved in making pile fabrics in accordance with the present invention comprise weaving a fabric of selected weftwise pile yarns, and then layering the woven fabric in layers of substantially equal warpwise length to form a compact stack of fabric layers with the ends of the weft yarns therein forming a preliminary pile pattern. As further indicated in the block diagram of FIG. 1, the thus formed stack of layered fabric then is enclosed in an open-ended container to form a confined block of pile yarn with the ends of the pile yarns exposed. According to the preferred embodiment of the invention the block of pile yarns then is positioned with the exposed pile yarn ends facing downwardly above an adhesive-coated substrate or backing and the pile yarn block is fed from the container in a stepwise manner in successive increments of an amount equal to the desired length of the pile. If desired, and as is preferred, adhesive material also may be applied to the pile yarn ends extending fron the container.

As further indicated in FIG. 1, a length of pile yarns is severed from the pile yarn block following each incremental feeding of the pile yarns from the container and the severed lengths of pile yarns or tufts are progressively deposited onto a substrate or backing during the severing operation.

The preferred embodiment of the methods and apparatus for forming the compact block of pile yarns is illustrated in FIGS. 1–8, many details of which will not be described herein, since the structure there shown is fully described in said copending application Ser. No. 316,740, filed Dec. 20, 1972, the disclosure of which is incorporated herein by reference.

PILE FABRIC WITH WEFTS OF PILE YARN

Referring now to FIG. 2, it will be observed that the pile yarn fabric, generally designated at **20**, is woven on a suitable loom which may be of any desired conventional or other type and is preferably in the form of a shuttleless loom equipped with conventional or other suitable means for controlling the harnesses or heddles **21** thereof and also equipped with a suitable weft selector means **23**. Weft selector means **23** is pattern controlled, as by a pattern device or pattern control means **24**, for selectively introducing predetermined pile yarns **25**, one at a time, to a weft inserting means **26** to be inserted in the warp shed prior to each beat-up of a reed **27**.

The weft selector means **23** may be of the type disclosed in said last-mentioned copending application, wherein the weft selector means **23** is equipped with suitable selector fingers, not shown, which are moved into an active position, one at a time, for guiding respective weft yarns to the weft inserting means **26**. In this instance, the weft selector means **23** not only selects the main weft yarns **25**, but is also selects a separate identifying weft yarn **25***a* to be later described. It should be noted, however, that the pattern control means **24** controls the weft selector means **23** so as to select pile yarns **25** of relatively different color or other appearances and to present them to the weft inserting means **26** which thus arranges the pile yarns in parallel juxtaposition according to a predetermined pattern during weaving of the fabric **20**.

The warps of which the warp sheds are formed are largely composed of sparsely spaced binder warp yarns **30** (FIG. 6) which are quite small or fine relative to pile yarns **25**. Preferably, binder warp yarns **30** are formed from a material which is barely visible, such as continuous monofilament nylon strands of about 15 to 20 denier, with the harnesses **21** being so controlled as to effect a shed change following each beat-up of reed **27**.

In its preferred embodiment, the pile yarn fabric **20** may be woven any convenient width, e.g., about 8 feet to 12 feet wide, in accordance with the number of lenths of pile fabric to be produced from the subsequently layered fabric **20**. It is preferred that, in such a fabric, the relatively fine binder warp yarns **30** are spaced approximately ¼ inch to ½ inch apart from each other across the width of the fabric to aid in maintaining the patterned relationship of the weftwise pile yarns **25** during formation of the patterned block of pile yarns. It is preferred that the binder warp yarns **30** are removed from the final pile fabric F (FIG. 9) in making a high quality pile fabric. However, in some instances, as for example in making pile fabrics of lower quality and for purposes of economy, the binder warp yarns **30** might not be removed from the final pile fabric F, it being noted that the binder warp yarns are practically invisible when formed of small monofilaments, which monofilaments are severed or mutilated into short length segments when pile tufts are severed from the patterned block of pile yarns.

At least one visually distinct side edge identifying warp yarn **30***a*, which is of contrasting appearance, such as size, color or the like, relative to the weftwise pile yarns **25** and binder warp yarns **30,** is interwoven with the weft yarns adjacent each longitudinal side edge of the fabric **20.** Additionally, similar intermediate identifying warp yarns **30***b* are spaced weftwise of the fabric throughout the width thereof at locations about 5 to 6 inches apart for purposes to be later described.

It is important to note that, in order that the identifying warp yarns **30***a*, **30***b* are clearly visible to an operator during the subsequent layering of the fabric, the identifying warp yarns **30***a*, and **30***b* are formed largely as floats (FIGS. **5** and **6**) and thereby form a float weave throughout the length of the fabric **20.** All of the identifying warp yarns **30***a*, **30***b* pass through the fabric **20** from one side to the other, and vice versa, at a common respective weftwise pile yarn **25** or **25***a* in each instance. The floats formed of the identifying warp yarns **30***a*, **30***b* may be of any desired length which is readily visible to operators during the forming of the fabric into layers as will be later explained. For example, each identifying warp yarn **30***a*, **30***b* may be floated over **7** or **8** weftwise pile yarns **25** and then may be floated beneath **7** or **8** pile yarns **25,** this procedure being repeated throughout the length of the fabric as illustrated, for example, in FIG. **6.**

For the purposes of this disclosure, it may be assumed that all of the pile yarns **25** shown in FIG. **2** are of different colors relative to each other. The identifying weft yarn **25**a also may be a pile yarn similar to pile yarns **25,** but should be of a different color than pile yarns **25,** or it should be otherwise visually distinct from pile yarns **25.**

Since it is desirable, according to the invention, that all of the layers L (FIGS. **3** and **5**) of the woven pile yarn fabric **20** employed in forming a given block of patterned pile yarns are in predetermined alignment with each other so as to provide a clear definition of the design areas in the pile pattern to be formed, it is preferred that all of the fabric layers are of substantially the same warpwise length. Accordingly, during the weaving of fabric **20** on the loom shown in FIG. **2,** the fabric is formed into successive warpwise interconnected sections of substantially uniform length by inserting at each of a plurality of substantially uniformly spaced locations in the fabric **20** at least one, or a group of, the identifying weft yarns **25***a*.

It will be observed in FIGS. **5** and **6** that the fabric **20** has weftwise indentifying yarns **25***a* at spaced locations along its length with the identifying weft yarns **25***a* being arranged in groups of three in this instance. The center of each group of three identifying weft yarns **25***a* is positioned a substantially uniform distance from the center of the next adjacent group of identifying weft yarns **25***a*, and they define therebetween a corresponding fabric section which constitutes a layer L of the fabric when it is folded into a compact cake or stack **20**b (FIGS. **3, 4** and **5**) of successive superposed layers in a manner to be later described.

It will be observed in FIG. **5** that the fabric **20** is woven with weftwise or transverse bands of pile yarns **25** of different colors arranged in predetermined patterned order. For example, the particular exploded upper layers L of the fabric in FIG. **5** include weftwise bands *a–g* successively arranged along the length of each such layer. Each band *a*, *c*, *e* and *g* may be formed from brown colored pile yarns, with each band *b*, *d*, *f* being formed from red colored pile yarns as indicated by comparing the exemplary composite pattern shown in FIG. **4** with the portions of the pattern shown in FIG. **5.**

It is apparent that, if individual design portions of the composite pattern formed of multiple layers L of the fabric are of varying shape, size or disposition relative to a given transverse plane through all of the fabric layers L in the stack **20***b*, then the warpwise dimensions of certain weftwise bands, such as bands *a–g*, will vary from layer to layer L, the number of such bands will vary in different layers and/or some or all of the bands may be omitted in certain layers; i.e., all of the weftwise pile yarns **25** in certain layers may be of the same appearance with the exception of the weftwise fold-line identifying yarns **25**a.

From the foregoing description, it is apparent that the groups of identifying weft yarns **25***a* define fold-lines extending parallel with the weftwise pile yarns along which the fabric **20** is folded as it is moved back and forth to form the stack **20***b* of superposed layers L of the respective sections of the fabric and with the ends of the pile yarns in the layers L collectively forming a composite pattern of pile yarns **25** of relatively different colors or other appearances.

APPARATUS FOR MAKING PILE YARN BLOCKS

The folding of the pile yarn fabric **20** may be effected, and alignment of the successive layers L may be effectively obtained, utilizing a layering apparatus substantially of the type illustrated in FIGS. **3, 4, 7** and **8.** Such apparatus is especially useful in instances where the fabric layers L are quite large. In this regard, the fabric **12** may be woven about 3 to 12 feet wide and each warpwise layer L thereof may be 9 to 12 feet long. The latter warpwise dimension determines the width of the carpet or other pile fabric to be formed from the stack **20***b*.

It will be observed in FIGS. **3** and **7** that the layering apparatus generally comprises an operator's elevated platform **40** having an opening **41** therethrough to accommodate a vertically movable, preferably substantially rectangular, worktable **50.** Worktable **50** should be of such size as to properly support thereupon a supporting panel **42** which is preferably of about the same width as the weft of each fabric layer, but which should be of slightly greater length than the warpwise length of each fabric layer L, since panel **42** later serves as one side wall of a container broadly designated at **60** in FIGS. **4, 9, 10, 11** and **12.**

Worktable **40** is supported on a plurality of vertically adjustable posts which may be in the form of upright screws **43** (FIGS. **3** and **7**). Screws **43** may be adjusted by suitable connections with a hand-crank **45** conveniently mounted on one of the guard rail posts of platform **40** so as to be within easy reach of a workman standing on platform **40.** Thus, the level of worktable **50** may be varied relative to platform **40** by suitable manipulation of hand-crank **45** so that the table **50** and any layers of fabric thereon may be positioned on a level convenient to workmen on platform **40** and may be adjusted from time to time during the layering of the fabric.

To facilitate moving the woven fabric **20** back and forth on panel **42** to fold the fabric **20** and form the stack **20***b* (FIG. **3**), the fabric **20** may be wound onto an arbor or roll **65** as it is taken up on the loom of FIG. **2** to form a roll **20***c* of the woven fabric **20.** Roll **20***c* is removed from the loom and mounted on a suitable reciprocable overhead carriage **70** (FIGS. **3, 7** and **8**) movable along a pair of laterally spaced tracks **71** by suitable connections with an electrically operable drive means embodied in an electric motor **72** in FIGS. **3** and **7.** Tracks **71** extend substantially horizontally and are spaced a substantial distance above the platform **40** and may be supported, as shown, upon the same framework which supports platform **40.**

Carriage **70** includes opposite end plates **73** having rollers **74** on their upper portions on which the arbor **65** is supported. The lower portions of end plates **73** have opposite ends of a pair of parallel guide rolls or nip rolls **75** journaled thereon which are suitably driven so that the left-hand guide roll **75** in FIGS. **7** and **8** will be driven in a clockwise direction whenever carriage **70** moves from left to right while the right-hand guide roll **75** idles for drawing fabric **20** from the roll **20***c* between the guide rolls **75.** Conversely, the right-hand guide roll **75** is driven in a counterclockwise direction for feeding fabric **20** to the worktable **50** as the left-hand guide roll **75** idles during movement of carriage **70** from right to left in FIG. **7.** In order to effect the reciprocatory movement of carriage **70,** electric motor **72** may be controlled by a suitable manually operable reversing switch **76** (FIG. **7**) interposed in an electrical circuit to motor **72** and positioned within convenient reach of a workman on platform **40.**

To aid in properly aligning the successive layers L of fabric **20** so that the pile yarns will reflect the desired composite pattern as shown, by way of example, in FIGS. **3, 4** and **5,** four substantially horizontal rows of perimetrical or outer substantially upright retaining rods or pins **80–83** are associated with worktable **50.** The longitudinal or warpwise rows of pins **80, 81** are spaced from each other a distance slightly less than the width of the woven fabric **20** and a distance about equal to the distance between the side edge identifying warp yarns **30***a* in FIGS. **5** and **6.**

The transverse or weftwise rows of retaining rods **82, 83** extend between the opposite ends of the rows **80, 81** and may be spaced from each other a distance slightly less than that between the identifying weft yarns **25***a.* One or more intermediate transverse or weftwise rows of substantially upright retaining rods or pins are provided which extend parallel to the outer end rows of pins **82, 83** and are disposed between the outer longitudinal rows **80, 81.** By wap of example, two intermediate rows of retaining rods **84, 85** are shown in FIG. **5** to aid in maintaining corresponding intermediate weftwise pile yarns **25** of each fabric layer in a substantially straight condition during the layering operations. This aids in preventing the occurrence of skew or bow in the woven fabric layers.

The lower ends of pins **80–85** are suitably secured in a supporting frame **86** positioned on the workroom floor. For the convenience of the workmen, it is preferred that pins **80–85** are of substantially the same height and project upwardly about 25 to 35 inches above the level of the elevated platform **40** so that a workman standing on platform **40** may reach well over the upper ends of the pins for manually impaling the fabric layers thereon.

Since it may be desirable to form the compact stack 6 to 12 feet high to accommodate a single pattern repeat, it follows that the retaining pins **80–85** should be of a comparable height. Also, the pins should be of relatively small diameter; e.g., about ¼ to ½ inch in diameter. Therefore, it is preferred that a suitable guide means is provided for stabilizing the medial portions of the upright retaining rods **80–85.** To this end a suitable rectangular stabilizing frame **87** (FIG. **7**) is suspended, as by pliable members **90,** from worktable **50** and is provided with suitable holes therethrough which are spaced according to the spacing of the pins **80–85** and are loosely penetrated by the pins **80–85.**

From the foregoing description, it can be seen that a workman may cause the carriage **70** to move in one direction or in the opposite direction, as the case may be, to deposit each successive layer L of the fabric **20** on the supporting panel **42** then resting on table **50.** Following each pass of carriage **70** over worktable **50,** the operator insures that the fold is formed at the corresponding group of identifying weft yarns **25***a* (FIG. **5**) and then the layer of fabric is impaled on the rows of retaining pins **80–85.** The retaining pins in each row may be spaced any desired distance apart, although it is preferred that they are spaced about 6 to 12 inches apart from each other and is desirable that the pins in the transverse rows **82–85** are spaced from each other a distance about equal to the distance between the several identifying warp yarns **30***a*, **30***b.*

Thus, the operator then may use the identifying warp yarns **30***a*, **30***b* as a visual reference in determining the point at which the pins in rows **80–85** are to penetrate each successive layer of the fabric **20.** Additionally, the two intermediate transverse rows of pins **84, 85** should be spaced such distance from the endmost transverse rows of pins **82, 83** that the successive layers L of the fabric **20** will be in proper alignment with each other when the pins in rows **84, 85** penetrate the fabric layers along weftwise pile yarns adjacent the point at which identifying warp yarns **30***a*, **30***b* penetrate the fabric between adjacent weftwise pile yarns **25.**

It is apparent that the corresponding weftwise pile yarns **25** then will be properly aligned with the intermediate transverse rows of pins **84, 85** to thereby ensure that the pile yarns **25** are not skewed or bowed with respect to warpwise and weftwise planes of the fabric layers. From time to time during the building of the stack **20***b* of superposed layers of fabric **20,** it is desirable to apply a compressive force to the accumulated layers of fabric **20** in order that the stack being formed will be of substantially uniform density throughout its height as viewed in FIGS. **3, 4** and **5.**

Accordingly, it will be observed in FIGS. **3** and **7** that a pressure platen **100,** suitably perforated at **100***a* to accommodate the several rows of retaining rods **80–85,** is suitably suspended from a carriage **101** provided with suitable rollers **102** thereon for engaging and riding along tracks **71.** As shown in FIGS. **3** and **7** platen **100** may be suspended from the lower end of a piston rod **103** having a piston **104** on its upper end mounted for vertical movement in a double-acting cylinder **105** carried by carriage **101.** Opposite ends of cylinder **105** are connected, by suitable conduits **106** and manually operable valve means **107,** to a suitable driven fluid pressure pump means **110** mounted on carriage **101.**

Whenever the operator wishes to compress the layer L of fabric **20** on the panel **42** then resting upon table **50,** the operator may control motor **72** so as to move carriage **70** to the right, out of the way of carriage **101** in FIG. **7.** Thereafter, carriage **101** may be moved manually or by any other suitable means, not shown, to position the same above and in vertical alignment with worktable **50.** The valve means **107** then is operated to move the platen **100** successively into and out of compressing engagement with the uppermost layer of fabric in the stack **20***b* without disturbing the alignment between the successive fabric layers. Platen **100** then is moved out of the way of carriage **70** so that additional layers of fabric **20** may be positioned upon the layers previously deposited on panel **42** then resting upon worktable **50.** Upon the desired number of layers of fabric **20** being accumulated and compacted in the manner heretofore described, the last layer of fabric may be severed from roll **20***c*, whereupon the completed compact stack or pile yarn block **20***b* is positioned in container **60.**

CONTAINER FOR PILE YARN BLOCK

Accordingly, it will be observed in the illustrated embodiment (FIG. **4**), that supporting panel **42** serves as the bottom wall of the container **60.** Before removing stack **20***b* from worktable **50,** opposite end panels **61, 62** are positioned against opposing sides of stack **20***b* at the sides thereof defined by the fold-lines or boundaries of the successive layers of fabric **20.** Thereafter, a top wall or panel **63,** provided with rows of perforations **63***a*–**63***f* therethrough corresponding to the rows of pins **80–85,** is positioned upon the uppermost layer of the fabric **20** forming the completed stack **20***b*. Upper panel **63** is preferably about the same size and shape as lower panel **42** and the panels **42, 63** are secured against the lower and upper surfaces of the stack **20***b* by suitable fastening means shown in the form of turnbuckles **64,** which firmly secure the lower and upper panels **42, 63** to the opposing end panels **61, 62** of container **60** to complete the formation of the confined patterned block of pile yarns.

It should be noted, however, that the inner surfaces of the panel or walls **42, 61, 62,** and **63** preferably are provided with a smooth polished finish so that the entire stack **20***b* of pile yarns may be incrementally forced outwardly from one open end of container **60.** Container is open-ended so that at least corresponding ends of the weftwise pile yarns in the stack **20***b* are exposed and so that pile yarn tufts may be severed from stack **20***b* following each incremental movement thereof outwardly from container **60,** as will be presently described. As heretofore indicated, the layering apparatus described with particular reference to FIGS. **3, 4, 5, 7** and **8** is described more in detail in said copending application Ser. No. 316,740 and, therefore, a further more detailed description of the layering apparatus is deemed unnecessary.

PREFERRED PILE FABRIC MANUFACTURING APPARATUS

After the patterned block of pile yarns **20***b* has been formed and the container **60** has been assembled around the pile yarn block **20***b*, any suitable hoisting means, not shown, may be used for lifting the container **60** off of worktable **50** and out of engagement with the retaining pins **80–85,** and then positioning the container in the pile fabric manufacturing equipment boradly designated at **115** and shown in FIGS. **9–14.**

Although it is preferred that the pile yarns forming the yarn block **20***b* in container **60** are in the form of carpet yarns, it is to be understood that the term "pile yarns" may, in certain instances, include continuous filaments or tows thereof and may also include rovings, slivers or any other material suitable for use as the pile of a pile fabric.

CONTAINER CARRIAGE

As shown in FIGS. **9, 10, 11** and **12,** container **60** has been turned on its side so that corresponding ends of the pile yarns of the compact block **20***b* therein have the composite pattern thereon facing downwardly. While such arrangement is not absolutely essential to the carrying out of the method of this invention, it facilitates the slicing or severing of the pile yarns into cut pile tufts and the depositing of the same on a substrate or backing.

Accordingly, it will be observed in FIGS. **9–12** that container **60** is positioned in a composite carriage broadly designated at **120** and which comprises a main or lower substantially rectangular carriage frame **120***a* and an upper or auxiliary substantially rectangular carriage frame **120***b* which normally rests upon the lower rectangular carriage frame **120***a*. The carriage frames **120***a*, **120***b* loosely surround a medial portion of container **60** with the upper carriage frame **120***b* being suitably removably secured to the walls **42, 61, 62** and **63** of container **60,** but with the container **60** being free to move vertically relative to the surrounding lower carriage frame **120***a*. Thus, container **60** and upper carriage frame **120***b* may be raised and lowered relative to lower carriage frame **120***a* for purposes to be later described.

Opposite sides of lower carriage frame **120***a* are provided with respective pairs of rollers **121** thereon which ride along suitable substantially horizontally disposed elongate tracks **122,** only one of which is shown in FIGS. **9, 10** and **11,** and which are preferably in the form of channel bars. Opposite ends of tracks **122** are suitably supported on the upper ends of standards or posts **124, 125.** Carriage **120** and container **60** with the yarn block **20***b* therein may be reciprocated forwardly and rearwardly along tracks **122** by a driven sprocket chain **126** whose upper reach in FIGS. **10** and **12** is suitably connected to the lower carriage frame **120***a*. Sprocket chain **126** is mounted on sprocket wheels **126***a*, **126***b* carried by the standards **124, 125,** and a carriage drive motive means or reversible electric motor **127** transmits rotation to sprocket wheel **126***b* through suitable sprocket and chain connections generally designated at **130.** Thus, motor **127,** sprocket chain **126** and the driving connections between motor **127** and sprocket chain **126** serve as means for moving container **60** forwardly and rearwardly along a substantially horizontal path in alternation.

SEVERING MEANS FOR PILE YARN BLOCK

A severing means, embodied in a stationarily mounted endless band type of cutter blade **135,** is positioned closely adjacent and below the path of container **60** and is arranged to sever the lower ends of the pile yarns in block **20***b* projecting from the open lower end of container **60** to form pile tufts T thereof during each forward movement of container **60** past the severing

means or blade **135.** Thus, the area adjacent cutting blade **135** also may be termed as a tuft forming zone.

With the exception of the blade **135** having a smooth or straight cutting edge, which faces rearwardly with respect to the direction in which the container **60** is moving during the severing operation, the severing apparatus may be in the form of a conventional band saw assembly, with the endless blade **135** being mounted on a pair of pulleys **135***a*, **135***b* (FIG. **9**) carried by a suitable frame **135***c* and one of which may be driven by an electric motor **135***d* (FIGS. **10** and **11**). It is apparent that cutting blade **135** occupies a substantially horizontal position transversely of the path of travel of the yarn block **20***b* projecting from the lower end of container **60.**

Blade **135** may be guided and maintained in the latter position during movement thereof by a suitable slotted guide bar **135***e* (FIG. **12**) which overlies the path of travel of backing **142** and the cut pile tufts T of the now formed pile fabric F. Opposite ends of guide bar **135***e* may be adjustably secured to frame **135***c* by any suitable means, not shown.

INCREMENTAL FEEDING OF YARN BLOCK FROM CONTAINER

According to the invention, means are operatively associated with the container **60** for incrementally feeding the pile yarns outwardly from the lower open end thereof in increments of an amount equal to the desired length of pile while the container occupies a position rearwardly of the severing means or cutting blade **135.** In its preferred embodiment, the pile yarn feeding means pushes downwardly on the entire pile yarn block **20***b* so that the block is pushed downwardly in sliding emgagement with the smooth walls of container **60** during each incremental feeding of the pile yarns in the block **20***b*. In this regard, it should be noted (FIG. **12**) that the opposing panels **42, 63** of container **60** are shown provided with smooth plastic sheets **66** on the proximal faces thereof and, of course, it is apparent that similar plastic sheets may be provided on the proximal surfaces of the opposing end panels or walls **61, 62** of container **60.**

In order to incrementally feed the pile yarns from the open lower end of container **60,** it will be observed in FIGS. **9, 10** and **11** that the upper end of pile yarn block **20***b* is engaged by a substantially horizontally disposed pusher plate **140** having a planar lower surface which engages the upper surface of the pile yarn block **20***b* and is positioned for substantially vertical movement in and relative to container **60.** Any suitable means may be provided for imparting incremental downward movements to pusher plate **140** in response to each rearward movement of container **60** and its carriage **120** a predetermined distance rearwardly of severing means **135.** To this end, a fluid operated ram **141,** preferably a hydraulically operated ram, has the lower end of its piston rod **141***a* attached to the upper surface or pusher plate **140.** Piston rod **141***a* extends into a cylinder **141***b* and has a piston **141***c* thereon. The upper end of cylinder **141***b* is connected to the uppermost portion of a suitable arch **120***c* of substantially inverted U-shaped form and whose legs are suitably secured, at their lower ends, to opposite side portions of the substantially rectangular upper carriage frame **120***b*.

As best shown in FIG. **12,** following the feeding of each successive increment of the pile yarns from the open lower end of container **60,** it is passed over cutting blade **135** to progressively sever tufts T from the fed increment of pile yarn block **20***b*. As the tufts T are being formed, they are progressively deposited on a forwardly moving adhesive-coated substrate or backing **142,** advancing relative to yarn block **20***b*, to form the patterned pile fabric F. The backing **142** may be in any desired pliable web form such as nonwoven, woven or knitted materials of natural or man-made fibers or combinations thereof. The backing also may be in the form of a web of paper or synthetic plastic material, either solid or foraminate.

In forming the pile fabric F utilizing an adhesive-coated backing, the pile yarns in block **20***b* may be of any desired material; e.g., natural, artificial and/or man-made fibers or yarns of any desired cross-sectional shape and size.

BACKING GUIDING AND ADVANCING MEANS

Referring now to FIGS. **9–12,** it will be observed that a backing guide means is provided for guiding the pliable backing or substrate **142** in an abruptly changing path converging forwardly and upwardly toward and into close proximity to the severing means or blade **135** and the path of the container **60.** To this end, a main or lower endless conveyor **143** is provided whose upper reach or run is supported on rollers **143***a*, **143***b*, **143***c*, and whose lower reach or run is supported on rollers **143***d*, **143***e*, **143***f*. It will be noted that roller **143***b* is disposed on a substantially higher level than rollers **143***a*, **143***c* so that the upper run of conveyor **143** moves in an abruptly changing path converging forwardly and upwardly toward and into close proximity to cutting blade **135** and to the path of the container. Additionally, the upper run of conveyor **143** diverges downwardly and forwardly away from the severing means or cutting blade **135** and away from the substantially horizontal path of travel of container **60.** For purposes of clarity, conveyor **143** is omitted in FIG. **9,** although rollers **143***a*, **143***b* and **143***c* are shown in FIG. **9.**

In order to ensure that the apex of the path of travel of the conveyor **143** and the backing **142** thereover is very nearly the same as the path of travel of the lower surface of the yarn block **20***b* in the course of forward movement thereof, and to thereby facilitate the progressive depositing of the tufts T (FIGS. **9, 12** and **14**) being severed from the yarn block **20***b* onto the backing **142,** opposite ends of the uppermost main conveyor supporting roller **143***b* are journaled in bearing blocks **144** mounted on suitable vertically adjustable members or screws **145.** Screws **145** may be manually rotated relative to the bearing blocks **144.**

Only one of the screws **145** is shown in FIG. **11,** wherein it will be observed that the lower portion thereof is threadedly mounted in a corresponding standard **146** carried by a frame **147** suitably secured to the floor upon which the main frame of the apparatus is supported. It is apparent that roller **143***b* also may be vertically adjusted to accommodate desired variations in the length of the tufts T to be formed during the severing of the lower ends of the pile yarns projecting from the container **60.**

DRYING AND CURING ADHESIVE ON BACKING

A substantial length of the portion of the upper reach of main conveyor **143** (FIGS. **10** and **11**) immediately downstream of the adjustable roller **143***b* passes over and in close proximity to or in engagement with a heated hollow platen, plenum or table **150** which may be heated by a suitable circulating hot oil or other hot fluid, for example up to 220° centrigrade or higher for curing the adhesive on the backing. Immediately downstream of heated platen **150** is a cooling platen or table **151** which may engage the lower surface of the upper run of conveyor **143** and is maintained at a relatively low temperature by a suitable circulating cold fluid, such as water. If water is used, for example, it may be circulated at slightly above freezing temperature. Since heating and cooling platens are generally well known in the textile finishing industry, a detailed illustration and description of the heating and cooling platens **150, 151** of FIGS. **10, 11** and **12** is deemed unnecessary.

The heated platen forms a drying and curing zone thereabove through which the pile fabric F is advanced from the severing means **135** for drying and curing the adhesive coating previously applied to the upper surface of backing **142.** It follows, therefore, that heated platen must be of such length and must be heated to such a temperature as to dry the adhesive coating and cure the same so that the tufts T will be firmly anchored to the backing **142.** The cooling platen forms a cooling zone thereabove through which the pile fabric F passes for cooling the same to facilitate subsequent take-up and handling of the pile fabric.

In order that the ambient air above platens **150, 151** is maintained at the desired temperatures to ensure transfer of heat and cold to the respective portions of pile fabric being advanced over the respective platens **150, 151,** it is preferred that backing advancing conveyor **143** is made of a metallic wire netting or mesh material. Conveyor **143** also may be made of a porous or foraminate pliable web material.

PRESSING TUFTS AND BACKING TOGETHER

According to the invention, the tufts T and backing **142** are pressed together as they are being advanced forwardly from severing means **135** and while they are advancing through the drying and curing zone above heated platen **150.** To this end, an upper endless conveyor **152,** cooperating with blade guide bar **135***e* (FIG. **12**) serves as suitable means for pressing the cut pile tufts T against the upper surface of the backing **142** following the depositing of the tufts on the backing. Thus, upper conveyor **152** is positioned above the upper run of main conveyor **143** and extends between the path of travel of container **60** and the upper surface of main conveyor **143.** Upper conveyor **152** is mounted on a main drive roller **153** (FIGS. **10** and **11**) and a relatively small rearend roller **154,** with a plurality of relatively smaller intermediate rollers **155** spaced between rollers **153, 154** for holding the lower reach of upper conveyor **152** in substantially parallel relation to the upper surface of the forward portion of the upper reach of main conveyor **143.** Intermediate rollers **155** are omitted in FIG. **9** for the purpose of clarity.

DRIVE FOR CONVEYORS

An automatically operable electromagnetic clutch means **160** is interposed between the drive mechanism for the container carriage **120** and the conveyors **143, 152** for automatically imparting a step in forward movement to conveyors **143, 152** relative to container **60** at substantially the moment that the leading edge of the exposed lower end of the yarn block **20***b* engages the cutting blade **135.** The clutch means **160** also is operated automatically to cut off the forward movement of the conveyors **143, 152,** preferably at the moment that the trailing edge of the exposed portion of the yarn block **20***b* moves forwardly of the cutting edge of the blade **135.**

The clutch means **160** is shown interposed between an output shaft **161** extending from motor **127** and an input shaft means **162** connected by suitable gearing **163,** to the drive roller **153** of upper conveyor **152** (FIG. **11**). The shaft means **162** also is connected by suitable gearing **164,** to one end of a shaft **166.** Shaft **166** extends downwardly substantially parallel with the upper reach of conveyor **143** and is drivingly connected to a pile fabric supporting roll **170** (FIGS. **10**A and **14**) having its periphery roughened, provided with spikes or covered with wire card clothing material or other suitable material to prevent roll **170** from slipping relative to pile fabric F. A transmission mechanism **171,** in turn, drivingly connects shaft **166** to the front end conveyor roller **143***c* so that conveyors **143, 152** and roll **170** are driven whenever clutch means **160** is energized or activated. Clutch means **160** may be provided with a suitable brake means, not shown, for stopping movement of conveyors **143, 152** and roll **170** immediately upon inactivation of clutch means **160.**

BACKING FEED AND PILE FABRIC TAKE-UP

Means are provided for permitting intermittent or periodic stepwise advancement of the backing **142** past cutting blade **135** and adjacent the path of yarn block **20***b* and container **60** without placing the backing **142** under undue or excessive strain and without the need for operating the pile fabric manufacturing apparatus **115** at an undesirably relatively slow speed. Accordingly, the backing **142** is continuously fed forwardly from a source of supply **142***a* (FIG. **10**) while a substantial length of the backing **142** is being accumulated at a location forwardly of the source **142***a*, but rearwardly of the backing advancing conveyor **143.** Thus, during each stepwise forward advancement of the backing **142** by conveyor **143,** the backing is withdrawn forwardly from the accumulated length thereof instead of being withdrawn directly from the source **142***a.*

Additionally, a length of the pile fabric F being formed on the backing advancing conveyor **143** is accumulated during advancement thereof at a location downstream of the cutting blade **135,** and the fabric is continuously taken up downstream of the accumulated length of the pile fabric by withdrawing the pile fabric from the accumulated length thereof at a rate substantially in accord with the average length of the stepwise forward movements of the backing past the cutting blade **135.**

More specifically, in order to permit the intermittent or stepwise movement of backing **142** in the manner heretofore described, the aforementioned pile fabric supporting roll **170** (FIG. **10**A) is positioned adjacent a pit **172** in which a compensating catenary loop of the pile fabric is formed. From the pit **172,** the pile fabric

extends upwardly over another supporting roll **170***a*, past a pair of rotary edge-trimming or slitting blades **173** and thence to a take-up mechanism including a pair of rolls **174, 175** on which a roll **176** of the pile fabric F may be wound. The slitting blades **173,** of which only one is shown in FIG. **10A,** may be driven by an electric motor **173***a* for removing any surplus or rough edge portions from the backing of the pile fabric F.

The take-up roll **175** may be driven by an electric motor **175***a*. As indicated in the electrical diagram of FIG. **13,** the output speed of motor **175***a* may be varied by a suitable, manually operable, variable speed control **175***b*, such as a rheostat or potentiometer. Of course, the variable speed control **175***b* (FIG. **13**) may be in the form of a separate, manually operable, speed variator or any well-known type interposed in driving connections between motor **175***a* and driven take-up roll **175** (FIG. **10A**).

In its course to the main conveyor **143,** it will be observed in FIG. **10** that the source **142***a* of supply for the backing **142** is embodied in a let-off roll equipped with suitable tensioning or braking means, not shown. From let-off roll **142***a*, the backing **142** successively passes over a plurality of rolls **142***b*–**142***h*, the roll **142***c* serving as a support beneath a doctor-blade type of liquid adhesive applicator generally designated at **177.** The adhesive applicator **177** may be of any well-known type which will apply a thin coating of liquid adhesive of the desired thickness upon the upper surface of the backing **142** in its course from the supply source **142***a* to the main conveyor **143.**

The adhesive may be of any suitable type which will firmly bond the tufts T and backing **142** together. The thickness of the liquid adhesive coating may be in the range of about 0.1 to 1.0 mm or more depending upon the types of backing and pile yarns used in forming the pile fabric F. Acrylic and polyvinyl acetate-acrylic copolymers, polyvinyl chloride, polyurethane, urea resin, melaminic resin, latex and the like are non-limiting examples of adhesive materials which may be used for bonding the tufts T to the backing.

The front supporting roll **142***h* for the backing being fed should have a spiked, knurled or clothing-covered peripheral surface similar to roll **170.** Roll **142***h* is positioned above a pit **180** in which a compensating catenary loop of the backing **142** is formed as a length of the backing accumulates between the supporting roll **142***h* and the conveyor **143.** As shown, backing **142** passes from pit **180** upwardly over the rearmost of the supporting rollers **143***a* which supports the rear portion of the upper reach of main conveyor **143.** Supporting roll **142***h* normally is driven continuously by an electric motor **181** whose speed may be varied by a manually operable variable speed control **181***a* similar to the variable speed control **175***b* (FIG. **13**).

Thus, it can be seen that the supporting let-off roll **142***h* may be driven continously, and the take-up roll **176** also may be driven continuously at a rate in accord with the average rate of the stepwise forward movements of the backing **142** past cutting blade **135.** It should be noted that the catenary loops formed of the backing **142** and the completed fabric F in the respective pits **180, 172** permit the forward stepwise movements of the conveyors **143, 152** and the portions of the backing and pile fabric engaged thereby. By providing the continuous let-off of the backing **142** and the catenary loop thereof in the pit **180,** each time the conveyors **143, 152** initiate forward movement, they will not exert undue strain upon the backing **142.** This is particularly desirable in the event of the backing being made from a relatively flimsy or loosely woven material.

VARYING DENSITY OF TUFTS ON BACKING

According to the invention, means are provided facilitating the forming of pile fabrics of varying pile densities. Accordingly, a suitable variable speed mechanism or speed variator **190** is operatively connected to the backing advancing means for varying the rate of advancement of backing **142** relative to the rate of forward movement of container **60** to thereby vary the density of the tufts as they are deposited onto the backing. More particularly, it will be observed in FIGS. **10** and **11** that a speed variator **190** is interposed in the shaft means **162** between clutch **160** and the gearing **163** for the upper conveyor **152.** It is apparent that the speed variator **190** may be manually adjusted, or any suitable pattern controlled means, not shown, may be provided for adjusting the speed variator, in order to vary the forward speed of the conveyor **143, 152** and roll **170** whenever the clutch **160** is activated so as to thereby vary the density of the tufts as they are being deposited onto the backing **142.**

During each forward movement of container **60** in the preferred embodiment shown in FIGS. **9** and **10,** for example, it is preferred that a liquid adhesive is applied to the lower end of the pile yarn block **20***b* projecting from container **60** to thereby further aid in insuring that the tufts to be formed subsequently are firmly secured to the adhesive-coated upper surface of backing **142.** Accordingly, it will be observed in FIGS. **9** and **10** that a suitable roller type of adhesive applicator **200** is suitably supported so that the upper surface of the roller thereof will wipe against the lower surfaces of the pile yarns projecting from the container **60** in the course of each forward movement of container **60.** The roller type of adhesive applicator **200** may be positioned in contact with a suitable supply **201** of liquid adhesive. Since such adhesive applicators are well known in the art, a more detailed description thereof is deemed unnecessary.

From the foregoing description of the apparatus shown in FIGS. **9–12** it is apparent that the operations of incrementally feeding the pile yarn block from container **60** and advancing the backing relative to the pile yarn block are effected in timed relation to the reciprocation of the container **60** along tracks **122.** Additionally, each time the trailing edge of the pile yarn block **20***b* moves forwardly beyond the cutting blade **135,** it is desirable to elevate the yarn block slightly so that it will not rub against the blade **135** in the course of the succeeding rearward stroke of container **60** since, otherwise, the rubbing of the lower ends of the pile yarns against the cutting blade **135** may produce undesirable lint and dust which might become deposited upon the previously adhesive-coated surface of the backing **142,** and such dust may inhibit a satisfactory bond between the backing and the succeeding pile tufts T to be formed in the course of the next forward movement of container **60.**

Accordingly, the method of operation will now be described in conjunction with a description of the electrical circuit of FIG. **13** not only to explain the operation of the apparatus **115** of FIGS. **9–12,** but also to include

a description of the means for elevating the container **60** and the pile yarn block **20***b* therein relative to cutting blade **135.**

METHOD OF OPERATION

For the purpose of this description, it may be assumed that a master switch S-1 in FIG. **13** and manual switches S-**2,** S-**3,** S-**4,** S-**5** to the respective motors **135***d*, **173***a*, **175***a*, **181** have been closed so that the stationarily mounted band type blade **135** is moving around the pulleys **135***a*, **135***b*, (FIG. **9**), with slitting blades **173** rotating, with the pile fabric roll **176** being rotated by the supporting take-up rolls **174, 175** to take-up the previously formed pile fabric, and with the let-off roll **142***h* being rotated to withdraw the backing **142** from the supply roll **142***a* and feed the same into the pit **180** to form the catenary loop in the backing while the conveyors **143, 152** are at rest. Also, it is to be assumed that the reverse winding of reversible motor **127** is energized with the container **60** moving from right to left in FIG. **10** and closely approaching the end of a rearward stroke thereof. Thus, as container **60** reaches the end of its rearward stroke, the container carriage **120** engages and changes the state of a rear limit switch **210** to open a normally closed contact set **210***a* and to close a normally open contact set **210***b*. In so doing, the flow of current to the coil of a previously energized motor reversing relay **211** is interrupted so that the state of the contact sets thereof is as illustrated in FIG. **13** and the forward winding of reversible motor **127** thus is energized.

At the time that the forward winding of motor **127** is energized, the closing of the normally open contact set **210***b* by carriage **120** contacting the limit switch **210** causes a pulse of current to flow through a suitable manually adjustable timing device **212** which may include electromagnetic means for changing the state of two contact sets **212***a*, **212***b*. This interrupts the flow of current to a solenoid **213** while establishing a flow of current through a solenoid **214.** Solenoids **213, 214** are operatively associated with a solenoid valve **215** and may be arranged so that, when solenoid **214** is energized, a regulated amount of hydraulic fluid will flow from a suitable pressurized source **216** through valve **215** and through a manually operable valve **217,** to the upper end of cylinder **141***b* of ram **141.**

Conversely, when solenoid **213** is energized and solenoid **214** is deenergized, valve **215** is closed quickly to interrupt the flow of fluid from source **216** to the upper end of cylinder **141***b*. The timing device **212** is adapted to be manually adjusted so that precisely the desired amount of fluid will flow from the source **216** to the upper end of cylinder **141***b* to cause the pusher plate **140** to feed the pile yarns in the container parallel to their axes from the container in an increment of an amount equal to the desired length of pile. Thus, it can be seen that the length of successive tufts T may be varied by utilizing the timing device **212** to adjust the extent of the successive increments of feeding of the pile yarns from container **60** and also by adjusting the supporting roll **143**b for main conveyor **143** so that the current blade **135** will sever the pile yarns the desired distance above the lowermost ends thereof and the lowermost ends of the pile yarns will be properly received upon the adhesive-coated surface of the backing **142.**

As heretofore indicated, the movement of switch **210** by container carriage **120** at the end of the left-hand or rearward stroke thereof in FIG. **10** interrupted the flow of current to relay **211.** With the consequent upward movement of the lower contact set **211***a* of relay **211** the flow of current to a container elevating relay **220** also is interrupted, resulting in the contact sets **220***a*, **220***b* thereof being opened and the current to a solenoid valve **221** being interrupted.

Upon interruption of the current flowing to solenoid valve **221,** valve **221** is closed to interrupt the flow of fluid pressure from a source **222** to a plurality of fluid-operated lifting devices shown in the form of rams **223.** One of each of the rams **223** is disposed adjacent each of the four corners of container carriage **120,** with the cylinders of the rams **223** being secured to the lower carriage frame **120***a*. The plungers or piston rods of the rams **223** project upwardly and engage the lower surfaces of respective projections **224** extending outwardly from the four corners of the upper carriage frame **120***b*.

It is apparent that, when valve **221** is open, rams **223** are subjected to fluid pressure from source **222** and thus raise the upper carriage frame **120***b*, the container **60** and yarn block **20***b* relative to lower carriage frame **120***a*. This facilitates the rearward movement of container **60** following the severing of a set or slice of tufts from the pile yarn block **20***b* so that the lower surface of the pile yarn block will not rub against the blade **135** in the course of the rearward movement thereof. It follows that, when the circuit to relay **220** was interrupted by the operation of switch **210** by container carriage **120,** the consequent exhaust of fluid pressure from rams **223** permits the upper carriage frame **120***b* to return to its lowest position resting upon lower carriage frame **120***a* so that container **60** then occupies its normal operating level.

It is thus seen that switch **210** provides means responsive to predetermined rearward movement of container **60** rearwardly of cutting blade **135** for (a) reversing the direction of movement of container **60,** (b) feeding a predetermined increment of the pile yarn block **20**b downwardly from the open lower end of container **60,** and (c) lowering the container **60** and the yarn block **20***b* from an abnormal raised position to a normal lowered position.

In the course of forward movement of container carriage **120,** a coating of liquid adhesive from the source **201** is applied to the lower ends of the pile yarns in the block **20***b* by the applicator roll **200** as the yarn block passes thereover. As the leading edge of the previously fed increment of the pile yarn block **20***b* approaches the cutting edge of the blade **135,** a switch actuating abutment **120***d* (FIGS. **9** and **10**) projecting outwardly from upper carriage frame **120***b* engages and momentarily closes a conveyor starter switch **225.** As shown in FIG. **10,** starter switch **225** may be mounted on one of the tracks **122** so as to be engaged by abutment **120**d during the forward movement of carriage **120.** However, it is to be noted that abutment **120***d* will pass above the feeler of switch **225** during the course of the subsequent rearward movement of carriage **120** because the upper rectangular carriage frame **120***b* is elevated relative to lower carriage frame **120** during rearward movement thereof.

Referring now to FIG. **13,** it will be observed that the closing of starter switch **225** energizes the coil of a

clutch relay **226,** thus changing the state of the contact sets thereof to complete a circuit through the electromagnetic clutch **160.** Thus, clutch **160** is activated to start driving the conveyors **143, 152** at the moment of, or immediately prior to, the leading edge of the pile yarn block **20***b* engaging the cutting edge of blade **135.**

It is apparent that a coating of liquid adhesive is applied to the upper surface of the backing **142** by the applicator **177** upstream of the severing means **135** and conveyors **143, 152.** Thus, upon initiation of forward movement of the proximal runs of conveyors **143, 152,** cutting blade **135** progressively severs the pile yarns transversely of their axes while the tufts T thus being formed are progressively deposited onto the adhesive-coated backing **142** to connect the severed pile yarns to the backing while the backing is being advanced relative to the block of pile yarns **20***b*. As heretofore indicated, the upper reach of cutting blade **135** is maintained in a predetermined position relative to the forward path of travel of container **60** by engagement of the blade **135** with the rigid guide plate **135***e* (FIG. **12**). Additionally, it will be noted that plate **135***e* extends downwardly and forwardly in substantially parallel relation to the upper surface of the forward portion of main conveyor **143,** thus aiding in properly positioning the successive tufts T on the adhesive-coated surface of the backing **142** as they approach the secondary or upper conveyor **152.**

Conveyor **152** also aids in maintaining the previously cut tufts T in substantially upright positions as they are held against the upper surface of the backing **142** during the heating, curing and cooling of the adhesive material thereon by the heating and cooling platens **150, 151** beneath the upper reach of main conveyor **143.**

In order to ensure that the pile yarns at the trailing or rear portion of the pile yarn block **20***b* are smoothly and cleanly severed by cutting blade **135** during the course of forward movement of yarn block **20***b* and container **60,** it will be observed in FIG. **12** that the trailing wall **42** of container **60** has a suitable elongate recessed back-up bar or shield member **227** suitably secured to the lower edge thereof whose recess **227***a* is open at the forward edge of bar **227** and is aligned with cutting blade **135.** Thus, recess **227***a* receives the rear edge portion of cutting blade **135** therein as container **60** reaches the end of its forward stroke to ensure that the ends of the trailing pile yarns in block **20***b* are cleanly severed by blade **135** as the tufts formed thereof are deposited upon the adhesive-coated backing **142.**

The reversible motor **127** may be equipped with conventional braking means, not shown, so that it will respond quickly to changes in the flow of current therethrough. Thus, at about the instant that the trailing or rearmost edge of the corresponding increment of pile tufts is severed from the lower end of pile yarn block **20***b*, a right-hand or forward limit switch **230** (FIGS. **10, 11** and **13**) is actuated by engagement of the container carriage **120** therewith to change the state of its contact sets **230***a*, **230***b*, **230***c* (FIG. **13**). It is apparent that actuation of limit switch **230** and the consequent closing of contact set **230***b* energizes the coil of reversing relay **211** to, in turn, energize the rearward or reverse winding of electric motor **127.**

At the same time, the opening of contact set **230***c* of switch **230** breaks the flow of current to the coil of relay **226,** thus interrupting the flow of current to clutch **160** and stopping further forward movement of the conveyors **143, 152** and roll **170** (FIGS. **10** and **10A**). The momentary closing of contact set **230***a*, as effected by engagement of switch **230** by the carriage **120,** closes a circuit to a suitable time delay mechanism **233** (FIG. **13**) which is of a well-known type including a condenser C and a resistor R which function in a well known manner to energize the coil of relay **220** upon the circuit to relay **233** being subsequently broken by the release of limit switch **230.**

It is apparent that limit switch **230** is released as motor **127** causes carriage **120** to start to move from right to left or rearwardly in FIGS. **9, 10** and **11.** Thus, by delaying the operation of relay **220** in the manner last described, the back-up bar **227** moves rearwardly of the rear edge of cutting blade **135.** Thereupon, the energization of the solenoid valve **221** is effected to, in turn, elevate the container **60** and yarn block **20***b* in the manner heretofore described. It follows that, as the carriage **120** moves rearwardly, the lower surface of the yarn block **20***b* then will not rub against the cutting blade **135,** thus insuring that cutting blade **135** will not cause lint, dust and the like to be dislodged from the pile yarns in the block **20***b* and thus deposited on the adhesive-coated backing **142.** It is apparent that container **60,** yarn block **20***b* and carriage **120** then return to the rearmost position in the path of travel thereof to complete a cycle in the operation of the apparatus of FIGS. **9–14** and to initiate a succeeding cycle in the operation thereof.

It is also apparent that the operation of the pile fabric manufacturing apparatus **115** may be repeated as many times as desired for obtaining any desired continuous length of pile fabric. Also, if desired, the size of the pile yarn block **20***b*, when measured parallel to the direction of forward and rearward movements thereof, may be equal to the desired length of a carpet or rug. In such instance, the extent of carpet formed by one movement of the yarn block **20***b* past the cutting blade **135** may be spaced from a succeeding length of carpet formed by a succeeding movement of the yarn block past the cutting blade simply by providing a suitable manually adjustable relay mechanism or any other suitable means for extending the intervals of operation of the conveyors **143, 152** after the yarn block **20***b* has moved ahead of the cutting blade **135.**

Because of the relatively high density of the compacted yarn block and the fact that such high density is maintained by the surrounding walls of container **60,** it has been found that practically the entire length of the weft yarns forming the pile yarns may be severed from the yarn block before it becomes necessary to replace the yarn block with another obtained from the apparatus of FIG. **3,** for example.

In any event, in order to replace the yarn block **20***b* and container **60** with another yarn block of similar structure, manually operable valve **217** in the upper portion of FIG. **13** may be operated to return the pusher plate **140** to a raised position relative to container **60.** At the same time, the timing device **212** may be manually adjusted to permit a continuous flow of fluid from the source **216** through valves **215, 217** to the lower end of cylinder **141***b* to elevate the pusher plate **140** in the manner described. Thereafter, valve **217** may be closed, the conduits extending therefrom to cylinder **141***b* may be removed from cylinder **141***b*

and a suitable hoisting mechanism then may be employed for lifting the container **60**, with the upper carriage frame **120***b*, upwardly away from lower carriage frame **120***a*. The arch **120***c*, ram **141**, pusher plate **140** and upper carriage frame **120***b* then may be removed from the corresponding container **60** and mounted on a fresh filled container **60** so that the fresh container **60** may be positioned in the lower carriage frame **120***a* preparatory to the manufacture of pile fabric from the pile yarn block therein in the manner heretofore described.

It is to be noted that, while the application of liquid adhesive to the lower surface of the pile yarn block **20***b* prior to the severing of the tufts therefrom by severing means **135** aids in obtaining a firm bond between the pile tufts T and the backing or substrate **142**, it has been found that satisfactory results are obtained when the liquid adhesive is applied only to the upper surface of the backing **142**. It is to be understood, therefore, that it is not essential in accordance with the invention to treat the lower ends of the pile yarns in the yarn block **20***b* to render them adhesive if the backing is provided with a suitable coating of adhesive thereon prior to the depositing of the severed pile yarn tufts onto the backing **142**.

It has been determined however, that by utilizing thermoplastic pile yarns in the block **20***b*, high density pile fabrics may be manufactured by heat-fusing the lower ends of the pile yarns together or to a substrate of thermoplastic material. To this end, a modified form of pile fabric manufacturing apparatus **115'** is shown in FIG. **15** wherein, instead of utilizing an adhesive applicator such as that indicated at **200** in FIG. **10**, a suitable heating device **250** is employed which is positioned closely adjacent and upstream of the cutting blade or severing means and immediately below the forward path of travel of the pile yarn block. In all other respects, the apparatus **115'** shown in FIG. **15** may be identical to that shown in FIGS. **9–14** and, therefore, the parts shown in FIG. **15** will bear the same reference characters as those applied to like parts shown in FIGS. **9–14**, where applicable.

Accordingly, it will be observed in FIG. **15** that the heating device **250** may be in the form of an infrared ray heat-radiating medium or heater having infrared lamps **251** therein which are spaced closely beneath the forward path of travel of the pile yarn block **20***b*, an increment of which had been previously discharged from the open lower end of container **60** in the manner heretofore described. Thus, the lower surface of the yarn block **20***b* is melted to cause the lower ends of adjacent pile yarns therein to adhere to one another, whereupon cutting blade **135** severs the pile tufts from the lower end of the block **20***b* and deposits the same onto the upper surface of the backing **142**.

In this instance, the backing **142** need not have been coated with a liquid adhesive. In fact, if backing **142** is partially or entirely of a thermoplastic material, the temperature of the heated platen **150** may be such as to aid in fusing the backing **142** to the previously melted lower ends of the tufts formed by the severing of the pile yarns from the block **20***b*. A portion of the resultant fabric is shown in FIG. **16** broadly designated at **252** wherein it will be observed that tufts T' are fused and bound together at their lower portions by a previously melted anchoring layer **252***a* of the thermoplastic material of which the pile yarn tufts T' are formed. In fact, assuming that the backing **142** in FIG. **16** is of a thermoplastic material, it is also apparent that the thermoplastic material **252***a* forming the anchoring layer may be formed, in part, from the backing **142**.

Referring to FIG. **17**, there is shown a portion of a pile fabric **253** which may be identical to the pile fabric **252** with the exception that, instead of the lower ends of the pile tufts T'' thereof being fused or otherwise secured to a substrate or backing, such backing is omitted and the lower ends of pile tufts T'' are simply fused together by the supporting anchoring layer **253***a* of previously melted thermoplastic material.

It is apparent that, in forming the pile fabric **253** of FIG. **17**, the backing **142** would be omitted in FIG. **15** and the successive slices of pile tufts severed from the lower end of pile yarn block **20***b* would simply be fused together when subjected to the heat from the infrared lamps **251** and thus deposited somewhat in the form of tiles upon the conveyor **143**. Of course, in forming the pile fabrics **252, 253** of FIGS. **16** and **17**, it is apparent that the conveyors **143, 152** then may be operated at a surface speed corresponding to that of the forward movement of the carriage **120**.

In all other respects, the apparatus **115'** shown in FIG. **15** may be constructed and operated in the same manner as that described for the pile fabric manufacturing apparatus **115** shown in FIGS. **9–14**. Therefore, a further description of the apparatus **115'** shown in FIG. **15** is deemed unnecessary.

In the drawings and specification there have been set forth preferred embodiments of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed is:

1. A method of making pile fabrics such as carpets, rugs and the like from a block of substantially parallel pile yarns in an open-ended container, which comprises incrementally feeding the pile yarns parallel to their axes from the container in successive increments of an amount equal to the desired length of pile, progressively severing the pile yarns transversely of their axes following each successive incremental feeding of the pile yarns from the container while progressively depositing the severed pile yarns onto an adhesive-coated backing to connect the severed pile yarns to the backing, and while advancing the backing relative to the block of pile yarns.

2. A method according to claim **1**, which includes following the depositing of the pile yarns, the step of pressing the successive deposited pile yarns and the backing together to aid in connecting the deposited pile yarns to the backing.

3. A method according to claim **1**, including the steps of drying and curing the adhesive on the adhesive-coated backing while pressing the deposited pile yarns and the backing together to aid in connecting the deposited pile yarns and the backing together.

4. A method according to claim **1**, which includes moving the block of pile yarns over the backing and over a stationarily mounted severing means in the same general direction as that in which the backing is being advanced during the severing of the pile yarns and the depositing of the severed pile yarns onto the backing.

5. A method according to claim **4**, in which the advancing of the backing comprises advancing the same

at a faster rate than that at which the block of pile yarns is being moved to obtain a desired density of the severed pile yarns on the backing.

6. A method according to claim **4,** in which the advancing of the backing comprises imparting stepwise forward movements thereto with the length of each step substantially corresponding to that length of pile fabric to be formed by the severing of one slice from the pile yarns, and moving the block of pile yarns rearwardly of the severed pile yarns last deposited onto the backing following the severing of each successive slice from the pile yarns and during respective intervals between successive stepwise forward movements of the backing.

7. A method according to claim **6,** which includes continuously feeding the backing forwardly from a source located rearwardly of the severing means while accumulating a length of the fed backing at a location rearwardly of the severing means but forwardly of the source, and wherein the step of imparting stepwise forward movements to the backing comprises drawing the backing from the accumulated length during each stepwise movement of the backing.

8. A method according to claim **6,** which includes continuously feeding the backing from a source rearwardly of and toward the severing means while forming a catenary loop of the backing at a location upstream of the severing means, and the step of imparting stepwise forward movements to the backing including drawing the backing from the catenary loop past the severing means during each of said stepwise movements.

9. A method according to claim **6,** in which the advancing of the backing further comprises accumulating a length of the pile fabric formed of the backing during advancement thereof at a location downstream of the severing means, and said method further comprising continuously taking up the pile fabric downstream of the accumulated length of the pile fabric by withdrawing the pile fabric from the accumulated length at a rate substantially in accord with the average rate of the stepwise forward movements of the backing past the severing means.

10. A method according to claim **6,** wherein the advancing of the backing further comprises forming a catenary loop of the pile fabric during advancement thereof at a location downstream of the severing means, and said method further comprising continuously taking up the pile fabric downstream of the catenary loop by withdrawing the pile fabric from the loop at a rate substantially in accord with the average rate of the stepwise forward movements of the backing past the severing means.

11. A method according to claim **1,** which includes applying an adhesive material to the end of the block of yarns before each severing of the pile yarns transversely of their axes to aid in the subsequent connecting of the respective severed pile yarns to the adhesive-coated backing.

12. A method according to claim **1,** which includes moving the block of pile yarns over the backing and in the same general direction as that at which the backing is being advanced during the severing of the pile yarns and the depositing of the severed pile yarns on the backing, and wherein the severing of the pile yarns is effected at a predetermined substantially fixed point in the path of travel of the pile yarn block, and the advancing of the backing relative to the block of pile yarns including moving the backing in a path converging toward and into close proximity to the path of the block of pile yarns at said fixed point to aid in the depositing of the severed pile yarns onto the backing.

13. A method of making pile fabrics, such as carpets, rugs and the like, which comprises incrementally feeding downwardly a compact block of substantially parallel and substantially vertically extending thermoplastic pile yarns from an open-ended container and in increments of an amount equal to the desired length of pile, fusing the lower ends of the pile yarns together following each incremental feeding of the pile yarn block from the container by moving the pile yarn block in a substantially horizontal path over a heat-radiating medium which melts and thereby fusibly interconnects the lower ends of the adjacent pile yarns, and then severing the fed increment of the pile yarn block transversely of the axes of the pile yarns to form a tuft slice therefrom while continuing the movement of the pile yarn block in said substantially horizontal path and while moving the tuft slice being formed onto a support.

14. A method according to claim **13,** wherein the support is a backing and including the step of fusibly securing the slice being formed to the upper surface of the backing.

15. A method of making pile fabrics such as carpets, rugs and the like which comprises moving an open-bottomed container, with a compact block of substantially vertically arranged pile yarns therein, forwardly a predetermined distance in a substantially horizontal path extending over and generally parallel with an adhesive-coated backing, advancing the backing forwardly through a tuft forming zone in a path closely adjacent the lower surface of the pile yarn block and at a faster speed than that of the yarn block and the container, while progressively severing tufts from the lower ends of the pile yarns in the block in their course through the tuft forming zone and progressively depositing the tufts being formed onto the adhesive-coated backing to connect the tufts to the backing, stopping the forward movement of both the container and the backing each time the backing is advanced a distance corresponding to the length of pile fabric to be formed from a single slice of the pile tufts thus severed from the pile yarns, and then moving the container with the block of pile yarns therein rearwardly to a position upstream of said tuft forming zone while positioning the front end of the block of pile yarns rearwardly of the tufts last deposited onto the backing to complete a cycle in making the pile fabric.

16. A method according to claim **15,** which also includes advancing the backing forwardly upstream of the tuft forming zone by moving the backing in substantially spaced relation below the horizontal plane of the path of the container in the course of movement of the backing into the tuft forming zone, and said method further including the step of subjecting the lower ends of the pile yarns in the block to a treatment which renders the lower ends of the pile yarns adhesive during that portion of the forward movement of the container and the block of pile yarns upstream of the tuft forming zone.

17. A method according to claim **15,** wherein the severing of tufts from the pile yarns in the block includes moving the yarn block past and in engagement with a laterally moving cutting blade occupying a predeter-

mined substantially horizontal position in said tuft forming zone, and said method further comprising maintaining the container on a higher level during rearward movement thereof over the cutting blade than the level occupied by the container during its forward movement past the cutting blade so that the lower surface of the yarn block is spaced above and out of contact with the cutting blade during rearward movement of the yarn block.

18. A method of making patterned pile fabrics, such as carpets, rugs and the like, comprising forming a patterned block of pile yarns by the steps of forming successive interconnected sections of woven fabric utilizing pile yarns for the wefts thereof by selectively interweaving with a plurality of binder warp yarns a plurality of weftwise pile yarns of different colors in a predetermined patterned order, and by inserting visually distinct identifying weft yarns at substantially uniformly spaced locations in the fabric to define the junctures of adjacent fabric sections, forming a compact stack of layers of the woven fabric by moving the fabric back and forth while folding the same along the identifying weft yarns to form the successive fabric sections into a stack of superposed fabric layers while aligning the successive layers with each other so that the ends of the pile yarns therein collectively form a composite pattern, enclosing the compact stack of folded fabric in an open-ended container to form a confined block of the pile yarns with the ends of the pile yarns exposed and forming the composite pattern at an open end of the container, incrementally feeding the block of pile yarns from the open end of the container in successive increments of an amount in accord with the desired length of pile, applying a liquid adhesive coating to a backing, progressively severing the end of the pile yarn block following each successive incremental feeding of the pile yarns from the container to form tufts therefrom while progressively depositing the tufts being formed onto the adhesive-coated backing to connect the tufts to the backing, and while advancing the backing relative to the block of pile yarns.

19. A method according to claim **18,** which includes moving the block of pile yarns over the adhesive-coated backing and over a stationarily mounted severing means in the same general direction as that in which the backing is being advanced during the severing of the pile yarns and the depositing of the tufts onto the backing.

20. A method according to claim **18,** which includes following the depositing of the tufts, the step of pressing the successive deposited tufts and the backing together to aid in connecting the deposited tufts to the backing.

21. A method according to claim **18,** which includes moving the block of pile yarns over the adhesive-coated backing and over a stationarily mounted severing means in the same general direction as that in which the backing is being advanced during the severing of the pile yarns and the depositing of the tufts onto the backing, and wherein the advancing of the backing comprises advancing the same at a faster rate than that at which the block of pile yarns is being moved to obtain a desired density of the tufts on the backing.

22. A method according to claim **21,** in which the advancing of the backing further comprises imparting stepwise forward movements thereto with the length of each forward step substantially corresponding to that length of pile fabric to be formed by the severing of one slice from the pile yarns, and said method also including the step of moving the block of pile yarns rearwardly of the severed pile yarns last deposited onto the backing following the severing of each successive slice from the pile yarns and during respective intervals between successive stepwise forward movements of the backing.

23. A method according to claim **22,** which includes successively drying and curing the adhesive coating on the backing by moving the pile fabric formed of the backing and tufts forwardly through a heated zone downstream of the severing means during the stepwise forward movements of the pile fabric, and cooling the pile fabric by advancing the same through a cooling zone forwardly of the heated zone during the stepwise forward movements of the pile fabric, the advancing of the backing further comprising accumulating a length of the pile fabric during the stepwise forward movements thereof at a location forwardly of the cooling zone, and said method further comprising continuously taking up the pile fabric forwardly of the accumulated length of the pile fabric by withdrawing the pile fabric from the accumulated length at a rate substantially in accord with the average rate of the stepwise forward movements of the backing past the severing means.

24. Apparatus for making pile fabrics such as carpets and the like from pile yarns and a backing and comprising an open-ended container for accommodating therein a block of substantially parallel pile yarns, means supporting said container with the pile yarn axes extending substantially vertical therein, means for incrementally feeding the pile yarns downwardly parallel to their axes from said container in successive increments of an amount equal to a desired pile length, means cooperating with said feeding means for progressively severing the pile yarns transversely of their axes to form cut tufts thereof following each incremental feeding of the pile yarns from said container, means for applying a coating of adhesive material to the backing, and means for advancing the backing forwardly relative to and closely beneath the yarn block and said severing means during the severing of the pile yarns so that the tufts being formed of the pile yarns are progressively deposited onto the adhesive-coated backing and thereby joined to the backing during the progressive severing of the pile yarns.

25. Apparatus according to claim **24,** including means stationarily mounting said severing means, and drive means operatively connected to said container for imparting forward movement thereto past said severing means and at a slower rate than that of the backing.

26. Apparatus according to claim **25,** including means connecting said drive means to said backing advancing means, and means interposed between said drive means and said backing advancing means for relatively varying the rate of forward movement of said backing and said container to vary the density of the tufts joined to the backing.

27. Apparatus for making pile fabrics, such as carpets, rugs and the like, from pile yarns and a backing, said apparatus comprising an open-ended container for containing therein a compact block of substantially parallel, juxtaposed, pile yarns, means operatively associated with said container for incrementally feeding the pile yarns parallel to their axes from one open end of

said container in increments of an amount equal to the desired length of pile, means for moving said container forwardly in a predetermined path transversely of the pile yarn axes, severing means in the forward path of travel of each successive increment of pile yarns fed from said container and arranged to progressively sever the ends of the pile yarns during forward movement of said container past said severing means to form tufts of the pile yarns, means for applying an adhesive coating to the backing, and means for advancing the adhesive-coated backing forwardly past and adjacent said severing means and adjacent said pile yarn block during the severing of the pile yarns so that the tufts being formed are progressively deposited onto the backing and joined thereto during the severing of the pile yarns.

28. Apparatus according to claim **27,** including driving connections between said container moving means and said backing advancing means, and means interposed in said driving connections for varying the rate of advancement of said backing relative to the rate of forward movement of said container to vary the density of the tufts deposited onto the backing.

29. Apparatus according to claim **27,** including means associated with said backing advancing means for adjustably supporting said backing for movement in predetermined spaced relation below said severing means, and means for varying the extent of each increment of feed of said means for incrementally feeding the pile yarns from said container whereby the length of tufts deposited onto the backing may be varied.

30. Apparatus according to claim **27,** including guide means for guiding the backing in a path converging forwardly toward and into close proximity to said severing means and said path of said container, and said guide means also including means for guiding the backing in a forwardly diverging path away from said severing means and away from said forward path of said container, and means positioned forwardly of said severing means and between said path of said container and said diverging path of said backing for pressing the tufts and the backing together to aid in securing the tufts to the backing.

31. Apparatus according to claim **27,** wherein said severing means comprises an elongate cutting blade extending transversely across the path of said container, and said container including a transverse shield member having an elongate forwardly facing recess therein and disposed at the trailing edge of said compact block of pile yarns, the recess in said shield member being so positioned as to receive said cutting blade therein during the forward movements of said container past said severing means so that said shield member will aid in supporting each successive increment of the pile yarns at the rear end of the pile yarn block during the severing thereof in the course of each forward movement of said container.

32. Apparatus according to claim **27,** including means forwardly of said severing means for heating the pile fabric formed from the tufts and the backing for drying and curing the adhesive on the adhesive-coated backing.

33. Apparatus according to claim **32,** including means downstream of said heating means for cooling the previously heated pile fabric during the advancement of the pile fabric.

34. Apparatus for making pile fabric such as carpets, rugs and the like, from pile yarns and a backing, said apparatus comprising a container having an open lower end and containing therein a compact block of substantially parallel pile yarns, container guide means for guiding said container in a substantially horizontal path with the axes of the pile yarns substantially vertically disposed and projecting from the open lower end of said container, means for moving said container forwardly and rearwardly along said path in alternation, severing means positioned closely adjacent and below the path of said container and arranged to sever the lower ends of the pile yarns projecting from the open lower end of said container to form tufts thereof during each forward movement of said container past said severing means, backing guide means for guiding the backing in an abruptly changing path converging forwardly and upwardly toward and into close proximity to said severing means and said path of said container, adhesive applying means disposed rearwardly of said severing means for applying an adhesive coating to the upper surface of the backing in its course to said severing means, means operatively associated with said container for incrementally feeding the pile yarns downwardly from the open lower end of said container in increments of an amount equal to the desired length of pile while the container occupies a position rearwardly of said severing means, and means operable periodically and in timed relation with the forward movements of said container for advancing the adhesive-coated backing forwardly along said abruptly changing path past and adjacent said severing means at a faster rate than the rate of each respective forward movement of said container during the severing of tufts from the lower ends of the pile yarns in the block so that the tufts being formed are progressively deposited onto the backing and joined thereto to form the pile fabric during the severing of the pile yarns.

35. Apparatus according to claim **34,** including a variable speed mechanism operatively connected to said backing advancing means for varying the rate of advancement of said backing relative to the rate of forward movement of said container to thereby vary the density of the tufts deposited onto the backing.

36. Apparatus according to claim **35,** including an additional adhesive applying means disposed rearwardly of said backing guide means, and said additional adhesive applying means being disposed adjacent the path of the pile yarn block projecting from the open lower end of said container for applying adhesive to the lower ends of said pile yarns in the course of each forward movement thereof into operative relation to said severing means.

37. Apparatus according to claim **34,** wherein said backing guide means comprises a first endless conveyor having an upper reach on which the backing is supported and advanced past said severing means, and means including an additional endless conveyor positioned closely above and extending in substantially parallel relation to the upper surface of said first endless conveyor and forwardly of said severing means but below the path of travel of said container for pressing the tufts and the adhesive-coated backing together.

38. Apparatus according to claim **34,** wherein said feeding means operatively associated with said container comprises a substantially horizontal pusher plate positioned for substantially vertical movement in and relative to said container for pushing downwardly against the upper ends of the pile yarns in the yarn

block, and means operatively connected to said pusher plate for imparting incremental downward movements thereto to push corresponding increments of the pile yarns out of the open lower end of said container.

39. Apparatus according to claim **34,** including means responsive to forward movement of said container into a position closely adjacent said severing means for initiating operation of said backing advancing means, and means responsive to forward movement of said container relative to said severing means for stopping operation of said backing advancing means following the severing and depositing of each successive slice of tufts onto the backing.

40. Apparatus according to claim **39,** including means automatically operable during each rearward movement of said container for elevating said container and maintaining the same in an elevated position so that the lower ends of the pile yarns in said block will clear and be positioned out of engagement with said severing means in the course of each rearward movement thereof.

41. Apparatus according to claim **34,** including means upstream of said backing guide means for feeding said backing in a substantially continuous manner from a source toward said backing guide means, and said backing feeding means including a supporting roll for the backing and spaced rearwardly of said backing guide means for cooperating therewith so that a length of the backing may be accumulated between said supporting roll and said backing guide means to facilitate the periodic advancement of the backing past said severing means as the backing is being fed continuously by said backing feeding means.

42. Apparatus according to claim **34,** wherein said backing guide means includes a fabric supporting roll at its front end, fabric take-up means downstream of said backing guide means, means for driving said take-up means in a substantially continuous manner, an additional fabric supporting roll spaced forwardly of said first-named fabric supporting roll and supporting the pile fabric in its course to said take-up means, and said supporting rolls being arranged so that a length of the pile fabric may accumulate therebetween to facilitate continuous take-up of the pile fabric during the periodic advancement of the backing past said severing means.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,847,692

DATED : November 12, 1974

INVENTOR(S) : Emanuele Bondi

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2 of the face sheet of the patent, "14 Drawing Figures" should be --18 Drawing Figures--

Sheet 1 of the Drawings, top heading, "Sheet 1 of 8" should be --Sheet 1 of 9--

Sheet 2 of the Drawings, top heading, "Sheet 2 of 8" should be --Sheet 2 of 9--

Sheet 3 of the Drawings, top heading, "Sheet 3 of 8" should be --Sheet 3 of 9--

Sheet 4 of the Drawings, top heading, "Sheet 4 of 8" should be --Sheet 4 of 9--

Sheet 5 of the Drawings, top heading, "Sheet 5 of 8" should be --Sheet 5 of 9--

Sheet 6 of the Drawings, top heading, "Sheet 6 of 8" should be --Sheet 6 of 9--

Sheet 7 of the Drawings, top heading, "Sheet 7 of 8" shouldbe --Sheet 7 of 9--

Sheet 8 of the Drawings, top heading, "Sheet 8 of 8" should be --Sheet 8 of 9--

Sheet 9 of the Drawings was omitted, which included Figures 14, 15, 16 and 17. (A xerox copy of this sheet is attached), top heading should be --Sheet 9 of 9--

Signed and Sealed this

Nineteenth Day of October 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

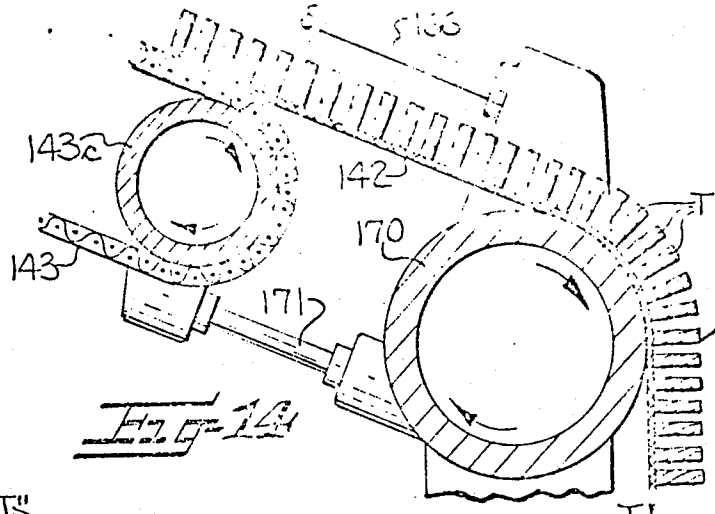


Fig-14

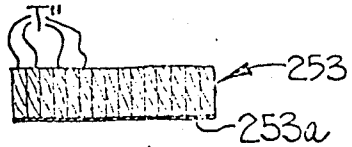


Fig-17

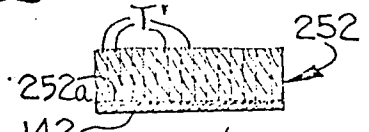


Fig-16

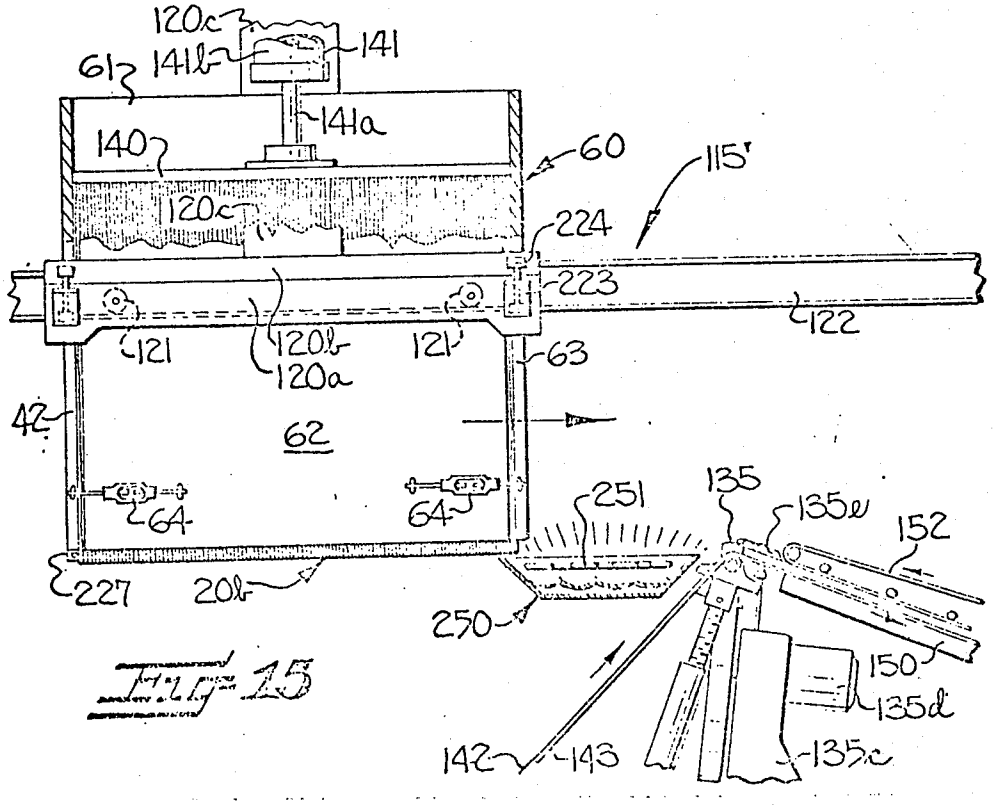


Fig-15