April 26, 1966 I. B. POLEVITZKY 3,247,814

TUFTING MACHINE

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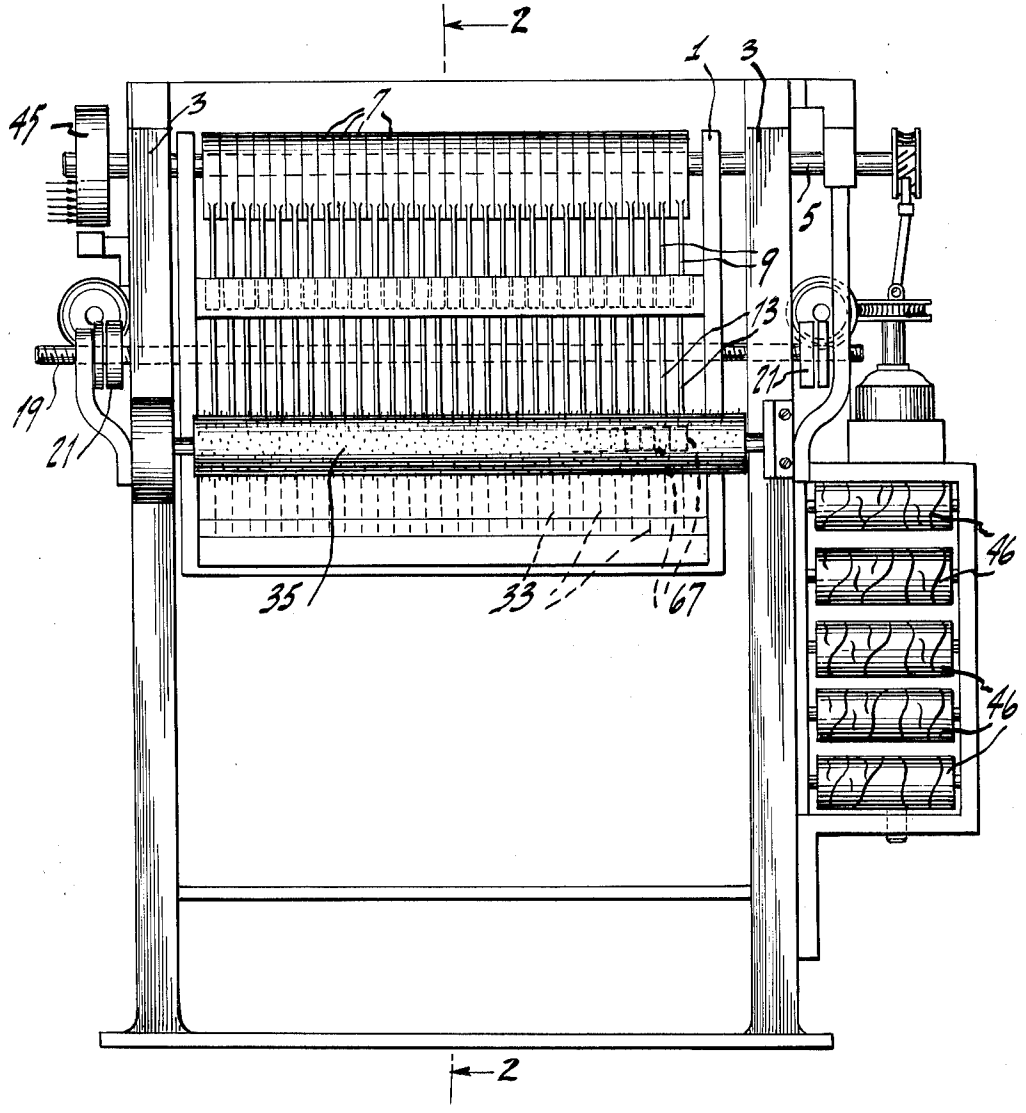


Fig. 1.

INVENTOR

IGOR B. POLEVITZKY

BY

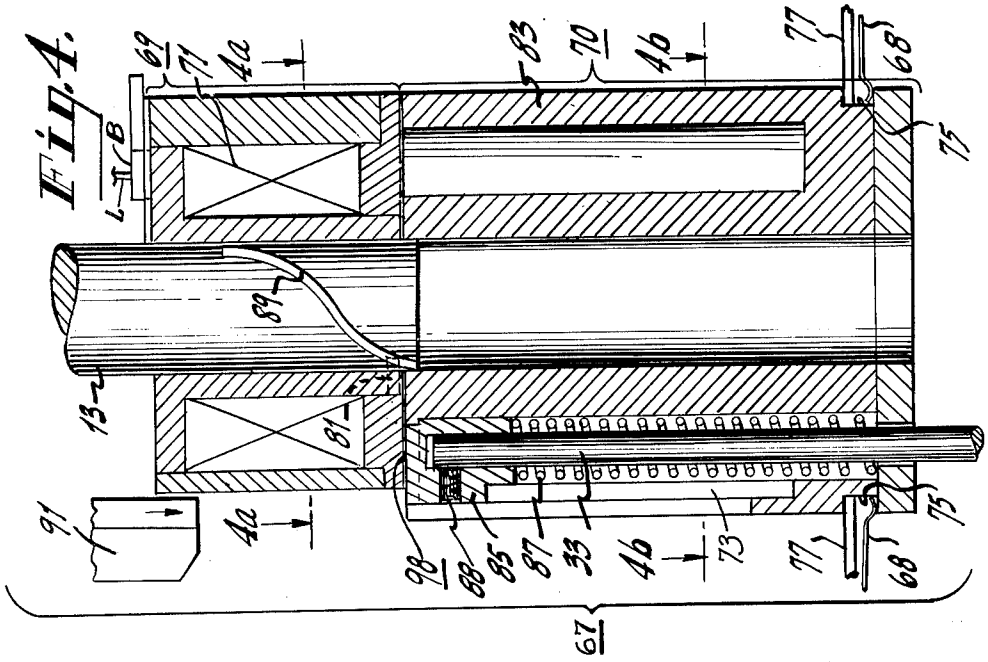
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TUFTING MACHINE

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Fig. 4.



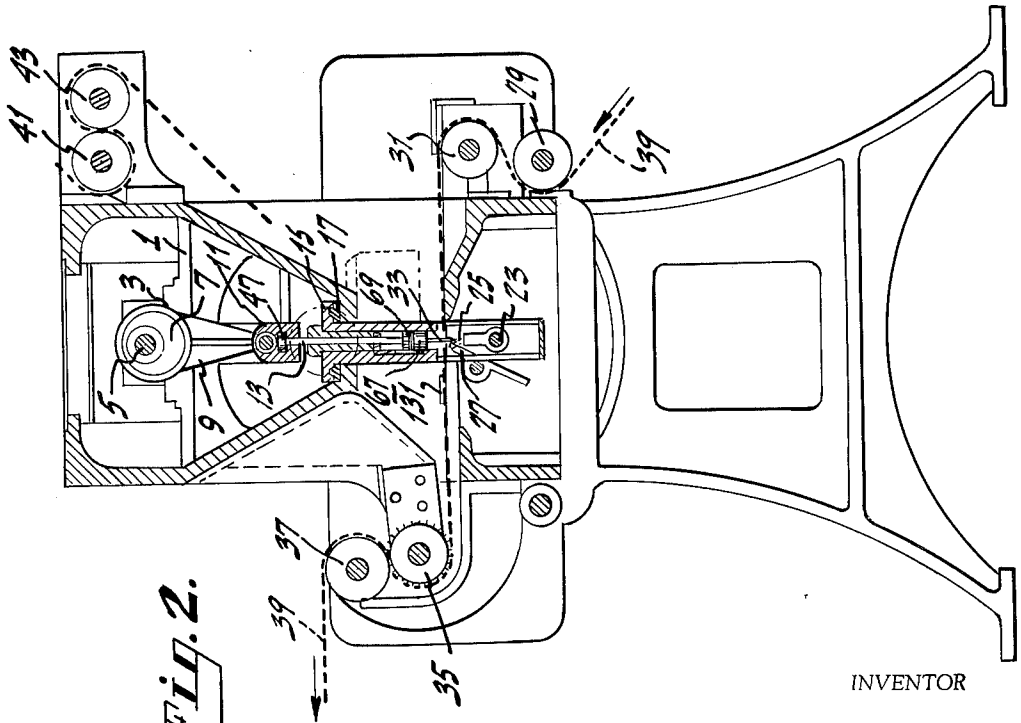


Fig. 2.

INVENTOR

IGOR B. POLEVITZKY

BY C. A. Puska

Attorney

April 26, 1966 I. B. POLEVITZKY 3,247,814

TUFTING MACHINE

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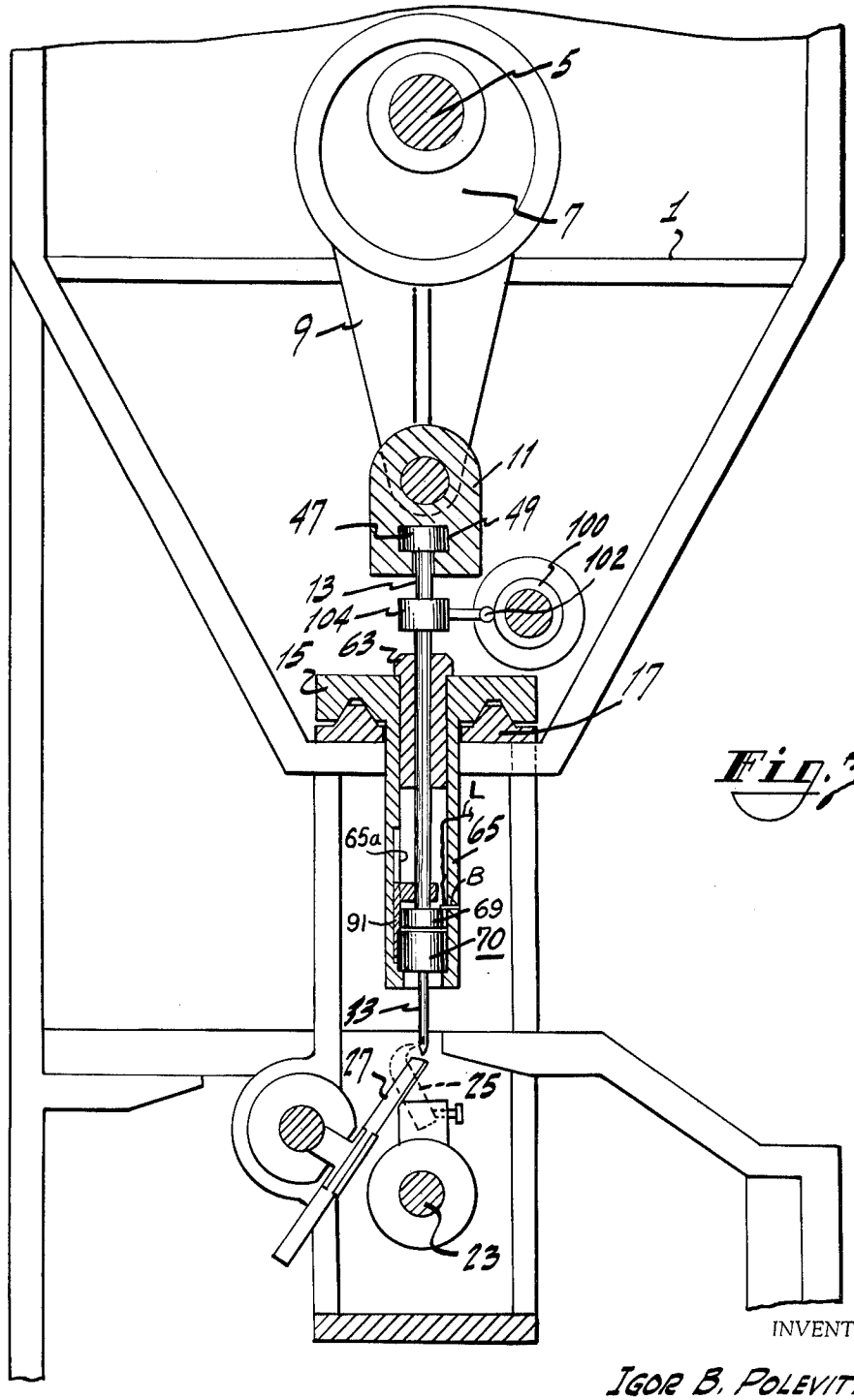


Fig. 3.

INVENTOR

IGOR B. POLEVITZKY

BY C. A. Ruska

Attorney

April 26, 1966 I. B. POLEVITZKY 3,247,814

TUFTING MACHINE

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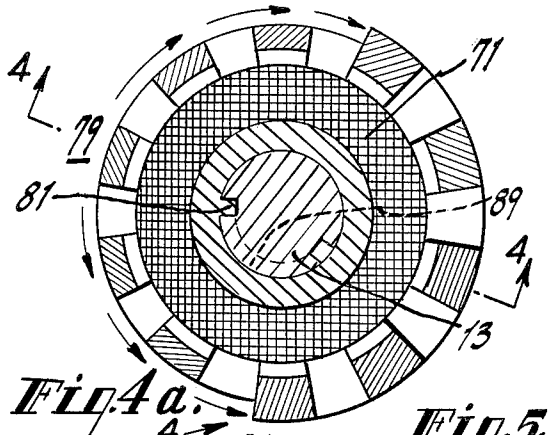


Fig. 4a.

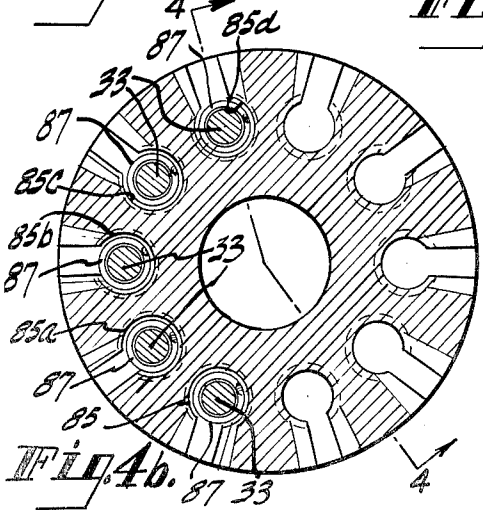


Fig. 4b.

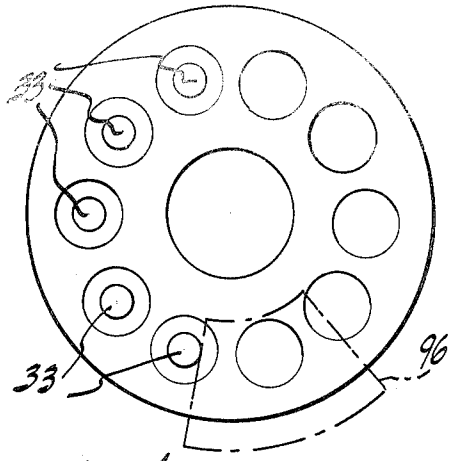


Fig. 4c.

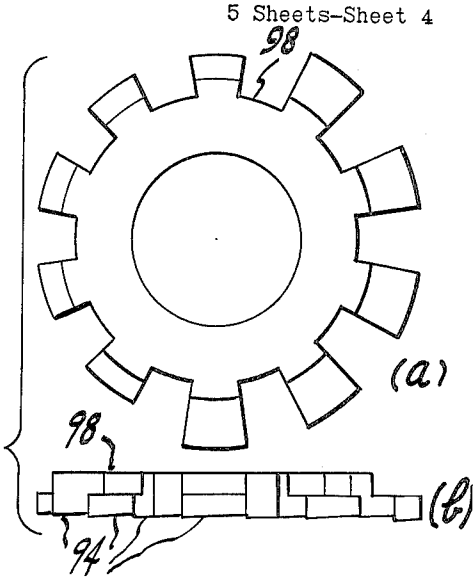


Fig. 5.

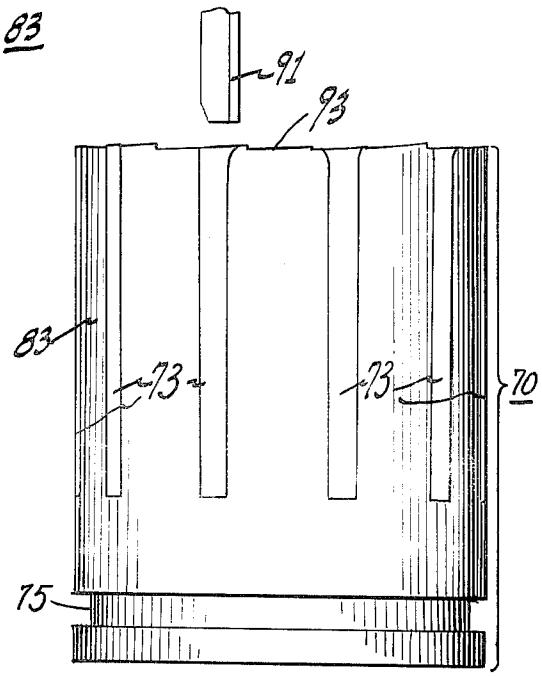


Fig. 6.

INVENTOR

IGOR B. POLEVITZKY

BY

Attorney

April 26, 1966 I. B. POLEVITZKY 3,247,814

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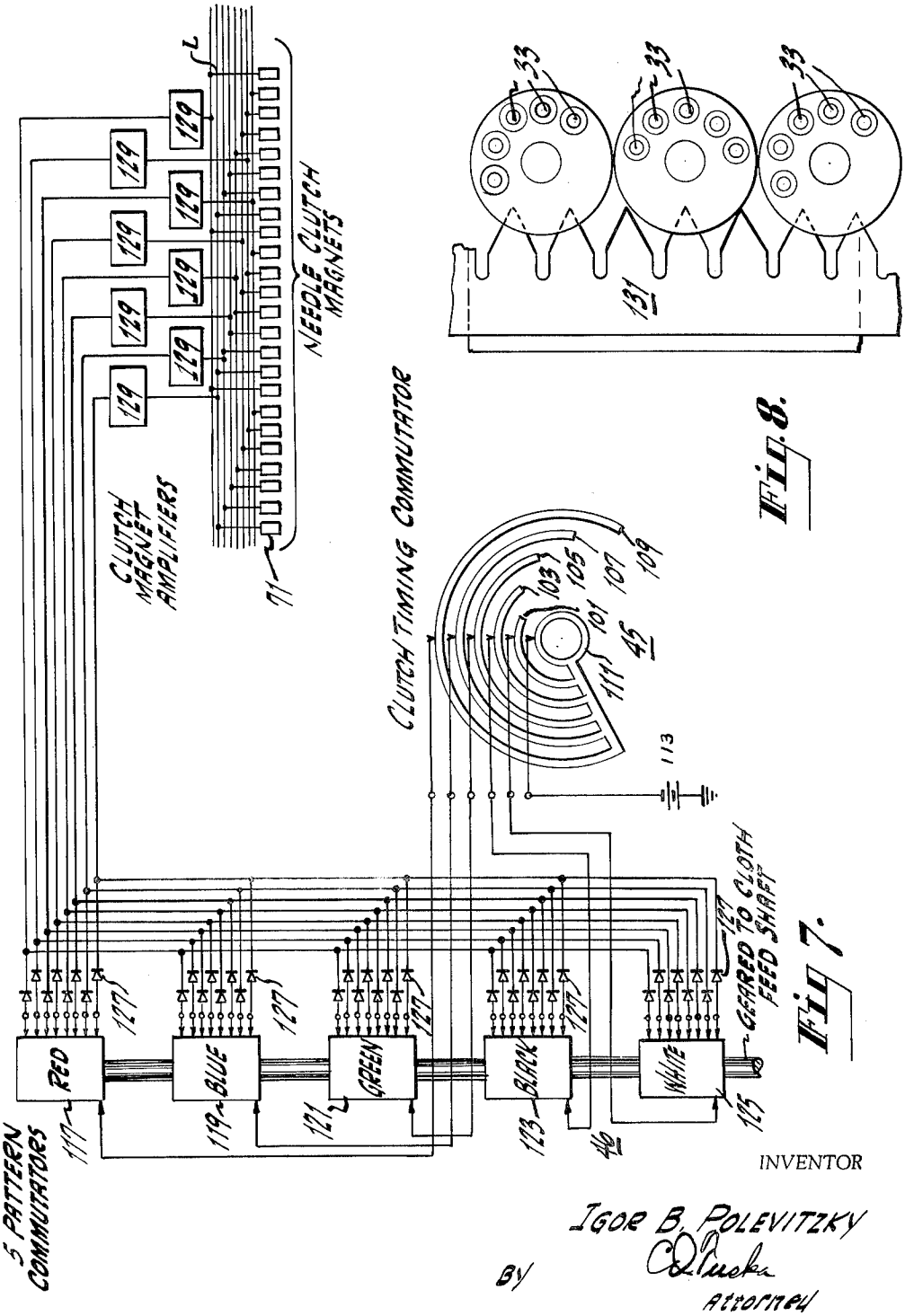


FIG. 8.

FIG. 7.

United States Patent Office 3,247,814 Patented Apr. 26, 1966

3,247,814

TUFTING MACHINE

Igor B. Polevitzky, Miami, Fla., assignor to Image Designs, Inc., New York, N.Y., a corporation of New York

Filed May 14, 1962, Ser. No. 194,426
14 Claims. (Cl. 112—79)

This invention relates to an improved tufting machine and especially to a carpet tufting machine in which tufts of different colors or different materials may be selectively applied to a backing material in accordance with a predetermined pattern. The invention may be applied to commercially available machines which may be modified in accordance with the invention hereinafter described. By way of example, the invention may be applied to machines of the multiple-needle type in which the needles and cooperating loopers are used to apply tufts to a backing material.

Tufting and other types of yardage machines have been used to produce carpets, rugs, mats and similar articles of variable colors by employing yarns that are dyed at different lengths. While such colored yarns produce colored yardage materials, the colors appear more or less at random as the method does not lend itself to precision or to rapid color selection. Moreover, such machines, by employing yarn tensioning devices which are controlled in accordance with a predetermined pattern, are used to produce materials in which the tuft heights are adjusted in accordance with the pattern. Finally, overlays and dyed pattern materials are well known.

In contrast to these known methods of making tufted surfaces, the instant invention has for one of its objects a tufting device in which a plurality of yarns of different colors may be respectively threaded through a plurality of needles that are quickly, automatically and accurately shifted into operating position in accordance with prearranged "instructions." Thus, each tuft will be made of a yarn of the desired color in the desired place.

It is another object of the invention to provide a tufting machine in which the color effects may be multiplied several fold by combining the primary colors in small clusters in accordance with established colorimetry techniques. By way of example, if clusters of 4 colored tufts are chosen from tufts of red, green, blue, white and black, 27 different colors or color values will appear to one viewing the cluster at an appropriate distance, i.e. through an angle of the order of 2 minutes.

An additional object is to provide an automatic needle selector device that may be adapted to commercially available machines with a minimum of machine modification.

The invention will be described by referring to the accompanying drawings, in which:

FIG. 1 is a front view of a tufting machine to which the invention is applied;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1, but showing the electromagnetic clutch and needle carrying mechanism schematically;

FIG. 3 is a side view partly in section of the needle carrying and selector mechanism applied to a tufting machine;

FIG. 4 is a sectional view of the electromagnetic clutch and needle carrying mechanism of the invention approximately along the lines 4—4 of FIGS. 4*a* and 4*b*;

FIG. 4*a* is a sectional view taken along the lines 4*a*—4*a* of FIG. 4;

FIG. 4*b* is a sectional view taken along the lines 4*b*—4*b* of FIG. 4;

FIG. 4*c* is a plan view of the several needles, needle guides and needle chatter reducing device of the invention;

FIGS. 5*a* and 5*b* are plan and side views of a clutch detail which eliminates slipping;

FIG. 6 is a side view of a portion of the mutiple-needle carrying device, push rod operating channels, and push rod;

FIG. 7 is a schematic diagram of the commutators which are used to control the needle selectors and color programming of the tufting machine; and

FIG. 8 is a plan view of a comb and scissor arrangement for cutting the reverse side of yarn loops.

Referring to FIGURES 1 and 2, a sub-frame **1** supports bearings **3** in which a needle stroke shaft **5** is journalled. Eccentrics **7** are secured to the shaft **5** and actuate connecting rods **9**. Connectors **11** (see FIG. 3) are pivotally mounted on the ends of the connecting-rod members **9**. Push rods **13**, with heads engaging the slots in the connectors **11**, are mounted in a carriage **15** that is part of the sub-frame **1**. The carriage is oscillated back and forth on its bed **17** transversely of the direction of feed of backing material **39** by any suitable means such as a power driven screw **19** and clutches **21**. An alternative drive for carriage **15** may be a cam and cam follower. Typical slufting mechanisms are shown in the patents to Batty et al. 3,109,395 and Amidon 2,313,725. The screw **19** is actuated in synchronism with the needle stroke shaft **5** and a shaft **23** which carries the tufting hooks **25**. In order to catch the tufts at the several lateral stations of needle penetration, plural tufting hooks **25** corresponding in number to the intended number of lateral penetration stations would be provided. A third synchronized shaft may be used to carry tuft cutting knives **27**. The hooks engage the yarns to produce loop tufts and the knives may be used to cut the tufts as is well known.

The backing material **39** is fed from a roll, not shown, over rolls **29**, **31**, past the needles **33**, and around two driven take-up rolls **35**, **37**, as indicated by the broken line **39**. The yarns are fed through tubes from skeins, not shown, over yarn tensioning rolls **41**, **43**. The yarns often carry static charges which may be led to ground through a suitable conducting bar positioned near the needles but not shown here. The several shafts are connected together with chains and sprockets or with gears whereby the needle, take-up rolls, oscillating carriage and needle selection (hereinafter described) are moved in synchronism. The main shaft is also coupled to commutators **45** and **46** which control the needle selection and color pattern. The commutator **46** has pattern drums rotating at a slower speed than the commutator **45**, as hereinafter described.

The needle carrying and selecting mechanism will be described by referring to FIGS. 3, 4, 4*a*, 4*b*, 4*c*, 5*a*, 5*b* and 6. It should be understood that FIG. 3 is an enlarged view of the portion of FIGS. 1 and 2 which includes the needle selector assemblies and FIGS. 4, 5 and 6 are detailed portions of FIG. 3. The push rods **13** are each provided with wrist pins **47** which engage bearings **49** in the connectors **11**.

Each of the push rods **13** pass through a guide member **63** that is secured to the carriage **15**. An extension **65** of the carriage includes a selector **67**. This selector **67** is provided with two separable parts. The upper part **69** includes the following: a solenoid **71**, clearance region **79** of about 180° (see FIG. 4*a*), a clutch part **98**, and a cam follower **81**. The lower part **70** of the selector **67** includes: a rotatable cylinder **83** having five angularly-spaced channels for receiving selectively slidable needle-sockets **85**–**85***d*; a guide recess **75**; and a biasing spring **68**. Supports **77** engage the guide recess **75** to prevent downward movement of the lower part **70** of the selector **67** and to provide some friction against rotation. Each needle socket is biased upwardly by a spring **87** and is

provided with a locking device, such as set screw 88, for its needle 33. The top of each needle socket has an extension projecting into the corresponding guide slot 73 of the drum 83 forming part of the lower portion of selector 67.

The push rod 13, which reciprocates but does not rotate, has an accurately milled cam slot 89 which is engaged by cam-follower 81 for positive rotation of the upper part 69 of the selector 67. The push rod also has a finger 91 for passing through the clearance region 79 in the upper part 69 of the selector and a slot 73 of the lower part 70 of the selector to engage the top of that needle socket which, by preselection, is in the operable position. The vertical portion of finger 91 is in part received by the guide slot 65*a* in the carriage extension 65 and reciprocates in a path which extends through the arcuate path of the needle sockets. The top of the lower part 70 of the selector provides a magnetic armature 93 (FIG. 6) for the solenoid 71 in the upper part of the selector. The upper face of the armature is provided with shoulder portions that engage teeth or serrations 94 in the lower adjacent surface of the clutch element 98 of the upper part 69 of the selector. The toothed surface prevents slippage in the solenoid-operated clutch only when it is rotated to select a needle during downward motion of push-rod 13. The clutch interface may be, as known in the electrical art, of magnetic and diamagnetic materials to provide quick and free release of the clutch upon deenergization of its solenoid.

For reason of economy, the rotation of the cylinder 83 to select a needle and the subsequent reciprocation of the selected needle should be made as rapidly as possible. Whichever needle is selected, it must always operate at a fixed point in proper relation to the loop hook 25 so the latter can engage the yarn but it has been found that the higher the operating speed the greater the chances of malfunctioning due to needle chatter. The undesired chattering movements may be readily eliminated by attaching a small permanent magnet 96 (FIG. 4c) to a position on the carriage near the proper operating point of the needle: the magnet not only accurately locates the needle relative to the loop hook but also eliminates needle chatter.

While only one selector has been described, there may be, for example, ninety-six needle selectors 67 spaced about one and one-quarter inches, center-to-center, along the width of backing material ten feet wide. For discussion of the mode of operation of the needle selectors, it is assumed all push rods 13 are about to start the downward stroke under control of eccentrics 7 on shaft 5. As the push rods move downwardly, the slots 89 with their cam-followers 81 positively rotate both parts of the selectors 67 because the solenoids 71 cause engagement of the upper and lower selector parts 69, 70. The supports 77 prevent the selectors from moving downwardly. Such rotation of the selectors 67 continues until their respective solenoids are deenergized when the commutators (as hereinafter discussed in connection with FIG. 7) disconnect them from the power supply. The angular motion of the lower part 70 of each selector ceases when the associated solenoid is deenergized (this may occur at the same instant or at different instants for the various selectors), but all push rods 13 continue their downward motion and cause the fingers 91 to push the tops of the selected needle sockets and drive the needles downwardly with their yarns of predetermined colors. The selected needles and yarns are thus passed through the backing material 39 and the loop hooks 25 loop the yarns in the usual manner at appropriate point in the cycle. Then the needles start their upward stroke leaving the yarn tufts in the backing material in the usual manner. The needle sockets are urged upwardly by their respective springs 87 and the push rods return to their top position thereby returning the upper and lower portions of all selectors to their initial angular position. Because of the previous needle selection, the lower part 70 is usually rotated less than the upper part and therefore returns sooner to the initial position. However, the clutch part 98 permits slippage in this reverse direction (i.e., on the upward stroke of rod 13) so that the initial relation of parts 69, 70 is restored. Just before the next downward stroke of the push rods, the carriage 15, under control of the screw-and-clutch operated cross-feed 19–21, is moved as in conventional tufting machines a short distance laterally to the next needle position in the same tufting line. After the desired number of needle strokes, the line of tufts is complete and then the backing material is advanced one line with the needle selectors ready to start operation for tufting the new line in reverse direction.

On each downward stroke the respective needle selections will depend upon their commutator connections, and in this manner a large number of color combinations may be used in each line with or without repetition in the succeeding lines.

The programming device employs two commutators as shown schematically in FIG. 7. The timing commutator 45 selects the desired color needle and commutator 46 provides desired information of the pattern. The first commutator 45 is driven directly by the main shaft 5 and therefore operates at 1 revolution per needle stroke. Since there are, according to the present embodiment of the invention, 5 needles to be controlled per selector, the commutator includes 5 elements 101, 103, 105, 107, 109, of different arcuate lengths plus the slip-ring 111 which connects the power source, for example battery 113, to the 5 commutator elements. The respective commutator elements 101–109 are respectively engaged by brushes which are connected individually to the five pattern drums 117, 119, 121, 123, 125 of commutator 46 that may be driven by a shaft connected to one of the cloth takeup roll 35 or 37. As an alternative, the second commutator may be gear driven from the main drive shaft 5. The important thing is to drive the second commutator at a speed which provides adequate programming of the needle selection and hence color yarn selection. It should be understood that the circumference of the commutator determines the length of the color pattern before the color pattern repeats itself. The width of the color or the number of loops of similar color is determined by the number of color selectors that are connected in parallel. In the present embodiment, groups of 8 color selectors are connected together for the purpose of simplification. Nevertheless, it should be understood that single selectors may be controlled and programmed to produce even single loops of the selected color at predetermined width and length locations on the backing material. Furthermore, as previously explained, different color effects may be obtained by appropriately grouping the colors in small clusters.

Now returning to the commutator description: The second commutator 46 consists of 5 conductive cylinders 117, 119, 121, 123, 125. Insulating pieces of tape may be connected across the width of the commutator to prevent the associated brush or brushes from making contact at the position corresponding to the needle to be released thereby to make a yarn loop or tuft of the desired color. Since the commutator elements 117–125 correspond respectively to red, blue, green, black and white, it is possible to provide an interruption for any one of the colors for each downward stroke of the needle selectors. The possibility of current feedback is prevented by including rectifiers or any unilateral element 127 in each of the brush leads. The current interruption may be amplified by 8 clutch magnet amplifiers 129, that are interposed between the rectifiers and the needle clutch magnets. That is, the steady state condition of current flowing in the clutch windings 71 may be suddenly decreased to any desired degree to disengage the selected needle mechanism from the magnetic clutch whereby the needle spring begins the yarn looping stroke. Windings 71 are preferably connected to clutch magnet amplifiers by conven-

tional brushes B and flexible leads L. After completion of the down-stroke, the clutch winding **71** is again energized via commutator **45** to restore the selected needle holder to its initial angular position during return of the push rods **13** to their top position.

It should be understood that the present invention provides an improvement in the commercially known loop tufting machines by including a needle selector and by including means for moving the assembly of needle selectors, looping hooks, etc. with respect to the backing material through which the yarn is looped. The selection of colors is a matter of selecting and operating the needle carrying the yarn of the desired color. The selection may be made on a programming commutator not unlike the commutators used in embossing. In following a color pattern there is the probability that several rows of loops across the width of the material may deliberately be skipped before the same color is repeated. Such skipping would consume yarn and add to the back side bulk of the looped material. In the event that such excess yarn on the back side of the material is undesirable, the excess may be avoided by a comb and scissors arrangement **131** located to the left of the needle array as shown in FIG. 2 and in greater detail in FIG. 8. The comb and scissors may be operated in synchronism with the movement in the backing material to hold the free yarn length within permissible limits. Finally, while the invention has been described with reference to the 5 needle selectors and hence 5 color selection, it should be understood that fewer colors, for example red, green and blue by omission of needles, or addiitonal colors may be employed by increasing the number of needle holders and needles in each selector. In a similar manner the number of loops per square inch may be varied by appropriate changes in the size and spacing of the needles and the rate of movement of the backing material. Finally, zig-zzag stitching or overlay tufting may be employed. Zig-zag operation may be accomplished by moving the push rods **13** by means of cams **100** and cam followers **102** coupled to the push rods by a slidable collar **104**. The cam may be synchronously driven by connecting the cam shaft to the main shaft **5**.

What is claimed is:

1. A tufting machine improvement including in combination a needle actuating push rod, a selector rotatably coupled to said rod, a plurality of needle holding elements movably supported by said selector, a magnetic clutch connected between said push rod and said selector, and means carried by said push rod for actuating a selected one of said plurality of needle holding elements upon demagnetization of said clutch.

2. An attachment for tufting machines, said attachment comprising a selector consisting of an upper and lower portion, said upper portion including an electromagnetic clutch having a serrated portion for engaging a corresponding armature member secured to said lower portion and said lower portion movably carrying a plurality of angularly spaced needles, means for energizing said electromagnetic clutch whereby said upper and lower portions are held together, means for rotating the upper portion of said needle selector while said clutch is energized to place one of said plurality of needles in operative position, means for deenergizing said electromagnetic clutch to stop rotation of said lower portion of the selector at a desired position of one of said needles, and means for driving said one needle downwardly.

3. In an attachment of the character of claim **2**, magnet means for preventing undesired movements of said one needle in its operative position.

4. A needle selector for tufting machines comprising a push rod having a curved cam surface, a pair of upper and lower rotatable devices, a plurality of angularly spaced needles movably carried in each of the lower of said rotatable devices, said upper rotatable devices each having a cam follower for said curved cam surface and an electromagnetic clutch, a commutator for energizing and deenergizing said clutch whereby the deenergization of said clutch will stop the rotation of said lower rotatable device and a finger carried by said push rod and positioned to engage and to move a selected needle downwardly during intervals in which the rotation of at least the lower rotatable device has been stopped.

5. In a device of the character of claim **4**, a magnet for accurately locating said selected needle in its proper operating position for said downward motion.

6. In a device of the character of claim **4**, means for biasing each of said plurality of needles against said downward motion.

7. An improved yardage machine for selective color tufting including a plurality of devices, each of said devices movably carrying a plurality of independent needles each adapted for threading with a different color yarn, each of said pluralities of independent needles having a single cooperative looper and a single operative position with reference to said looper, means including an electromagnetic clutch for rotating any one of said plurality of needles into said single operation position and for stopping said rotation at said operative position, additional means for moving said one needle up and down, a commutator operated in synchronism with said up and down needle movement for timing the energization and deenergization of said clutch and a second commutator connected to said first commutator for programming the color selection of a desired needle of each of said plurality of devices.

8. An improved machine for selectively applying color tufting to a backing material including in combination a plurality of rotatable devices each including an upper portion and a lower portion, said lower portion having angularly spaced channels in which needles for various color tufting are respectively movably disposed, electromagnetic clutches respectively carried by said upper portions of said devices; means for rotating each of said plurality of devices to a preselected needle position, a tuft looper mechanism operatively located under said preselected position to engage tufting material carried through said backing material by a downward movement of the needle at said preselected position, a plurality of fingers for moving the needles at said preselected position, and means operatively associated with said plurality of rotatable devices to move said devices and said looper mechanism laterally with respect to said backing material.

9. In a machine of the character of claim **8** including a commutator operated in synchronism with said fingers to deenergize said electromagnetic clutches at said preselected needle position, and a second commutator including a plurality of sections for respectively determining the selection of a particular needle of the plurality of needles in the lower portions of said devices and operated in synchronism with said lateral movement.

10. An arrangement for selectively positioning any one of a group of needles comprising a reciprocable push rod having a spiral cam slot, and an electromagnetic clutch having a first part with a cam-follower engaging said cam slot to provide for rotation of said first part alternately in opposite directions and having a second part which carries and movably supports the needles in spaced arcuate relation, said second part rotating with said first part when said electromagnetic clutch is energized and stopping upon deenergization thereof.

11. An arrangement as in claim **10** including a finger reciprocating with said push rod in a fixed path normal to the arc along which the needles are spaced.

12. An arrangement as in claim **11** including a timing commutator mechanically coupled to said push rod and making one revolution per reciprocating cycle of the push rod, said timing commutator having arcuate contact elements and brushes respectively therefor, said arcuate contact elements in number corresponding with the needles and having different lengths respectively corresponding

with the arcuate distances of the needles from the path of said finger for controlling deenergization of said electromagnetic clutch when the corresponding needle is positioned in said path.

13. An arrangement as in claim 11 including a pattern commutator rotated in slow timed relation to said timing commutator and comprising pattern contact drums respectively in circuit with the brushes of said timing commutator and one of which in accordance with the pattern determines which brush controls the timing of the deenergization of the electromagnetic clutch.

14. An arrangement for selectively positioning any one of a number of operative members, comprising a two-part electromagnetic clutch, a push rod positively coupled to the first clutch part whereby reciprocating motion of said rod causes rotation of the first clutch part in alternate directions, and a solenoid carried by said first part for

energizing the clutch; the said operative members being movably carried and supported in spaced arcuate relation by the second clutch part which is arranged to be positively rotated in one direction by and with the first clutch part as long as the solenoid is energized, and to stop such rotation at the instant the solenoid is deenergized.

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JORDAN FRANKLIN, *Primary Examiner.*

DAVID J. WILLIAMOWSKY, *Examiner.*