Aug. 10, 1971 A. N. SPANEL ET AL Re. 27,165

TUFTING APPARATUS FOR THE MANUFACTURE OF CARPETS, RUGS, AND THE LIKE

Original Filed Oct. 23, 1965 18 Sheets-Sheet 1

Fig. 1A

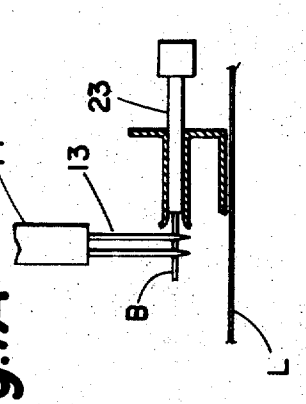
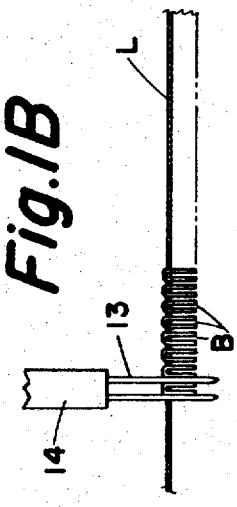


Fig. 1

Fig. 1B



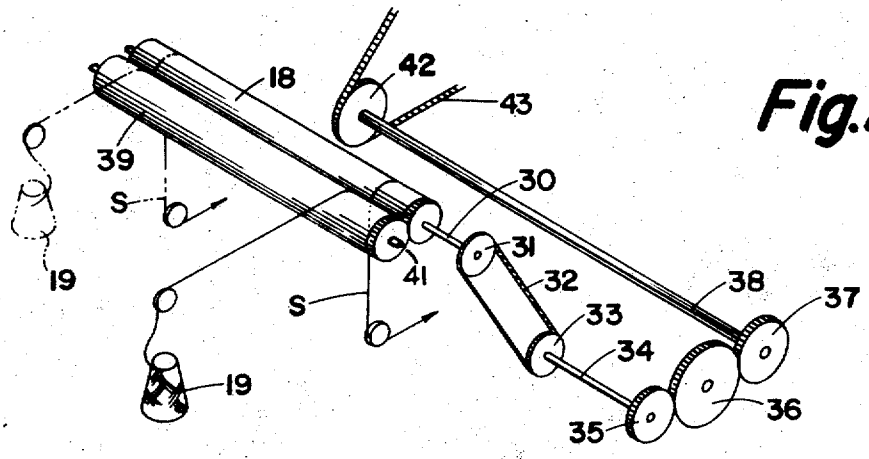


Fig.2

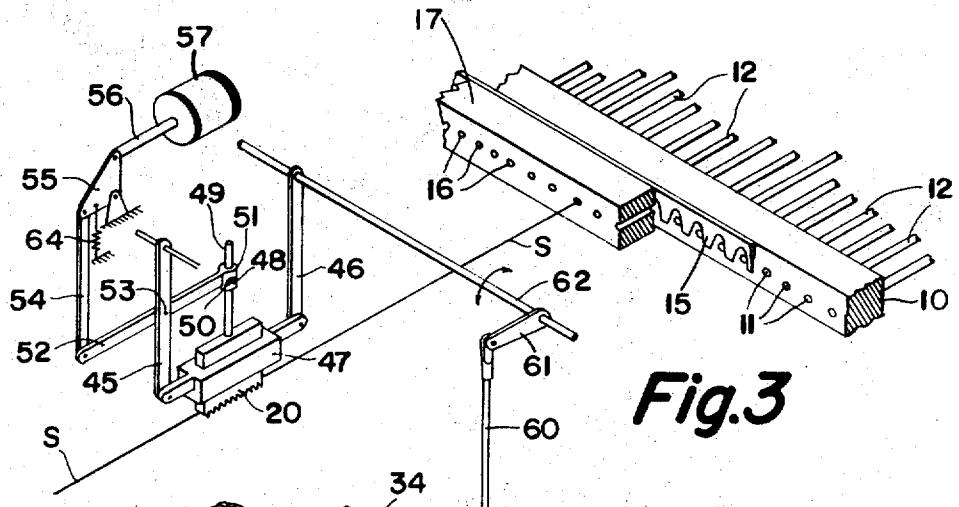


Fig.3

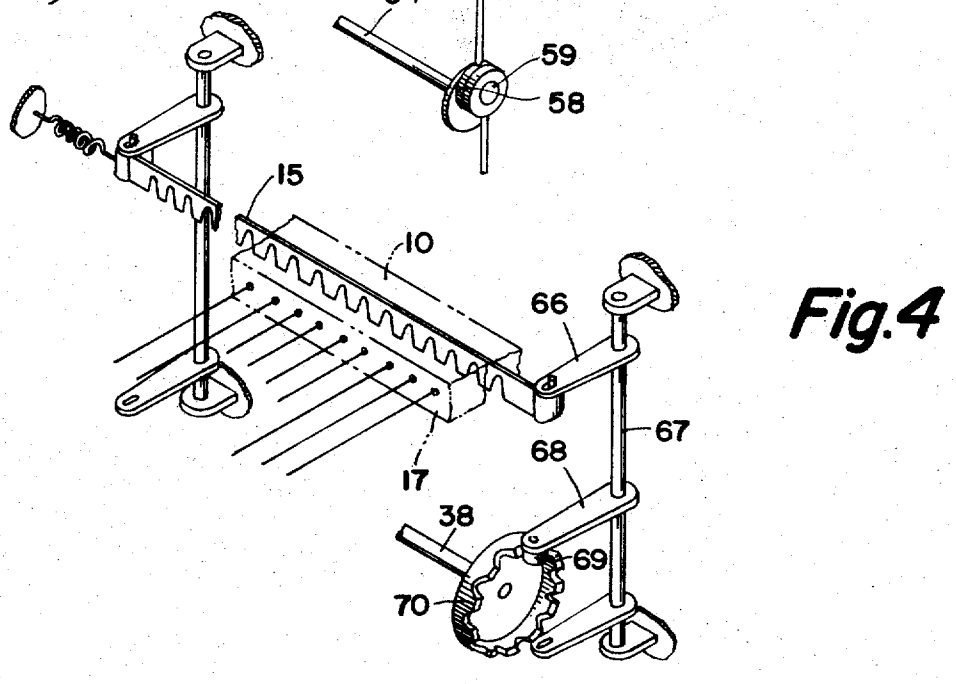


Fig.4

Fig.5

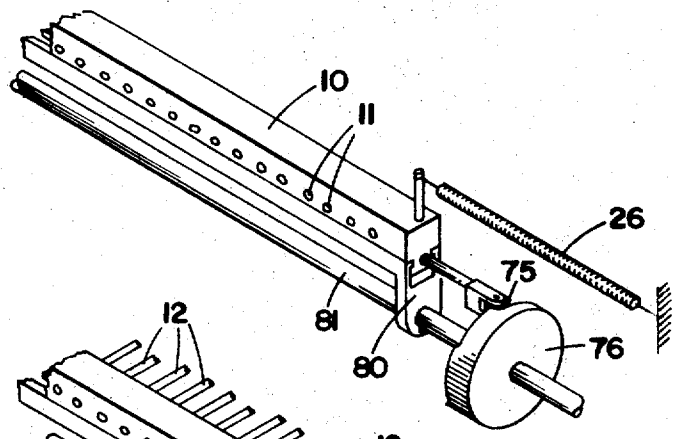
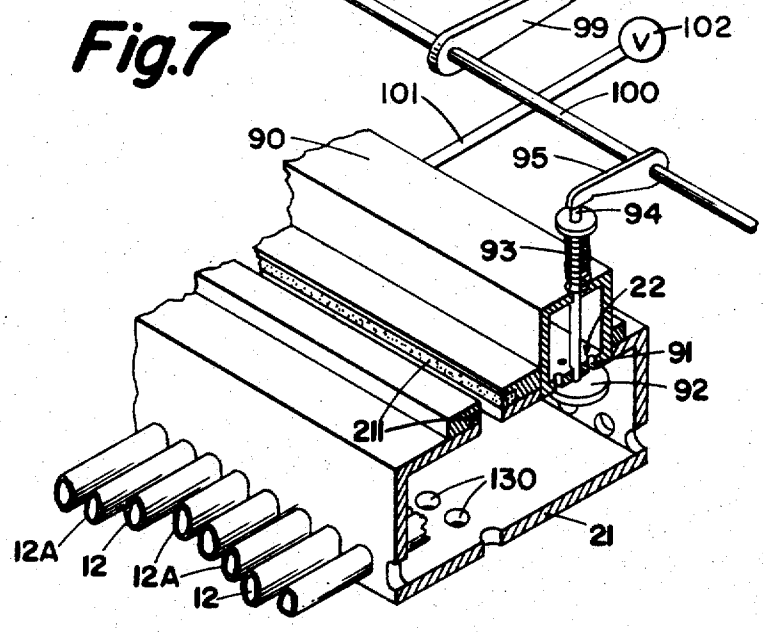


Fig.6

Fig.7



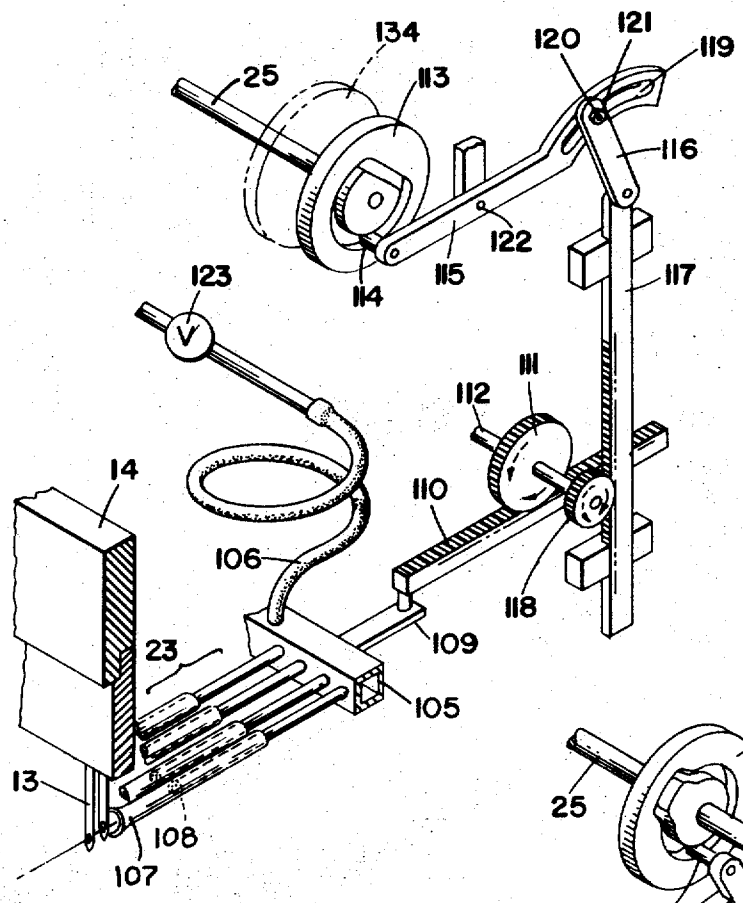

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Fig.8

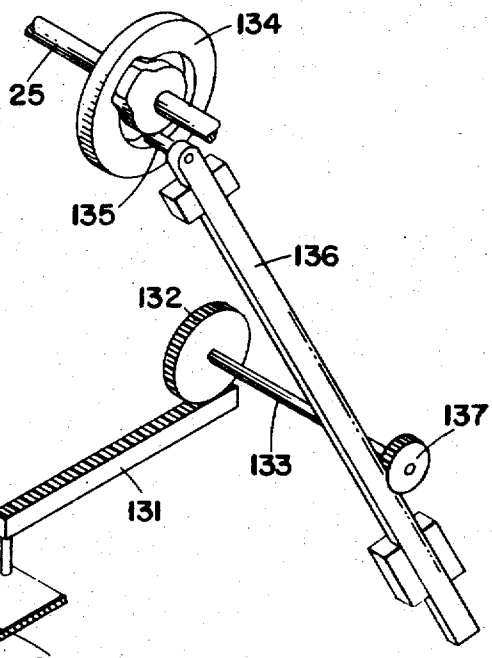
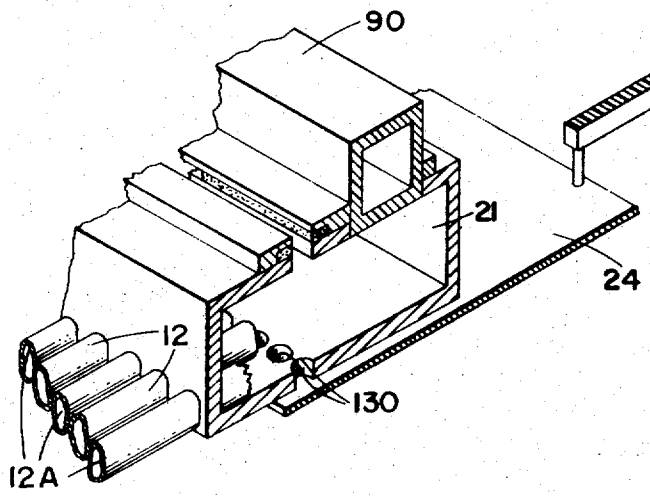

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Fig.9


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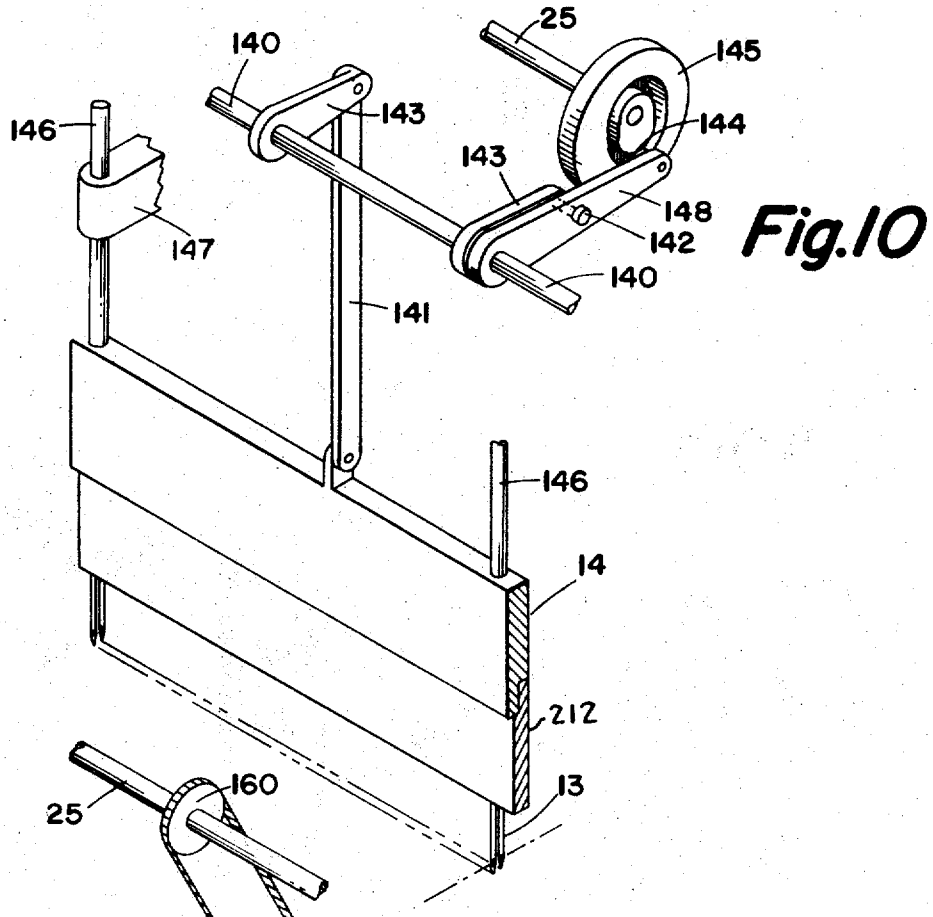

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Fig.10

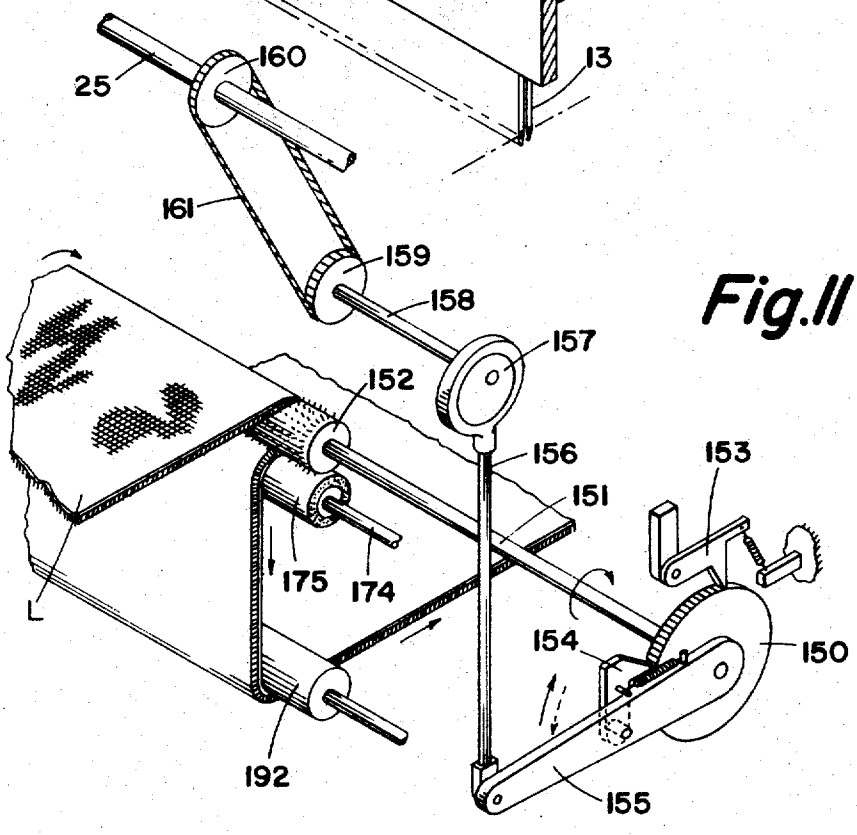

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Fig.11

Fig.12A

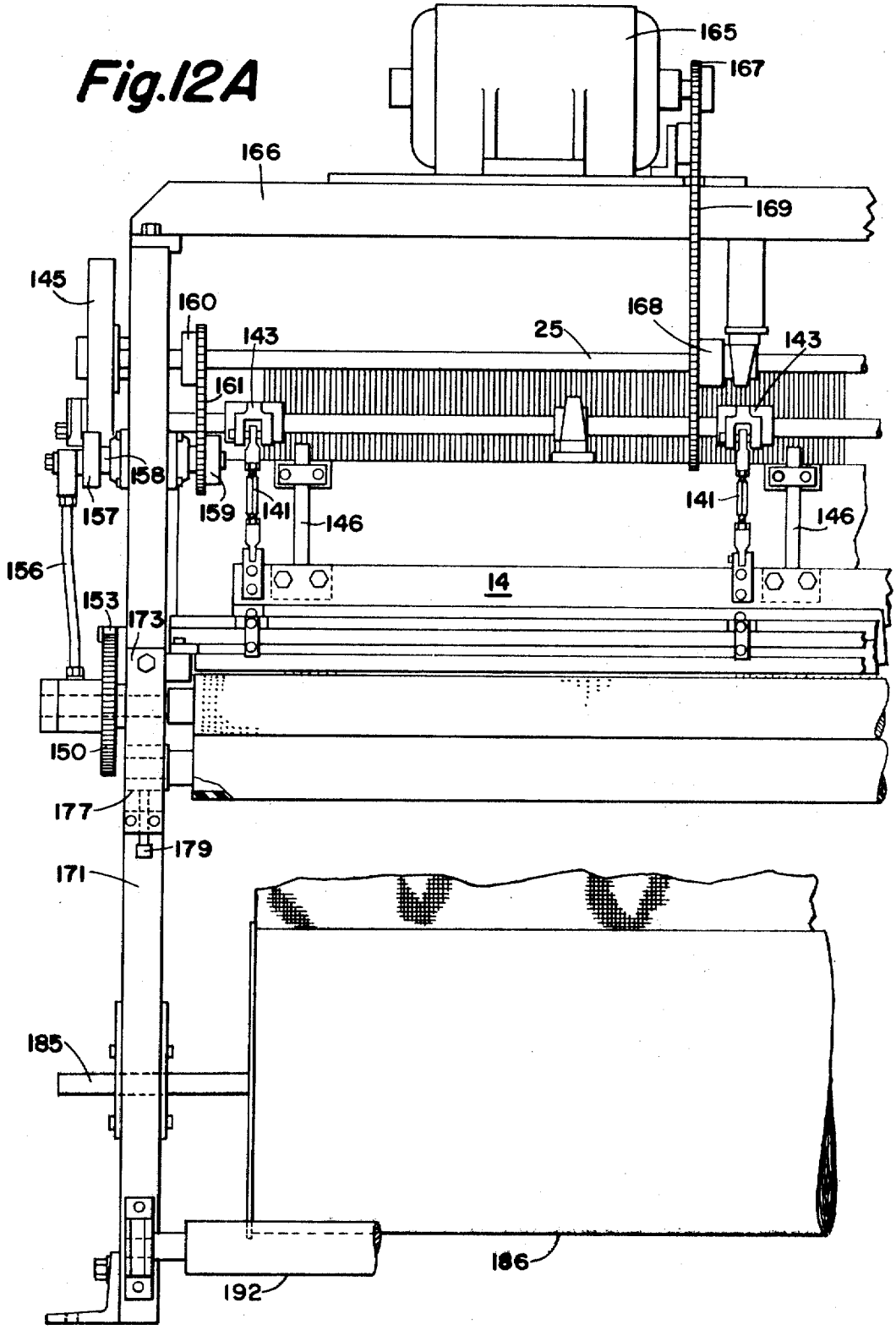

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Fig. 12B

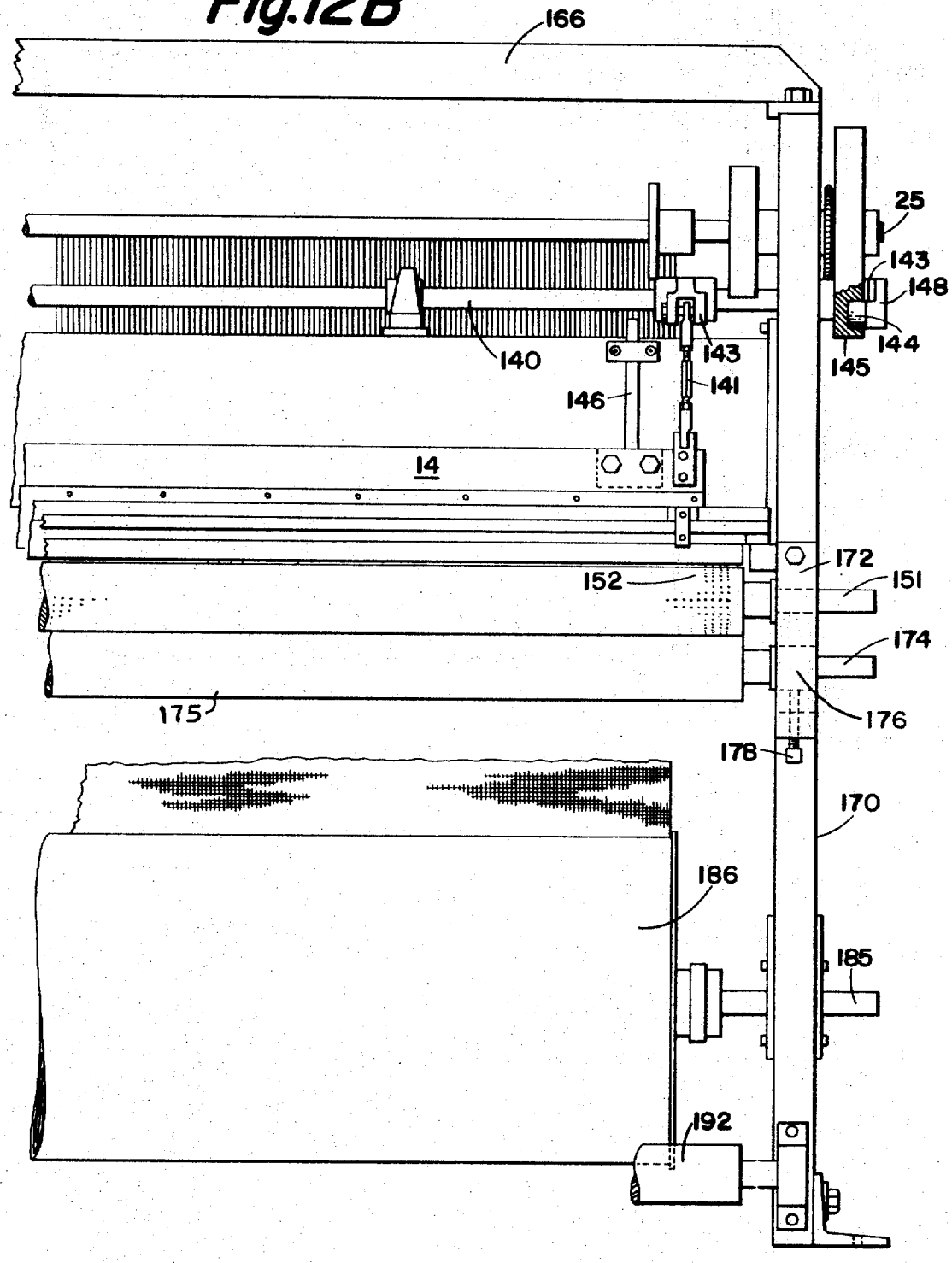

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Fig.13

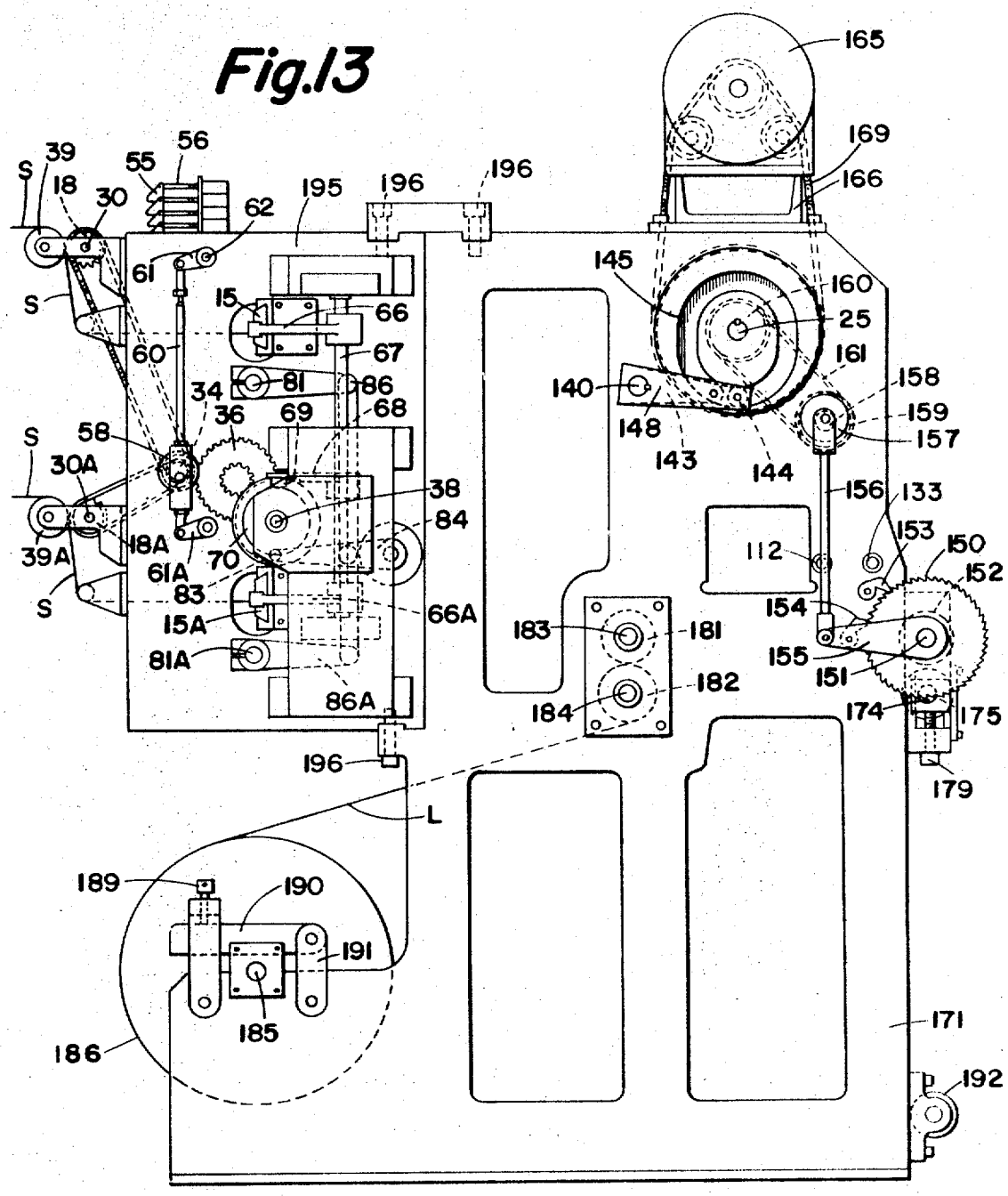

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Fig.14

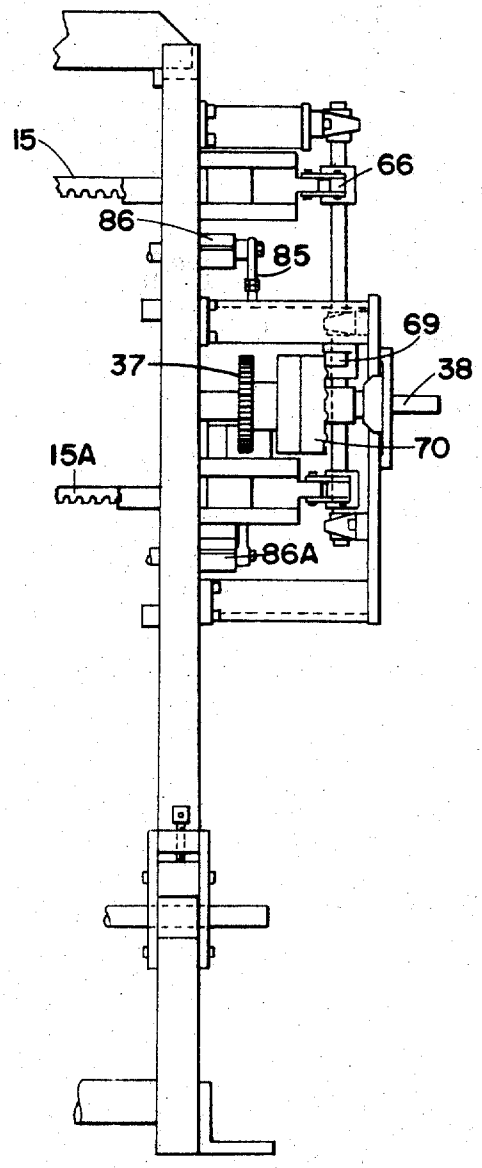

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Fig.16

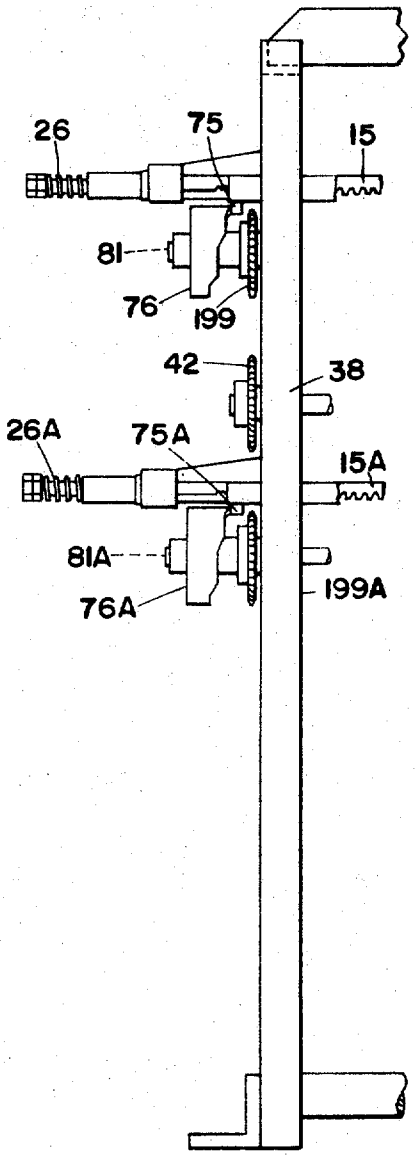

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Fig.15

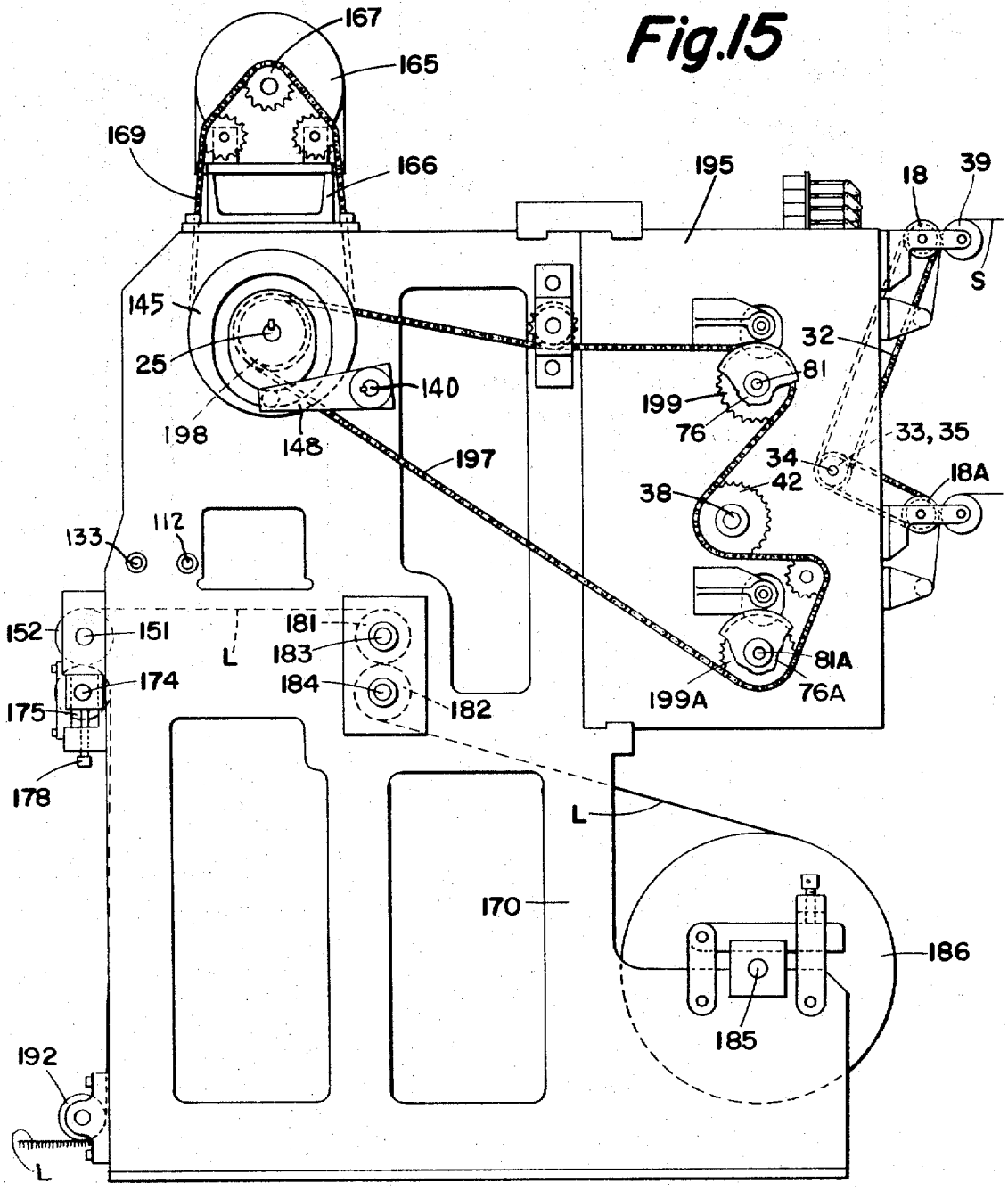

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Fig.17

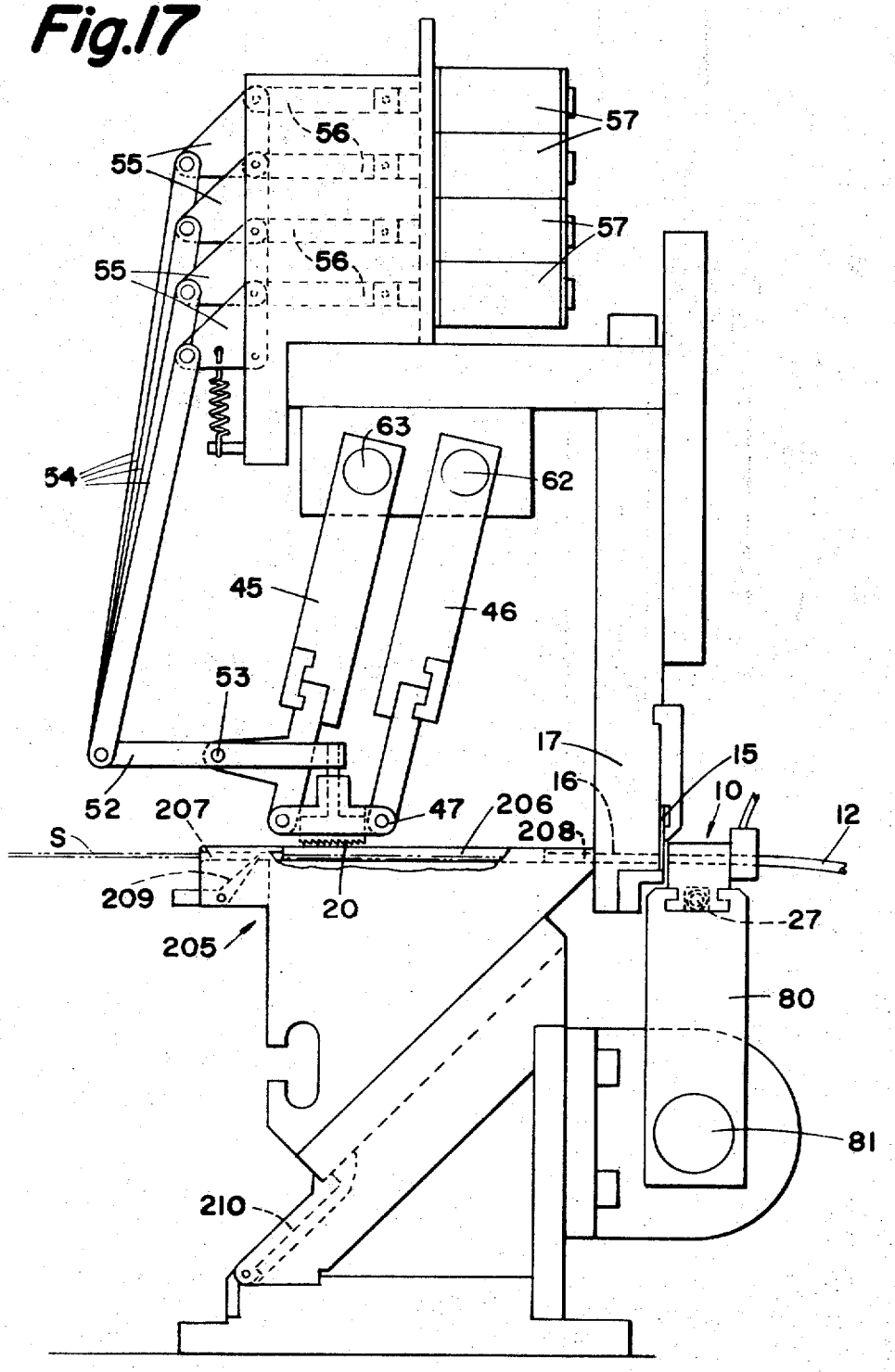

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Fig. 18A

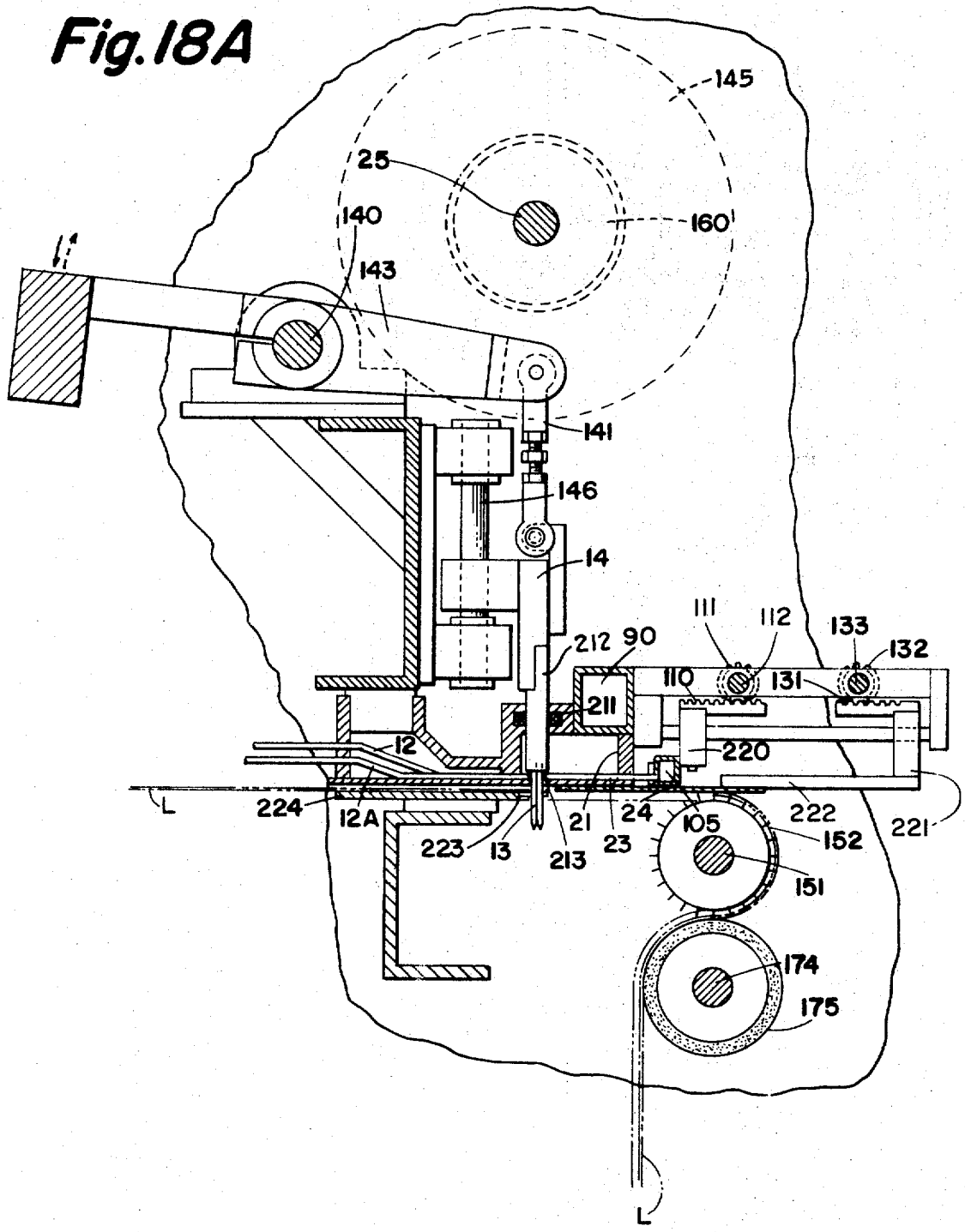
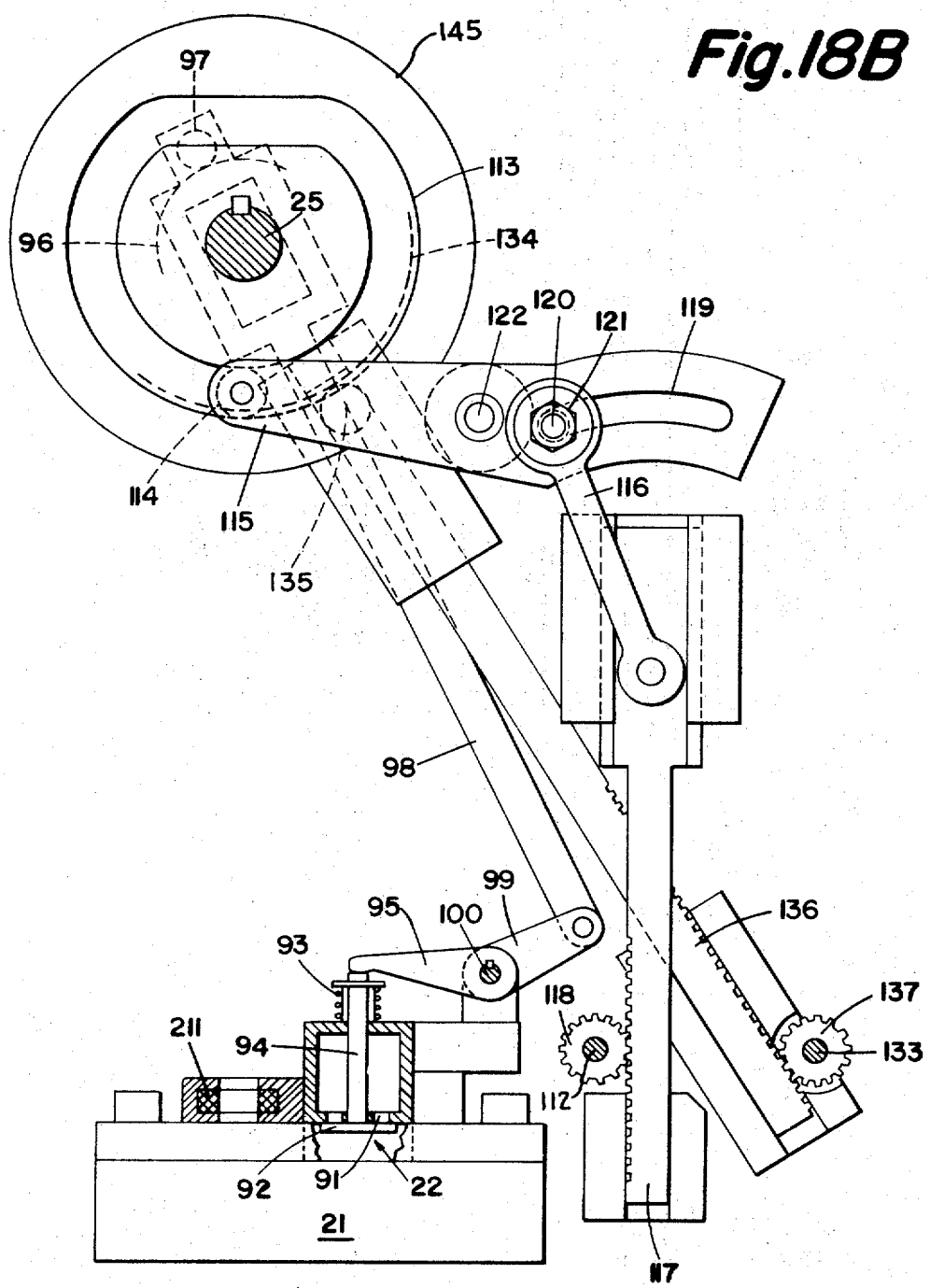

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Fig.18B


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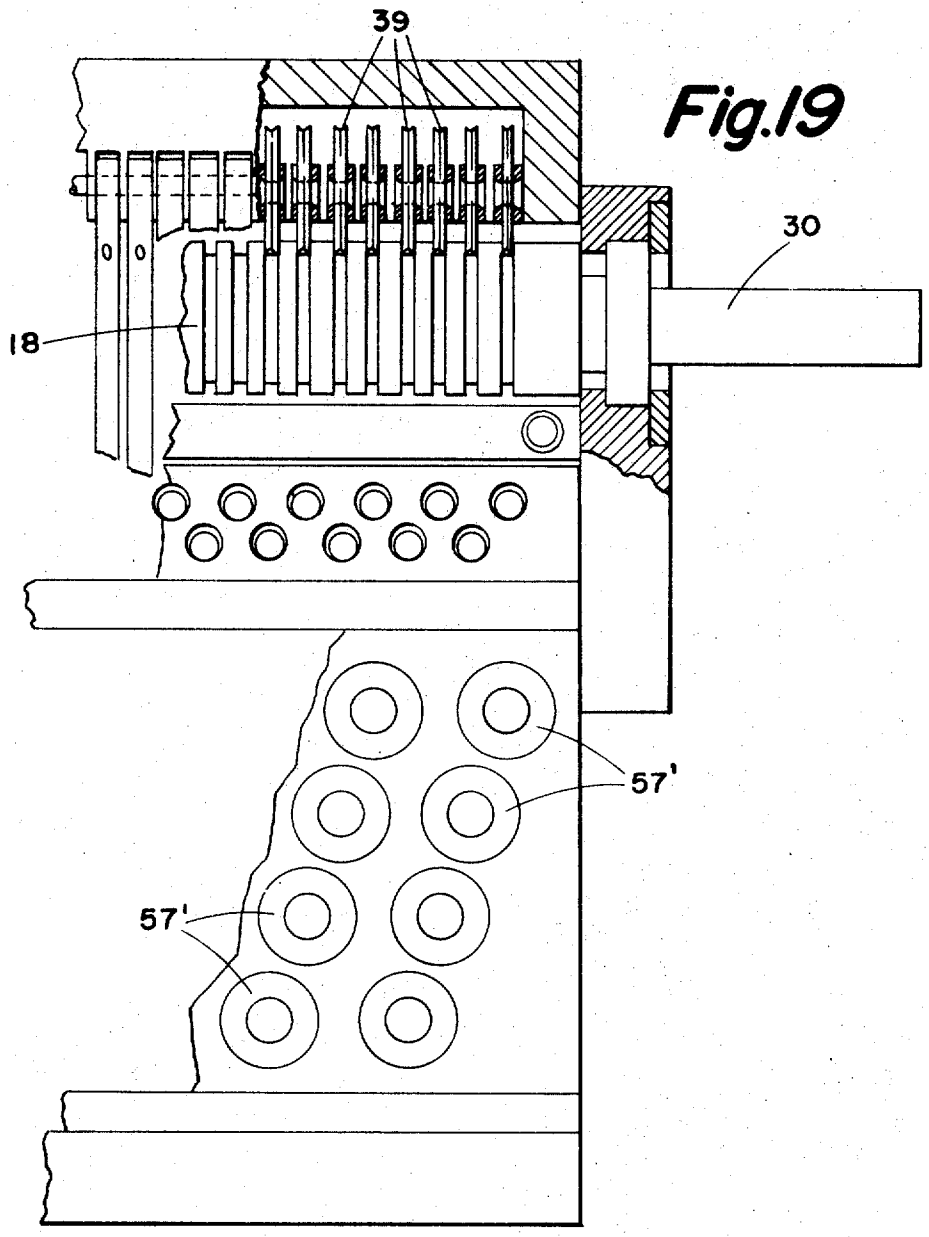


Fig.19

Fig. 20

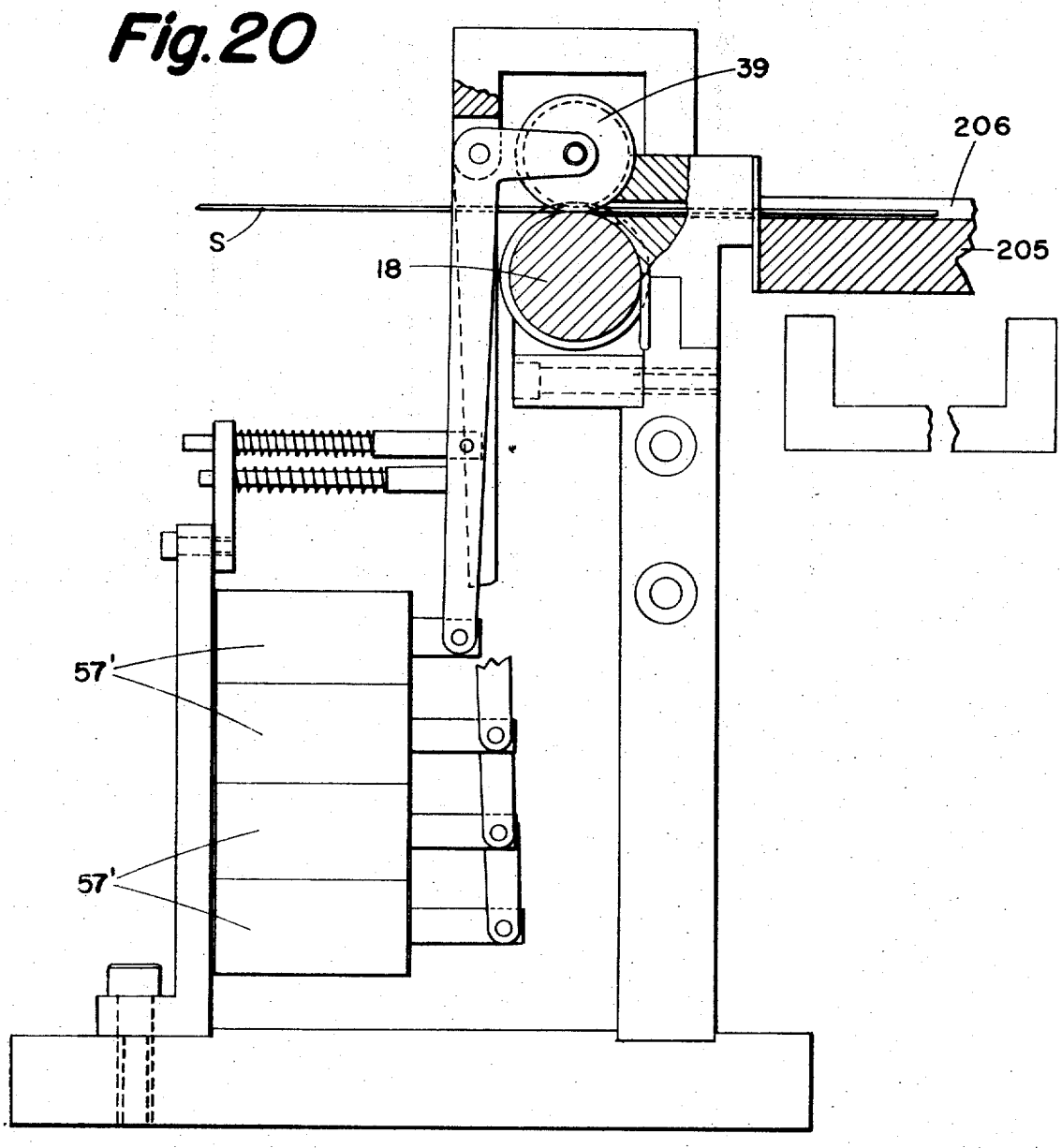


Fig. 21A

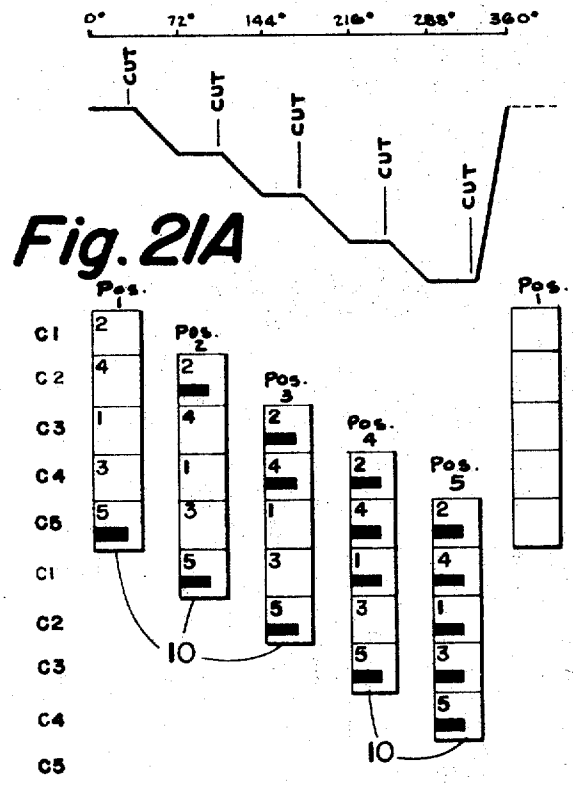


Fig. 21C

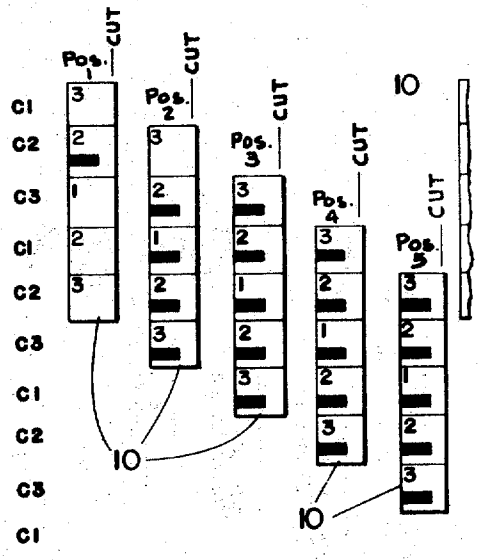


Fig. 21B

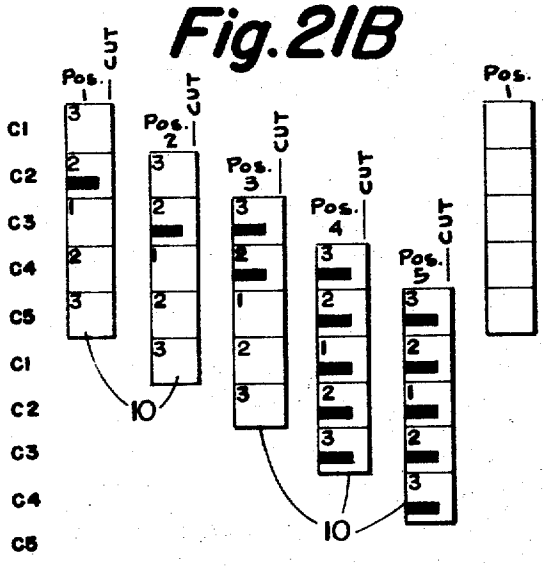


Fig. 21D

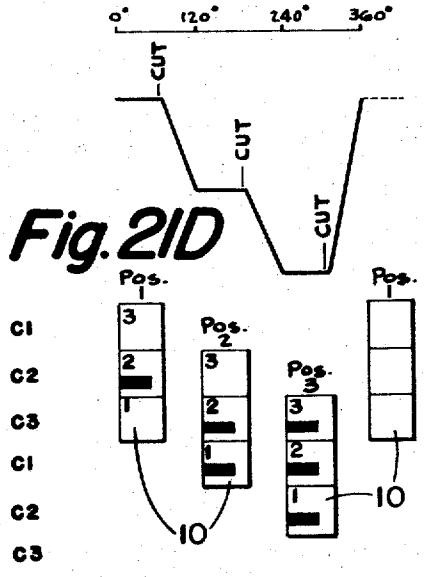


Fig. 22A

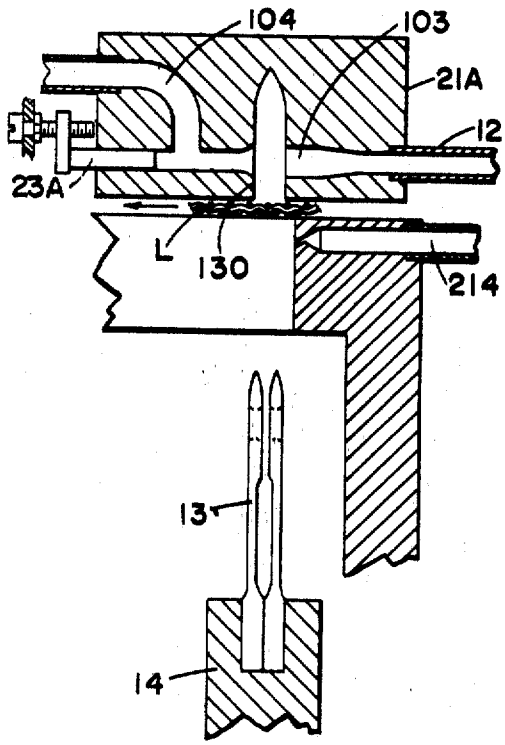


Fig. 22B

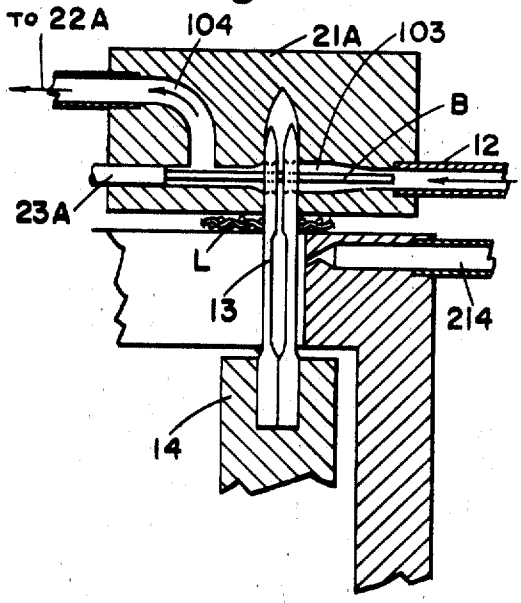
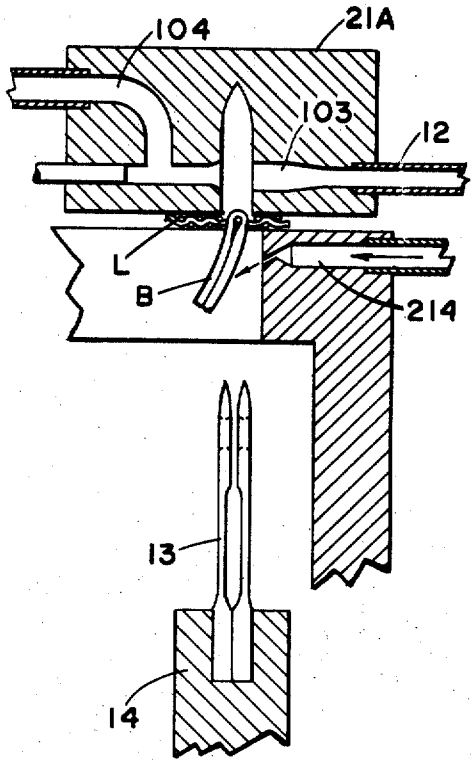


Fig. 22D



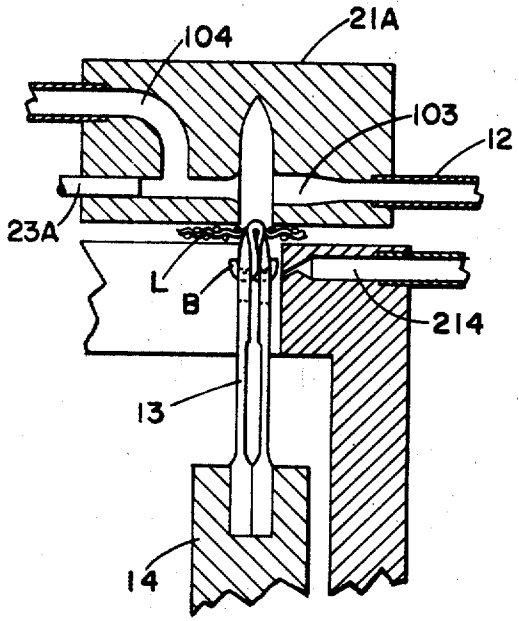


Fig. 22C

Fig. 23A

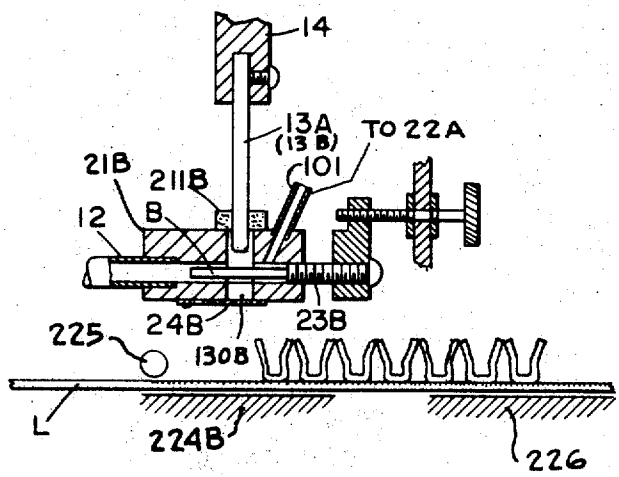
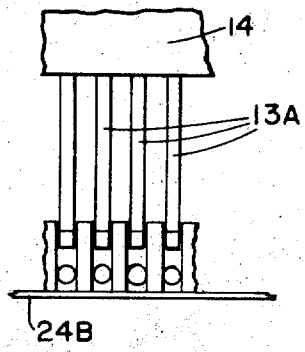


Fig. 24



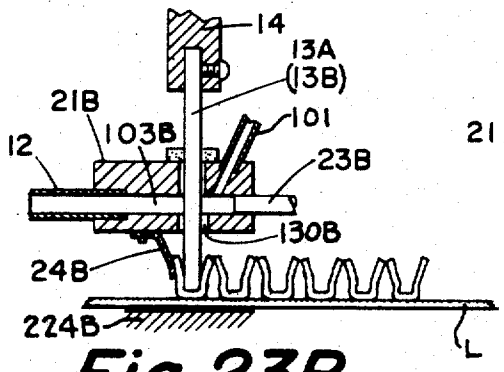


Fig. 23B

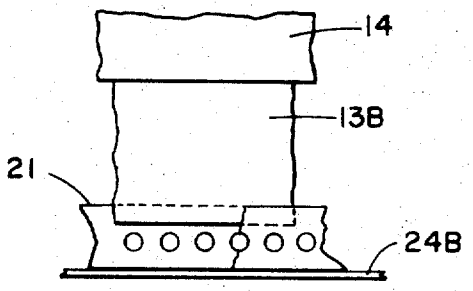


Fig. 25

United States Patent Office

Re. 27,165
Reissued Aug. 10, 1971

27,165

TUFTING APPARATUS FOR THE MANUFACTURE OF CARPETS, RUGS, AND THE LIKE

Abram N. Spanel, 344 Stockton St., Princeton, N.J. 08540, and Loy E. Barton, Bradenton, Fla.; said Barton assignor to said Spanel

Original No. 3,387,577, dated June 11, 1968, Ser. No. 503,342, Oct. 23, 1965. Application for reissue Sept. 17, 1969, Ser. No. 866,416

Int. Cl. D05c *15/16*

U.S. Cl. 112—79 38 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

Yarn bits are cut from yarn strands and *pneumatically* transported [by suction] to bit-loading stations where they are positioned by stop means for transfer to a backing layer by bit-applying elements as provided by needles, narrow blunt-edged blades, or a single [wide] blunt-edged blade.

This invention relates to mechanisms and methods for manufacturing carpets, rugs, pile textiles and the like by application of yarn-bits to a backing layer in location and color to reproduce any desired pattern.

In accordance with the present invention, the bit-applying elements of a tufting machine (specifically the needles, for example), are supplied in each cycle of the machine with yarn-bits of color and position, to reproduce the corresponding line of a desired pattern by a pneumatic transmission arranged specifically comprising at least one pair of associated guide and magazine structures. Each magazine structure has an array of passages respectively forming part of a path for pneumatic transmission of a yarn-bit to a corresponding needle or other bit-applying element. Each guide structure or means for receiving the ends of yarn strands has an array of similarly spaced passages for threading, in a repeated color sequence, with the yarn strands; the number of colors in each sequence should be not less than, and is preferably equal to, the total number of colors required by all lines of the pattern. The number of yarn passages, per guide structure, should preferably exceed the number of needles to be supplied therefrom to accommodate an additional color sequence of yarn strands.

During a cycle of the machine as used for two or more color operation, each passage of the magazine effectively scans, step-by-step, a complete color sequence of the guide-structure passages. For each step position of the scan, the magazine passages are each in alignment with a guide-passage corresponding with that step position and independent feed-means for the yarn strands are selectively controllable in accordance with patern requirements so that one or more or none of the magazine passages receive a yarn end fed from the ten aligned guide passage. In the interval between successive scan steps and after the time for operation of the feed-means, all yarn strands then extending between the guide and magazine structures are severed, as by timed knife means, so to leave yarn-bits of selected color in predetermined passages of the magazine.

During the machine-cycle, the yarn bits are transferred from the magazine by pneumatic means applied to bit transfer tubes, each having a receiving end aligned with a magazine passage and a discharge end adjacent the bit-loading position of the corresponding bit-applying element. In one arrangement using needles for applying the bits, the yarn-bits are centered, as by reciprocable pneumatic stops before movement of the needles from loading position and a shutter valve normally sealing a vacuum-manifold for the discharge ends of the transfer tubes is retracted to permit passage of the loaded needles from their loading position, through the backing layer, and then back to loading position. In another arrangement using needles for applying the yarn-bits, the eye ends of the empty needles pass through the backing layer to the bit-loading position, and after loading are returned through the backing layer for transfer of the bits thereto.

The invention further resides in a tufting machine having features of construction, combination and arrangement hereinafter described and claimed.

For a more detailed understanding of the invention, reference is made to the following description of preferred methods and apparatus and to the accompanying drawings in which:

FIG. 1 is a flow diagram illustrating the yarn and backing-layer paths and identifying components of the preferred apparatus;

FIGS. 1A and 1B are explanatory figures referred to in discussion of the tufting operation;

FIG. 2 schematically and in perspective illustrates the yarn-feed capstan of FIG. 1 and associated drive mechanism;

FIG. 3 schematically and in perspective illustrates one of the presser-feet of FIG. 1 and its drive mechanism;

FIG. 4 schematically and in perspective illustrates the yarn cut-off knife of FIG. 1 and associated drive mechanism;

FIG. 5 schematically and in perspective illustrates a yarn-bit magazine of FIG. 1 and mechanism for effecting its linear motion;

FIG. 6 schematically and in perspective illustrates the magazine of FIG. 5 and mechanism for effecting its lateral motion;

FIG. 7 schematically and in perspective illustrates a suction control valve of FIG. 1 and its operating mechanism;

FIG. 8 schematically and in perspective illustrates a bit-centering stop of FIG. 1 and its operating mechanism;

FIG. 9 schematically and in perspective illustrates the shutter-valve of FIG. 1 and its operating mechanism;

FIG. 10 schematically and in perspective illustrates the needle-bar of FIG. 1 and its operating mechanism;

FIG. 11 schematically and in perspective illustrates a pin roll of FIG. 1 and its driving mechanism;

FIGS. 12A and 12B jointly provide a front elevational view of a tufting machine incorporating mechanisms schematically shown in FIGS. 1 to 11 with parts omitted for clarity of illustration;

FIG. 13 is a side elevational view of FIG. 12A as viewed from the left;

FIG. 14 is a rear elevational view of mechanism shown in FIG. 13;

FIG. 15 is a side elevational view of FIG. 12B as viewed from the right;

FIG. 16 is a rear elevational view of mechanism shown in FIG. 15;

FIG. 17 is a detail view, on enlarged scale, of the presser-foot mechanism and some associated components;

FIGS. 18A and 18B are detail views, on enlarged scale, of the drives of the needle-manifold valve, the bit stops and the shutter-valve of the needle manifold;

FIGS. 19 and 20 are front and side elevational views, on enlarged scale, of part of a bank of control solenoids for the yarn-feed mechanisms;

FIGS. 21A–21D are explanatory charts referred to in discussion of various modes of operation of machines embodying the invention;

FIGS. 22A–22D illustrate the construction and steps of operation of a modified needle-loading and bit-applying arrangement;

FIGS. 23A and 23B schematically illustrate, in side elevation, the construction and steps of operation of another loading and bit-applying arrangement; and

FIGS. 24 and 25 respectively illustrate, in front elevation, multi-blade and uni-blade constructions suited for the bit-applying arrangement of FIGS. 23A, 23B.

Referring to FIGS. 1 and 3, the magazine **10** has a longitudinal row of spaced chambers **11** each with its discharge end in alignment with the receiving end of a bit-transfer tube **12**, serving as a *pneumatic* communication means. The discharge end of each of tubes **12** is adjacent the path of a corresponding one of the forked tufting needles **13** carried by a reciprocable needle-bar **14**. While each needle is at rest at the top of its stroke, a yarn-bit B is *pneumatically* delivered to it from the corresponding transfer tube **12** and centered (FIG. 1A). *The suction system hereinafter described in detail is illustrative of one form of pneumatic means for producing a differential of pressure for transport of the yarn-bits, it being understood that other forms of pneumatic means may be utilized.* During the subsequent down-stroke of the needles, the ends of the yarn-bits in them are pushed through the backing layer L (FIG. 1B) to project from the lower face of the layer. In other words, during the subsequent down-stroke of the needles, the centered bits in the double or forked needles are pushed through the backing layer L (FIG. 1B) to form initially a vertical U which is held by a portion of the backing layer straddled by the forked needles. For continued downward motion of the needles, the free ends of the bit ride out of the eyes of the needles before the end of the down-stroke (FIG. 1B) to form an inverted U. The empty needles return to their original position, each to receive another yarn-bit and the backing layer L, with its new line of tufting, is advanced one step in readiness to receive the next line of inverted U tufts.

In the interval between successive reciprocations of the needle-bar, as effected by the one-time shaft **25**, each of the chambers **11** of magazine **10** is loaded with a yarn-bit B cut by knife **15** from a yarn strand S, whose end positioned by a corresponding passage **16** in guide means or structure **17**, is opposite the receiving end of the chamber to serve as means for receiving ends of yarn strands. Each yarn strand S is looped (FIGS. 1 and 2) about a series of one or more capstan drums **18** between its supply spool **19** and its guide passage **16**. Between the capstan and guide passage **16**, the strand S passes beneath a reciprocating presser-foot **20**. When a bit-length of yarn is to be fed from a spool **19**, the associated presser-foot is permitted to drop, in response to a command signal, for engagement with strand S at the beginning of a forward feeding stroke. The resulting tension on the yarn tightens the yarn loop on the capstans, so to pull an additional length of yarn from the spool. The resulting slack in the yarn strand in front of presser-foot **20** is taken up by suction supplied, as later described, through the magazine chamber **11**. In consequence, a bit-length of yarn is pulled through passage **16** in the guide **17** and into the chamber **11**.

In a modification of the strand-feed arrangement just described, the forward motion of the presser-foot **20** and the mechanism for effecting such forward motion are omitted. In such modified feed arrangement, suction applied through the magazine chamber is effective to tighten the strand as looped over the capstans; the element **20** normally engages the yarn strand and is lifted therefrom when that strand is to be fed to a magazine chamber. The length of the bit cut from the end of the strand received by the magazine chamber may be controlled either by presetting the interval for which the cutter **15** opens the suction path from the magazine to the yarn guide or by presetting the interval for which the presser-foot **20** is up while the cutter **15** has opened such suction path.

Assuming that a command signal has been given to supply a bit-length of yarn from a particular spool **19** to the magazine chamber **11** for a particular needle, such bit-length is cut upon conclusion of the aforesaid feeding operation by a timed movement of the knife **15**. The yarn-bit so cut off and left in the magazine is transferred to the corresponding needle by suction applied to its transfer tube **12** via the manifold **21**. The timing of the bit-transfer suction is controlled by valve **22**. The yarn-bit B as propelled from the delivery end of tube **12** into the then aligned eyes of the forked needle (FIG. 1A) is preferably centered by a reciprocable stop **23**. After delivery of a yarn-bit to needle **13**, the shutter **24**, which seals off the needle passages in the bottom of manifold **21**, is retracted so to permit unobstructed movement of the needle first through the backing layer L and then back to its original position.

Although it is possible to use a single magazine for all needles, it is desirable principally for economy of space to use two or more magazines. In the particular tufting machine herein illustrated and described, two magazines **10** and **10A** are used. The transfer tubes **12** from the upper magazine **10** extend from its chambers **11** to say the odd-numbered tufting needles and the transfer tubes **12A** from the chambers of the lower magazine **10A** extend to the even-numbered tufting needles. Both sets of transfer tubes connect to the common suction manifold **21**, each adjacent its corresponding tufting needle. The yarn-feeding and cutting mechanisms associated with the lower magazine are the same as for the upper magazine and are identified by the same reference characters plus the suffix A to avoid unnecessary repetition of their description.

A suitable mechanism for driving the yarn-feed capstan **18** is schematically shown in FIG. 2. Because of the horizontal space needed by the yarn strands on a capstan, several capstans may be used. Each capstan then has a groove for each thread of yarn. The capstan shaft **30** is driven via sprocket **31**, chain **32** and sprocket **33** from cam shaft **34**, which in turn is driven via gear **35**, idler gear **36** and gear **37** from shaft **38**. The yarn-guide capstan drum **39** adjacent the capstan **18** is driven by gears **41** on their respective shafts. The drive shaft **38** for this yarn-feed mechanism is coupled by means, including sprocket **42** and chain **43**, to the one-time shaft **25** of the complete machine. The capstan drums **18** and **39** serve as a common torque amplifier for feeding yarn on demand from any one or more of all spools **19** of the upper tier.

A suitable operating mechanism for each presser-foot **20** is schematically shown in FIG. 3. The lower ends of links **45**, **46**, are pivotally connected to the respective end of a guide block **47** for the presser-foot. The pin **48** extending from the supporting rod **49** of the presser-foot is received by an arcuate slot **50** in the right-hand or rod-guiding end **51** of lever **52**. Intermediate its ends, the lever **52** is pivotally connected at **53** to the link **45**. The other end of lever **52** is coupled via link **54** and rocker plate **55** to the biased movable element or armature **56** of solenoid-motor **57** or equivalent. Normally, the presser-foot **20** is out of engagement with the yarn strand S for all angular positions of the parallel-link motion provided by links **45**, **46** and their interconnecting guide block **47**. The upper end of link **46** is attached to rock shaft **62** which is oscillated under control of the eccentric **58** via cam-follower **59**, link **60** and arm **61**. The eccentric **58** is attached to and driven by the shaft **34** which is also part of the capstan driving mechanism. To feed a bit-length of the strand S, the solenoid **57** is energized by a command signal at the beginning of a counter-clockwise motion of links **45**, **46**. The resulting clockwise movement of lever **52** about its pivot **53** lowers the presser-foot **20** into engagement with strand S. Such engagement is maintained until, at the end of the forward or feeding stroke of the presser-foot, the solenoid **57** is deenergized as by a limit switch. As later explained in

discussion of more detailed figures, the effective throw of eccentric **58** may be varied to change the bit-length and, therefore, the depth of pile of the finished carpet or rug.

A suitable mechanism for operating the knife **15** is schematically shown in FIG. 4. In the normal position of knife **15**, its teeth straddle the yarn paths from the passages **16** in guide **17** to the aligned chambers **11** of magazine **10**. At its opposite ends, the knife **15** is pivotally connected to arms **65**, **66**. One of these arms (**66**) is fastened to the vertical rock shaft **67** to which is also attached the supporting arm **68** of a cam-follower **69**. The arm **68** is biased to maintain engagement between cam-follower **69** and the face of a cam **70** detachably keyed to the shaft **38**. For reasons which later appear, the cam **70** may have one or more rises depending upon the number of loading positions of the magazine **10**. For economy of time, the magazine **10** has but one loading position for production of single-color carpet; two loading positions for two-color carpet, etc.

A suitable mechanism for effecting linear stepping of the magazine **10** with respect to strand guide **17** (FIG. 4) is schematically shown in FIG. 5. The magazine **10** is biased to maintain engagement between cam-follower **75** and the face of cam **76**, which for five-color operation has, as shown, five plateaus. The cam **76** is driven in synchronism with the one-time shaft **25** of the machine. For the particular cam shown in FIG. 5, as it makes one revolution, the magazine **10** is progressively stepped in one direction from its No. 1 loading position to its No. 5 loading position with a dwell between each step and then returns to its No. 1 position from the highest plateau corresponding with the No. 5 position. For one-color operation, the five-plateau cam **76** shown may be replaced by an unstepped disc; for two-color operation, by a two-plateau disc, etc. It will be understood that each forward step of the magazine **10** moves the inlet end of each of its chambers **11** from alignment with one yarn passage **16** in guide **17** to alignment with the next yarn passage **16**. Thus, for the five-plateau cam shown in FIG. 5, each chamber, during one revolution of cam **76**, is aligned with five successive yarn passages **16** to receive a yarn-bit from any one of the five corresponding supply spools. At the end of one revolution of cam **76**, all chambers of the magazine **10** are loaded with yarn-bits whether the machine is set for one-color operation, two-color operation, etc.

To facilitate transfer of the yarn bits, via the suction tubes **12**, the loaded magazine is rocked slightly away from the yarn guide **17**. A suitable mechanism for effecting such rocking motion is schematically shown in FIG. 6. The supporting arms **80** of magazine **10** are slidably keyed to the shaft **81** which is rocked, once per cycle of the machine, by cam **82** via cam-follower **83**, supporting arm **84**, link **85** and arm **86** fastened to shaft **81**. To avoid possible confusion, it is to be noted that the cam **76** for effecting linear motion of the magazine is not fastened to the rock shaft **81** but revolves freely on it. The shaft **38** to which cam **82** is attached is rotated in synchronism with the one-time shaft **25**.

A suitable mechanism for operating one or more valves **22** for suction-manifold **21** is schematically shown in FIG. 7. The duct **90** which extends along the top of manifold **21** in position clear of the needle-bar **14** has a plurality of ports **91**. Normally the ports of each valve are closed by the movable valve plate **92** which is biased to closed position by spring **93**. The upper portion of the stem **94** of the valve plate **92** extends above the top of duct **90** into the path of a tappet **95**. The valve or valves **22** are opened for a brief period in each cycle of the machine under control of cam **96** via cam-follower **97**, sliding link **98** and arm **99**. At one end, arm **99** is pivotally connected to link **98** and at its other end is attached to the tappet rocker shaft **100**. [The] *To provide flow of gas for pneumatic transport of the yarn bits to thread the needles,* duct **90** may be connected as by pipe **101** to the intake of a vacuum pump **102**. The duct **90** is of substantial capacity and so serves as a tank or reservoir whose pressure is reduced substantially below atmospheric pressure. In consequence, when the valve or valves **22** are opened, there is a sudden drop of pressure in manifold **21** and the resultant in-rush of air to it via transfer tubes **12**, **12A** provides for high-speed transport of the yarn-bits from the loaded magazines to the needles.

It may be desired where *low pressure or* vacuum is shown on one side that *a higher, superatmospheric* pressure be exerted on the opposite side to facilitate the movement of the yarn, under certain circumstances, and thereby also eliminating the accumulations of fuzz.

A suitable mechanism for operating the bit-centering stops **23** is schematically shown in FIG. 8. The stops **23** are small hollow tubes extending from the front face of a manifold **105** which is connected, as by flexible pipe **106**, to a vacuum line. The free end of each stop tube fits into a short extension tube **107** somewhat less than half the length of the longest bit to be threaded into the needle because the extent to which the yarn-bit extends beyond the needle is initially somewhat less than half the total length of the bit. With the associated needle **13** at rest at the top of its stroke, the open end of each tube **107** is in alignment with the needle eyes and close to the needle to receive one end of the yarn-bit as propelled through the eyes of the corresponding needles. The yarn end is prevented from entering the smaller tube **23** by the apertured plug or screen **108** which serves as a stop. The stopped end portion of the yarn-bit is somewhat compressed because of its high velocity impact with the screen **108** or equivalent. The suction in tube **23** lightly holds the bit so that when stop **23** is retracted, the compression is released and the bit is pulled to a point at which it is centered with respect to the needle axis. The holding suction may be preset to suitable value by valve **123**. Each of the guided slide-bars **109** extending rearwardly from manifold **105** is connected to a horizontal rack member **110** engaged by gear **111** on shaft **112**. Horizontal reciprocation of rack **110**, once per cycle of the machine, is effected by cam **113** via cam-follower **114**, lever **115**, link **116**, rack **117** and gear **118** on shaft **112**. The cam **113** is timed to retract the centering stops **23** before the needles descend and to return them to their original position suitably after the descending needles have drawn the right-hand ends of the bits from the extension tubes **107**. To provide for adjustment of the stroke of stops **23**, to accommodate yarn-bits of substantially different length, the lever arm **115** is provided with an arcuate slot **119**. The pivot pin **120** for the upper end of link **116** extends through slot **119** and can be clamped to lever **115** at any desired distance from fixed pivot **122**.

The retractable bit-stop arrangement of FIGS. 1 and 8 may be replaced by a manually-preset stop arrangement similar to that shown in FIG. 23A. In such modification of FIGS. 1 and 8, the stops **23** are so adjusted that the distance from each needle **13** to the stop is fixed at somewhat less than one-half of the total length of the yarn-bit. As the bit hits the fixed stop, it compresses, but the compression is relieved as the bit is drawn through the backing layer by the descending needle. In such simplified arrangement, the mechanism for cyclically retracting the stops and the means providing suction therethrough are omitted.

A suitable mechanism for operating the shutter-valve **24** of FIG. 1 is schematically shown in FIG. 9. Normally, the shutter **24** is in the forward position shown to seal off the needle passsages **130** through the bottom wall of manifold **21**. After the needles **13** have been threaded with yarn-bits, the shutter **24** is retracted to clear the passages **130** and so permit unobstructed movement of the needles from and back to their threading position. For such purpose, each of the racks **131** is coupled to shutter **24** and is engaged by a gear **132** on shaft **133**.

Once per revolution of the one-time shaft **25**, the shaft **133** is rotated, first, in one direction, and, then, in the other to its original position by cam **134** via the cam-follower **135**, rack **136** and gear **137** on shaft **133**.

A suitable mechanism for effecting one reciprocation of needle-bar **14** per machine cycle is schematically shown in FIG. 10. At points spaced along its length, the needle-bar is coupled to shaft **140** by link **141** and an arm **143** which is keyed to the shaft **140**. An arm **148**, loose on shaft **140** and coupled to an arm **143** by coupling pin **142**, carries a cam-follower **144** for engagement with cam **145** which is driven from the one-time shaft **25**. During its reciprocation, the needle-bar 14 is maintained in vertical plane by the usual arrangement of guide rods **146** and bearings **147**. The pins **142** or equivalent are provided to permit temporary decoupling of the needle-bar from its drive so that all needles may be raised in the clear above the suction manifold **21** (FIG. 1) for inspection and other maintenance purposes.

A suitable arrangement for effecting intermittent feed of the backing layer L is schematically shown in FIG. 11. The ratchet **150** is attached to shaft **151** of the toothed feed roll **152** and is prevented by lock pawl **153** from any retrograde motion due to tension on the layer L. The biased feed pawl **154** is pivotally mounted on rock arm **155** which is free to swing on shaft **151**. The free end of arm **155** is pivotally connected to the lower end of link **16** which couples arm **155** to the eccentric **157** fastened on shaft **158**. The drive from one-time shaft **25** to shaft **158** includes sprockets **159, 160** and chain **161**. Description of the operation of the pawl and ratchet feed is unnecessary. Provisions may be made to adjust the stroke of arm **155** and, therefore, the extent to which the layer L is stepped per cycle of the machine.

With the feed arrangement of FIG. 11, the tufted side of the rug or carpet engages the toothed feed roll **152**, with consequent tendency for the applied bits to loosen in the backing layer and for their loops to move away, more or less irregularly, from the untufted side of the backing layer. Such tendency may be overcome by the feed arrangement schematically shown in FIG. 1. In such modified arrangement, the toothed roll **152** is disposed to engage the untufted or loop-side of the backing layer and so press the tuft loops flat against the top-side of the backing layer. As shown in FIG. 1, the storage roll **188** may be driven from the intermittent drive for the feed roll **152** through a slip-drive mechanism including belt **187** to maintain the backing layer L under tension. Permanently to hold the flattened tuft loops in place, a quick-setting cement may be applied, as by spray-header **28**, to the untufted face of the finished rug or carpeting while enroute between tensioning roll **152** and storage roll **188**.

FIGS. 12A and 12B show the front of a tufting machine incorporating the mechanisms above described. The variable-speed motor **165** mounted on the top frame member **166** is coupled to the one-time shaft **25** via sprockets **167, 168** and chain **169**. The shaft **25** extends through the side frames **170, 171**, of the machine. The shaft **151** of the pin roll **152** is supported by bearings **172, 173** on the front side of the frame members **170, 171**.

The shaft **174** of the rubber-faced back-up roll **175** is similarly supported by the bearing blocks **176, 177**. The spacing between rolls **152, 175** is adjustable, as by screws **178, 179**, to accommodate carpeting of different pile heights. The rolls **152, 175** (FIG. 11) are beyond and below the needle-bar **14**. A similar pair of pin and back-up rolls **181, 182** (FIGS. 13, 15) is supported in advance of and below needle-bar **14** by shafts **183, 184** respectively. The latter pair of rolls **181, 182** is not power-driven but serves to hold the backing layer L flat and taut below the needle-bar. The supply roll **186** for the backing layer L is supported by shaft **185** extending between the side frames **170, 171** of the machine. To facilitate replacement of the supply roll **186**, its end bearings may

be released by unloosening clamping screws **189** (FIG. 13) and swinging links **190, 191** about their respective pivots. The backing layer L is threaded as best shown in FIGS. 13 and 15. The tufted backing layer passes under guide roll **192** at the back of the machine to a take-up roll not shown.

The mechanisms for feeding the yarn from the spools to the yarn guide, for driving the magazines and for operating the cut-off knives are all included in a sub-assembly **195** (FIGS. 13–16) held to the main frame of the machine by releasable coupling means including the pins or bolts **196**. The operating shaft **38** of these mechanisms may be driven in synchronism with the one-time shaft **25** of the machine via chain **197** (FIG. 15) and sprockets **42, 198** on the respective shafts; the idler sprockets **199, 199A** for this chain are loose on their respective supporting shafts **81, 81A**. The biasing springs **26, 26A** for the knives **15, 15A** most clearly appear in FIG. 16.

As shown in FIG. 17, the platform **205** below all of the presser-feet **20**, has guide recesses **206**, each receiving the yoke **47** of the associated presser-foot. A passage **207** guides each yarn strand S to the corresponding recess **206** and a passage **208** guides the yarn strand S from recess **206** into the corresponding passage **16** of the common yarn guide **17**. A biased brake-finger **209** engages each strand in the inlet passage **207** to prevent retrograde movement. When a presser-foot **20** is lowered in response to energization of its solenoid **57**, the yarn strand is pressed against the bottom of the recess **206** so that it is pushed forward during the feed-stroke of the presser-foot. The platform **205** may be removed for maintenance purposes by releasing the latches **210**. As shown in FIGS. 17, 19 and 20, the solenoids **57** for the strand-feeding mechanisms are arranged in a bank of staggered vertical and horizontal rows for economy of space; there are two such banks, one for each magazine **10, 10A** (FIG. 1).

Leakage of air into needle-manifold **21** is minimized by the felt packing **211** (FIG. 18A) which provides a seal for the extension **212** of needle-bar **14**. Each of the split needles **13** also passes through a felt washer **213** immediately above the discharge end of the corresponding bit-transfer tube **12** or **12A** and the receiving end of the stop tube **23** so to concentrate inflowing air about the needle eye. The vacuum-manifold **105** for the stop tubes **23** is supported externally of the needle-manifold **21** by a pair of slides **220** which carry rack **110**. This rack engages gear **111** on shaft **112** (FIG. 18A) which is rocked under control of cam **113** via cam-follower **114**, arm **115**, link **116**, rack **117** and gear **118** on shaft **112** FIG. 18B). The shutter **24** for normally closing the needle holes in the bottom of manifold **21** is supported from a second pair of slides **221** through the intermediary of bar **222** (FIG. 18A). The slides **221** carry the rack **131** (FIGS. 18A, 18B) which engages gear **132** on shaft **133**. This shaft is rocked under control of cam **134** via cam-follower **135**, rack **136** and gear **137**. The needle-comb **223**, spaced below the bottom of the needle-manifold **21**, serves as a continuation of the plate **224** over which the backing layer L is intermittently stepped in the path of the tufting needles **13**.

In FIGS. 12–20, elements of the various mechanisms are identified by the same reference characters as in FIGS. 1–11 so that further description of them appears unnecessary. FIGS. 19 and 20 show a modified yarn-feed arrangement in which each yarn feed solenoid **57A** is energized concurrently with a corresponding presser-foot solenoid **57** so as to rock the corresponding idler roller **39** and press the selected yarn strand against the feed-capstan **18**.

The preferred tufting machine above described provides many different modes of operation and is suited to produce tufted carpeting and the like having any desired number of colors and in any conceivable pattern. In explanation of such flexibility and of methods which can be performed, a relatively few specific examples are discussed below. For example, to produce a carpet or rug whose total pattern requires five different colors to meet the

demand for a bit of any of these colors at any point of any line in the pattern, the yarn-strands are threaded into passages **16** of guide **17** (FIG. 1) in the repeating sequence of the five colors Nos. 1 to 5, as indicated in the left-hand column of FIG. 21A. It is assumed that a bit-sequence of colors Nos. 2, 4, 1, 3, 5 is needed to meet the requirements for part of a pattern line. Therefore, a series of five adjacent chambers of magazine **10** (FIG. 3) should be so loaded. In such case, as shown in FIG. 21A, at loading position No. 1 of the magazine, the 5th chamber of the series is loaded with a C5 bit; at loading position No. 2 of the magazine, the first chamber of the series is loaded with a C2 bit; at loading position No. 3, the second chamber of the series is loaded with a C4 bit; at loading position No. 4, the third chamber of the series is loaded with a C1 bit; and at loading position No. 5, the 4th chamber of the series is loaded with a No. 3 bit. Thus, the five adjacent chambers of the magazine **10** have been loaded with yarn-bits in the required colors.

It can similarly be shown that for any single color Nos. 1 to 5, and for all demanded combinations and permutations of two or more of the colors Nos. 1 to 5, the chambers **11** of magazine **10** will be fully loaded with colored yarn-bits in the proper sequence to produce any desired line pattern. It is to be noted that for the five-position operation of magazine **10**, the total number of supply spools therefor need be only equal to the number (plus four) of chambers in magazine **10** because the color C5 need not be repeated. Specifically for a 15-foot rug and $\frac{5}{32}$ inch between strand bits, 1152 strand-bits are needed. Therefore, magazine **10** supplies 576 needles. The total required number of supply spools for magazine **10** is 576+4=580. Magazine **10A** also supplies 576 needles and requires 576+4=580 supply spools.

The five-position mode of loading may also be used, without disturbing the five-color thread, to produce a carpet or rug whose total pattern requires any lesser number of colors. One example of how a three-color demand is met is shown in FIG. 21B: the assumed required sequence in this case is Nos. 3, 2, 1, 2, 3. It is to be noted that all chambers of the magazine become loaded although no yarn is drawn from the C4, C5 color spools.

The five-position mode of loading may also be used with the guide **17** rethreaded with a repeating sequence of a lesser number of colors. One example of how a three-color demand is met is shown in FIG. 21C. To permit direct comparison with FIG. 21B, the same sequence (3, 2, 1, 2, 3) of color demand for five successive chambers of magazine **10** is shown. The difference between the loading patterns for five-position, five-color operation and five-position, three-color operation is evident, but, again, all chambers of the magazine are loaded with bits in proper sequence for discharge to the transfer tubes before the magazine is returned from its No. 5 position back to its No. 1 position. It can be similarly shown that for any single color Nos. 1 to 3 and for all combinations and permutations to two or more of the colors Nos. 1 to 3, the chambers of magazine **10** will be fully loaded with colored yarn-bits in proper sequence to produce any desired line pattern. In the same manner, it can be shown that with the guide rethreaded with a repeating sequence of any two colors, or any four colors, or with all strands of single color, the five-position mode of magazine loading meets all loading requirements that can be demanded.

However, unnecessary cutting and scanning movements of the magazine can be eliminated by threading the guides with only the colors required for the total rug pattern and by reducing the number of loading positions of the magazine to correspond with that number of colors. Again assuming a specific three-color example for purposes of explanation, FIG. 21D shows the yarn-color sequence in the guide to be C1 to C3. The color sequence demand in a series of three successive chambers of magazine **10** may be C3, C2, C1. In this case, at magazine position No. 1, the second chamber of the series is loaded with a C2 bit; at position No. 2, the third chamber is loaded with a C1 bit; and at loading position No. 3, the first chamber of the series receives a C3 bit so to conclude full loading of the series of chambers with color-bits in the demanded sequence. It can similarly be shown that for the three-position mode of loading, the demand for any single color No. 1 to No. 3 and for any or all possible combinations and permutations of two or more of the colors Nos. 1 to 3 results in proper loading of the magazine and without need to disturb the three-color threading of the guide.

From the foregoing examples, it should now be clear that for a magazine **10** having C-loading positions (where C is an integer equal to or greater than the number of colors required for a total rug pattern), the magazine is fully loaded with color-bits in proper line-sequence to meet any and all possible color combinations and permutations. It should also now be clear that a minimum number of cutting operations and a minimum number of loading stations are obtained when the guide **17** is threaded only with the required colors and in a repeating sequence of them.

For maximum production rate, the total number of supply spools for the magazine need be only

$$M=N+(C-1)$$

where:

M=number of spools
N=number of chambers per magazine
C=number of magazine loading positions.

In the particular machine shown as set up for five-position loading in manufacture of carpet which is 15 feet wide, there are, as above noted, 1152 needles and 580 supply spools for each of the two magazines **10, 10A**.

It is to be noted that for manufacture of single-color rugs, only one color yarn need be used and the magazine need not be stepped. In this case, the total number of yarn-supply spools will be equal to the number of magazine chambers, the magazine is left stationary, and the needle-stroke rate is the same rate at which yarn-bits are cut. Such threading and mode of operation affords maximum rate of production of single-color rugs.

It is to be further noted that if only one color is to be used for manufacture of a single-color rug with the machine set up and threaded for five colors, then the magazine, as stepped during each needle-stroke, is completely loaded from one spool per group of five magazine chambers. In such case, the production rate with one-color yarn is the same as if five colors of yarn were used but only $\frac{1}{5}$ of the total number of yarn spools would be used or needed.

The programming means for the command signals to the solenoids **57**, or equivalent, is not part of the present invention. It may utilize, for example, a magnetic record tape, a punched record tape or web, patterned contact drums, or a programmed computer or logic circuitry associated with light-responsive scanning means for a master pattern, etc.

FIGS. 22A–22D illustrate another and preferred method of assembling yarn-bits on the backing layer and a modification of the apparatus previously described to adapt it for performance of such method. In this method and apparatus, the backing layer L is indexed one pitch while the needle-bar **14** is in a down-dwell position (FIG. 22A) with each of the empty needles **13** in inverted position below the backing yarn layer and out of the suction-manifold **21A**.

As the bar **14** moves to its up-dwell position (FIG. 22B), the empty needle **13** passes through the backing layer L. In the bit-loading position of the dual needle **13** (FIG. 22B), its eyes are in the path of travel of a yarn-bit B and its shank is through the backing layer so to bring the needle-eye in the path of a yarn-bit B for *pneumatic* loading of the needle while its shank is extending through layer L. Suction is then applied to the

manifold **21A** to transport a yarn-bit B from the loaded magazine via tube **12** and through the needle eye. The end wall **23A** of the corresponding chamber **103** in manifold block **21A** serves as a stop for the yarn-bit as loaded in the needle. The suction-outlet port **104** is so located that the suction serves to brake the yarn-bit B as it approaches the centered position. Leakage of air is minimized because each needle passage **130** of the manifold **21A** is substantially blocked by the needle shank and the adjacent area of the backing layer L.

As the loaded needle **13** moves downwardly (FIG. 22C), the free ends of the yarn-bit are pulled through the backing layer L and the central part of the yarn-bit between the split shank of the needle is engaged by the top face of the backing layer and drawn to a tight loop which, in this method and arrangement, is not loosened by return of the needle to bit-loading position.

By the time the needle-bar **14** has reached its downdwell position (FIG. 22D), the now applied yarn-bit B is clear of the eye of needle **13**. Before the next upstroke of the needle the backing layer L is indexed to the left and a blast of air from nozzle **214** blows the tuft legs of the bit B out of the path of the empty needle as it next ascends to pass through layer L to bring its eye-end into the suction-loading chamber or passage **103**. Thus, the loop of the previously applied bit is not loosened but remains tight against the upper face of the backing layer L. This insures a good bond to any layer of thermoplastic or the like subsequently applied to the untufted side of the rug or carpet and also a smooth appearance of the resulting back face of such manufactured article.

It is, of course, to be understood that suction for all suction-loading chambers **103** (FIG. 22A) may be controlled by a valve **22A** (FIG. 22B) operated in synchronism with the needle-bar **14** and that the air blast to a common nozzle **214**, or plurality of nozzles, may be similarly controlled by an air-value.

In the modification of the bit-applying arrangement shown in FIGS. 23A and 23B, the tufting needles **13** are replaced on the needle-bar **14** either by a like number of narrow, blunt-edged blades **13A** (FIG. 24), each serving as one bit-applying element, or by a single, blunt-edged blade **13B** (FIG. 25) of width suited to provide all bit-applying elements.

In either case, when the needle-bar **14** is at its upper position (FIG. 23A), the lower blunt edge of each bit-applying element is above the empty loading station formed by a chamber **103B** (FIG. 23B) in the suction-manifold **21B**. At that time in the machine cycle, as in previously described arrangements, suction is momentarily applied to transfer a yarn-bit B (FIG. 23A) via tube **12** to the loading station. The stops **23B** (FIGS. 23A, 23B) are present so that the delivered bit B is centered with respect to the path of reciprocation of the bit-applying element. Loss of air is minimized by provision of sealing element **211B** which is fixed to the upper face of manifold **21B** for continuous engagement with the bit-applying element **13A** (**13B**) and by provision of the flap valve **24B** which is biased to close the lower passage **130B**.

As the needle-bar **14** descends, each bit applying element **13A** (**13B**) engages the corresponding bit B, pushes it through passage **130B** in the shape of a U, and presses the loop portion, or bottom, of the U-shaped bit against the upper face of the backing layer L for boding engagement therewith (FIG. 23B). Conventional bonding techniques may be used. For example, if the backing layer L is of thermoplastic material or coated therewith, it may be activated by heat supplied via the underplate **224B** at the bit-applying zone and/or the element **225** in advance of the bit-applying zone; in such case, setting of the bonds between the applied bits and the backing layer may be effected or accelereated by cooling of underplate **226** beyond the bit-applying zone. In another example, a quick-setting adhesive may be applied to the upper face of the backing layer L immediately in advance of the bit-applying zone; in such case, the element **225** may be a spray-header. In connection with the method and apparatus of FIGS. 23A, 23B, 24, 25, it is to be noted that a relatively small loop or fold-over portion of each strand, sufficient for permanent bonding, is pressed into a cement surface, hot or cold, or into a thermoplastic surface, or into any suitable quick-acting gripping surface which is also flexible.

As in the previously described arrangements, the suction for all loading chambers **103** (FIGS. 22A–25) may be controlled by a valve **22A** operated in timed relation with the needle-bar **14**.

It shall be understood the invention is not limited to the particular machines illustrated and described but also comprehends modifications and equivalents within the scope of the appended claims.

It is also to be understood that the apparatus may be used for manufacture of fabrics other than those described. For example, it is clear that the adhesive bit-strand gripping surface could be applied or located on the tufted side of the backing material and the untufted side could be made to have the appearance of petit-point. In such case, the tufts would be short and the adhesive could be applied before, during or after tufting. Similarly, the adhesion could be thermoplastic in character, for example, and the bit-strands made to adhere by the application of heat and pressure on the surface opposite the tufted surface.

What is claimed is:

1. A tufting machine for applying yarn-bits to a backing layer comprising

bit-loading stations adjacent said backing layer,

bit-applying elements for engaging and transferring yarn-bits from said stations to said backing layer,

stop means for positioning yarn-bits at said stations for transfer by said bit-applying elements,

mechanism for repeatedly reciprocating said bit-applying elements past said stop means,

means for receiving the ends of yarn strands fed from respective supply spools and having communicating means for discharging yarn bits into the bit-loading stations against said stop means and in the respective paths of said bit-applying elements,

suction means associated with said communicating means for transporting yarn-bits after severance from said strands, and

severing means in advance of said bit-loading stations and operating in timed relation to said reciprocating mechanism to cut said yarn-bits from said strands.

2. A tufting machine as in claim **1** in which said communicating means are tubes and in which the bit-applying elements are needles having eyes which are in alignment with the discharge ends of said tubes for the loading position of said needles at said stations.

3. A tufting machine as in claim **2** additionally including a suction chamber in which the needles are loaded at said stations, from which the eye-ends of the loaded needles emerge to pierce the backing layer and apply the yarn-bit, and back into which the eye-ends of the needles are retracted before indexing of the backing layer to its next bit-receiving position.

4. A tufting machine as in claim **2** additionally including a suction chamber with loading stations into which the eye-ends of the needles are moved after passing through the backing layer, and from which the eye-ends of the needles return back through and clear the backing before the eye-ends of the needles next pierce the backing layer to apply the yarn-bit, the backing layer being indexed layer to enter said loading stations.

5. A tufting machine as in claim **1** in which the bit-applying elements are blunt-ended blade elements for pushing yarn-bits from the loading stations and applying them to said backing layer.

6. A tufting machine as in claim 1 in which
means for feeding the yarn strands to corresponding passages of said communicating means include
capstan means over which the strands are looped, and
selectively energizable control means for determining when and which yarn strands are tightened on said capstan means to feed a bit-length of yarn from corresponding supply spools and to advance it toward said means for receiving the ends of the yarn strands.

7. A tufting machine as in claim 1 including
a magazine structure adjacent said means for receiving the ends of yarn strands and having bit-storage chambers having the same spacing as passages of said means for receiving the yarn-strand ends, and
means for effecting relative stepping movement of said magazine to align each of said chambers of the magazine with successive passages of said means for receiving the yarn-strand ends between successive operations of said severing means.

8. A tufting machine as in claim 7 in which
means are provided to displace said magazine structure from said means for receiving the yarn-strand ends when all chambers are loaded with yarn-bits, and
timed pneumatic-control means associated with said communicating means to effect transfer of the yarn-bits from the displaced magazine to the bit-applying elements.

9. A tufting machine as in claim 7 additionally including
magazine-loading means operative in the interval between successive cycles of reciprocation of the bit-applying element to charge said chambers of the magazine with yarn-bits.

10. A tufting machine as in claim 9 in which said magazine-loading means includes
a guide having rows of passages for receiving the ends of yarn strands fed from respective supply spools, and
cutting means operated in timed relation to said bit-applying elements for cutting yarn strands extending from said passages into aligned chambers of said magazine so to provide yarn-bits.

11. A tufting machine as in claim 10 additionally including
means for effecting relative stepping movement of said magazine and said guide in the interval between successive operations of said cutting means for charging of the magazine with yarn-bits of selected colors in predetermined positions.

12. A tufting machine as in claim 1 in which said stop means comprises
a plurality of bit-stops respectively in alignment with the discharge ends of said communicating means.

13. A tufting machine as in claim 12 additionally including
means operating in timed relation to reciprocation of the bit-applying elements for retracting said bit-stops to center the yarn-bits delivered to said stations.

14. A tufting machine as in claim 12 additionally including
manually-adjustable means for presetting said bit-stops in fixed position.

15. A tufting machine as in claim 1 in which
a suction-manifold encloses the bit-engaging end portions of said bit-applying elements at the loading stations and receives the discharge ends of said communicating means, and which has
means supplying suction in said manifold for pneumatic transport of yarn-bits via said communicating means to said loading stations.

16. A tufting machine as in claim 1 in which the bit-applying elements are needles and in which

a suction-manifold encloses said needles in their bit-loading position, receives the discharge ends of said communicating means, and has provision for needle access to the backing layer.

17. A tufting machine as in claim 16 additionally including
a needle-bar for supporting the needles, and
means for decoupling said needle-bar from its actuating mechanism to permit the needles to be lifted from said suction manifold for maintenance purposes.

18. A tufting machine as in claim 1 in which the bit-applying elements are needles and in which
a suction-manifold encloses said needles in their bit-loading position, receives the discharge ends of said communicating means, and has needle-apertures in the wall adjacent said backing layer, and which has
a shutter plate in position closing said apertures during the time for pneumatic transport of yarn-bits via said communicating means to said needles, and in retracted position during reciprocation of the needles for application of the yarn-bits to the backing layer.

19. A tufting machine comprising
a loading station having a passageway for flow of air,
a reciprocable bit-applying element,
means for moving said bit-applying element transversely across said passageway from a loading position to a bit-applying position,
structure having a passage extending to said passageway for receiving yarn,
yarn-cutting means,
means for moving said yarn-cutting means across said passage to detach a yarn-bit from the yarn, and
means for producing flow of air through said passage for transport of the yarn beyond said yarn-cutting means to an extent corresponding with the bit-length to be detached by said yarn-cutting means and for transporting the bit-length of yarn into the loading position relative to said bit-applying element.

20. A tufting machine comprising
a loading station having a passageway for flow of air,
a reciprocable bit-applying element,
means for moving said bit-applying element across said passageway from a loading position to a bit-applying position,
structure having a passage extending to said passageway for receiving yarn,
yarn-cutting means,
means for moving said yarn-cutting means across said passage to detach a yarn-bit from the yarn,
means for producing flow of air through said passage for transport of the yarn beyond said yarn-cutting means to an extent corresponding with the bit-length to be detached by said yarn-cutting means and for transporting the bit-length of yarn into the loading position relative to said bit-applying element, and
timing means associated with said yarn-cutting means and said bit-applying element providing that the yarn bit detached from the yarn is pneumatically fed as a discrete bit to said loading station before movement of said bit-applying element from its loading position.

21. In a tufting machine for forming tufts on a backing, the combination of
tufting needle means having an eye-threading position on one side of the backing and a tufting position on the other side of the backing,
means for moving said tufting needle means from said eye-threading position to said retracted position,
pneumatic means for propelling tufting material to transversely thread the eye of said tufting needle means while in threading position on said one side of the backing, and
severing means operable to cut tufting material from a strand thereof.

22. In a tufting machine for forming tufts on a backing, the combination of
tufting needle means having an eye-threading position on one side of the backing and a tufting position on the other side of the backing,
means for moving said tufting needle means from said eye-threading position to said tufting position,
pneumatic means for propelling tufting material to transversely thread the eye of said tufting needle means while in threading position on said one side of the backing,
means for arresting the tufting material in threaded relation with the tufting needle means for transfer to the backing when the tufting needle means passes to said retracted position on the other side thereof, and
severing means operable to cut the tufting material from a strand thereof.

23. In a tufting machine for forming tufts on a backing, the combination of
tufting needle means comprising a pair of spaced shank members with aligned eyes having a threading position on one side of the backing and a tufting position on the other side of the backing,
means for moving said tufting needle means from said eye-threading position to said tufting position,
pneumatic means for propelling tufting material to transversely thread said aligned eyes while the tufting needle means is in said threading position on one side of the backing, and
severing means operable to cut the tufting material from a strand thereof.

24. In a tufting machine for forming tufts on a backing, the combination of
tufting needle means comprising a pair of shank members with aligned eyes and having a threading position on one side of the backing and a tufting position on the other side of the backing,
means for moving said tufting needle means from said eye-threading position to said tufting position,
pneumatic means for propelling tufting material to transversely thread said aligned eyes while the tufting needle means is in said threading position,
means for arresting the tufting material extending through said eyes for transfer to the backing when said tufting needle means passes to said tufting position on the other side of the backing, and
severing means operable to cut the tufting material from a strand thereof.

25. A tufting machine comprising
a plurality of tufting means,
means for moving said tufting means from a loading position to a bit-applying position,
means providing passages at least in part disposed transversely of said tufting means, each for supplying yarn to a corresponding tufting means while said tufting means is at said loading position,
pneumatic means providing for flow of air through said passages to transport said yarn to said loading position extending transversely of said tufting means, and
means for cutting the yarn for transfer by said tufting means of yarn bits to form said tufting.

26. A tufting machine comprising
a plurality of tufting needle means,
means for moving said tufting needle means from a threading position to a tuft-applying position,
means providing passages each for supplying yarn to a corresponding needle means when in said threading position,
cutting means located in cooperative relation with said passages for cutting bits of yarn, and
pneumatic means providing for flow of air through said passages to feed strands of the yarn bit-lengths beyond said cutting means and for transport of said bits to said needle means and into threaded relation therewith.

27. A tufting machine comprising
tufting needle means,
means for moving said tufting needle means from a threading position to a tuft-applying position,
a common outlet passage means providing a plurality of yarn-inlet passages for supplying yarn via said common outlet passage to said needle means when in said threading position,
a group of yarn selectors providing for supply of yarn to a plurality of said inlet passages and each including a yarn-restraining means,
means for controlling said yarn selectors to select the yarn to be supplied to said tufting needle means,
pneumatic means providing for flow of air to move the selected yarn a bit-length toward and into threaded relation with said needle means while in said threading position, and
means disposed in the path of said yarn for severing therefrom said bit lengths.

28. In a tufting machine for applying tuft bits to a backing, the combination of
threading stations adjacent one side of the backing,
means for passing said tufting needles through the backing to and from the respective threading stations,
strand-severing means for severing bits from strands of tufting material,
pneumatic means including flow passages respectively extending from said strand-severing means and arranged transversely of said tufting needles in the region of said threading stations for propelling severed bits from said strand-severing means, each in threaded position with said needles for application to the backing, and
bit-stop means at each threading station comprising a tubular member serving as an extension of the corresponding flow passage but of smaller cross-section to stop each bit in said position.

29. In a tufting machine for applying tuft bits to a backing, the combination of
threading stations adjacent one side of the backing,
tufting needles, and means for passing said tufting needles through the backing to and from the respective threading stations,
strand-severing means for severing bits from strands of tufting material,
pneumatic means including flow passages extending from said strand-severing means to said threading stations respectively for propelling the severed bits from said strand-severing means into threaded relationship with said tufting needles, each to position for its application to the backing,
bit-stop means for each threading station comprising a member movable in the corresponding flow passage, and
cam means for controlling the position of said movable bit-stop means.

30. A tufting machine comprising
tufting needle means,
means having a common outlet passage and having a plurality of communicating yarn-inlet passages for supplying yarn via said common outlet passage to said needle means when in said threading position,
means for moving said tufting needle means from a threading position to a tuft-applying position,
a group of yarn selectors providing for supply of a selected yarn to a corresponding inlet passage and including a plurality of yarn-restraining means,
means for selectively operating said yarn-restraining means to release said selected one of the yarns,
pneumatic means providing for flow of air to move the selected yarn a bit-length toward and into threaded relation with said needle means, and
means disposed in the path of said yarn for severing therefrom said bit-lengths.

31. In a tufting machine for forming tufts on a backing, the combination of

tufting means including threadable tufting elements,

means for passing said tufting means through the backing toward and from a loading position,

pneumatic means for transporting tufting material toward said tufting means repeatedly to thread said tufting means when in said loading position,

severing means repeatedly for cutting lengths from said tufting material for the tufting of said backing, and

timing means associated with said tufting means and said severing means providing for the respective threading of said tufting means while in said loading position.

32. In a tufting machine for forming tufts on a backing,

tufting needle means,

means for passing said tufting needle means through the backing toward and from a threading position,

strand-severing means for cutting bits from a strand of tufting material,

a multi-strand selector arrangement including means to release a selected strand and to restrain the remainder, and

means providing for flow of air to feed the selected strand to said strand-severing means and to transport the successive bits from said strand-severing means to effect threading of the needle means while in said threading position.

33. In a tufting machine for forming tufts on a backing, the combination of

tufting needle means,

means for passing said tufting needle means through the backing toward and from a threading position,

means for cutting the tufting material into bit-lengths,

means for feeding said tufting material a bit-length beyond said cutting means, and

pneumatic means for threading said needle means, while in said threading position, with said bit-length of tufting material.

34. In a tufting machine for forming tufts on a backing,

tufting needle means,

means for passing said tufting needle means through the backing toward and from a threading position,

means for cutting into bits a strand of tufting material,

a multi-strand selector arrangement including means to release a selected strand and restrain the remainder,

means for feeding the selected strand beyond said cutting means by a bit-length thereof, and

pneumatic means for threading said needle means, while in said threading position, with said bit-lengths of the selected tufting material.

35. In a tufting machine for forming tufts on a backing, the combination of

tufting needle means,

means for moving said tufting needle means through the backing toward and from a threading position,

means for repeatedly threading said tufting needle means with tufting material upon successive movements of said tufting needle means to threading position,

severing means,

pneumatic means for feeding said tufting material to said severing means and to said tufting needle means, and

means for operating said severing means each time said needle means is in its threading position for application thereto of tufting material.

36. A tufting machine for applying tufting yarn to a backing comprising

loading stations adjacent the path of travel of said backing through said tufting machine,

yarn-applying elements for engaging and transferring tufting yarn from said stations to said backing,

supply spools for the tufting yarn,

means for arresting the yarn at said stations for transfer by said yarn-applying elements,

actuating means for actuating said yarn-applying elements toward and away from the path of travel of said backing,

means for receiving the ends of yarn strands fed from respective supply spools and having communicating means for discharging yarn into said loading stations and in the respective paths of said yarn-applying elements,

pneumatic means associated with said communicating means for transporting the yarn for tufting,

severing means disposed in advance of said loading stations, and

timer means for coordinating the operation of said severing means with said actuating means to cut tufting yarn from said strands transported to said loading station by said pneumatic means when said yarn-applying elements are in a position away from the path of travel of said backing.

37. A tufting machine as in claim 36 in which said arresting means comprises a plurality of yarn stops respectively in alignment with communicating means.

38. An apparatus for producing yarn bits of length to provide tufting, comprising

means for feeding yarn from a source of supply a bit length at a time,

a device having a passageway for receiving said yarn,

a reciprocable bit-applying element,

means for moving said bit-applying element across said passageway from a loading position to a bit-applying position,

pnueumatic means for moving said yarn a bit at a time transversely of said bit-applying element while in its said loading position, and

yarn-cutting means acting across said passageway to detach a yarn bit from said yarn.

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