

June 17, 1969

T. A. E. BENDER

3,450,076

STITCHING, TUFTING AND CARVING MACHINE

Filed Oct. 7, 1966

Sheet 1 of 4

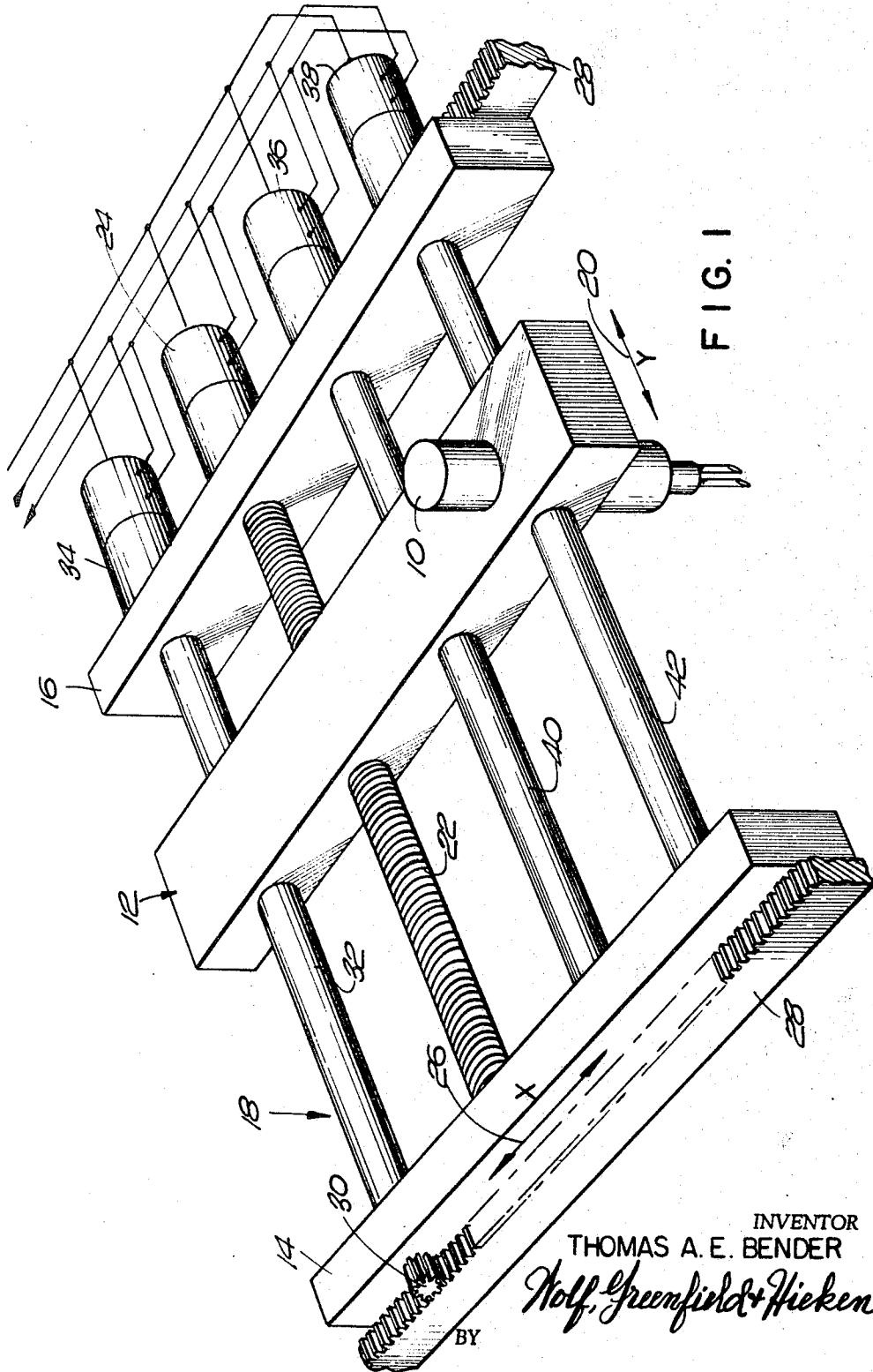


FIG. 1

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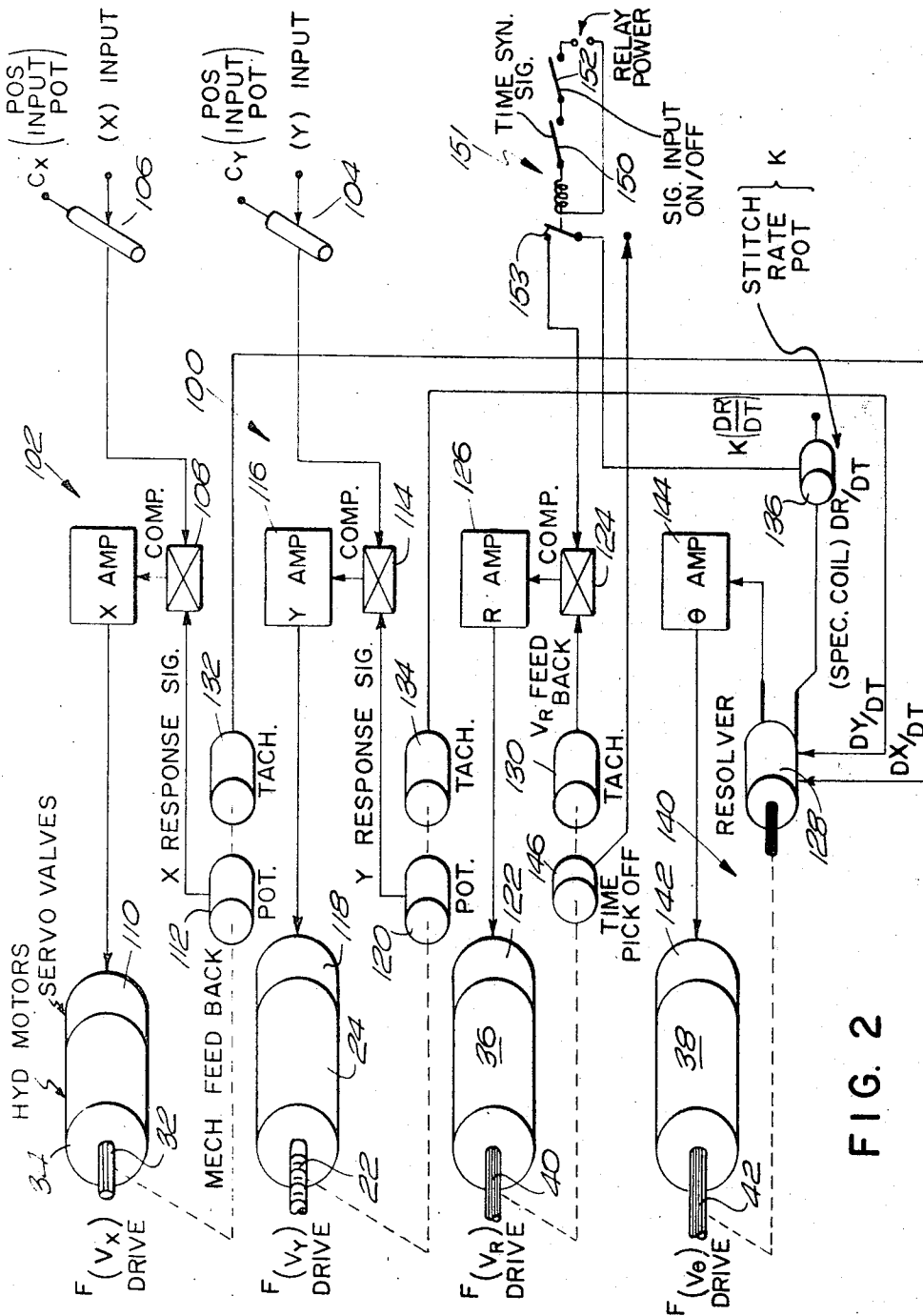


FIG. 2

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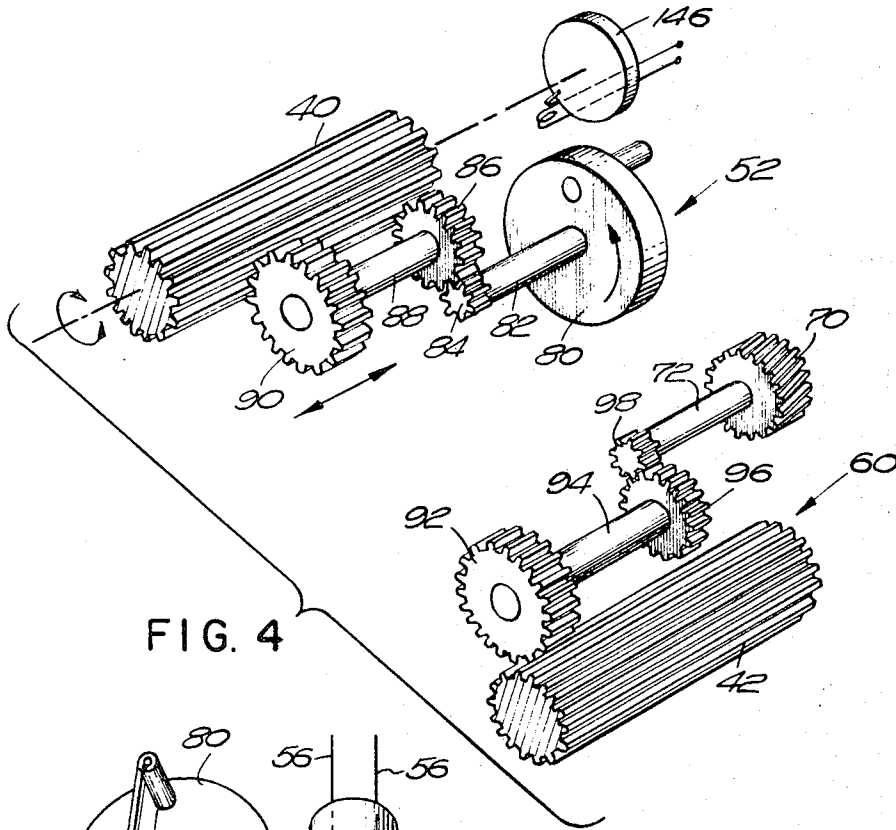


FIG. 4

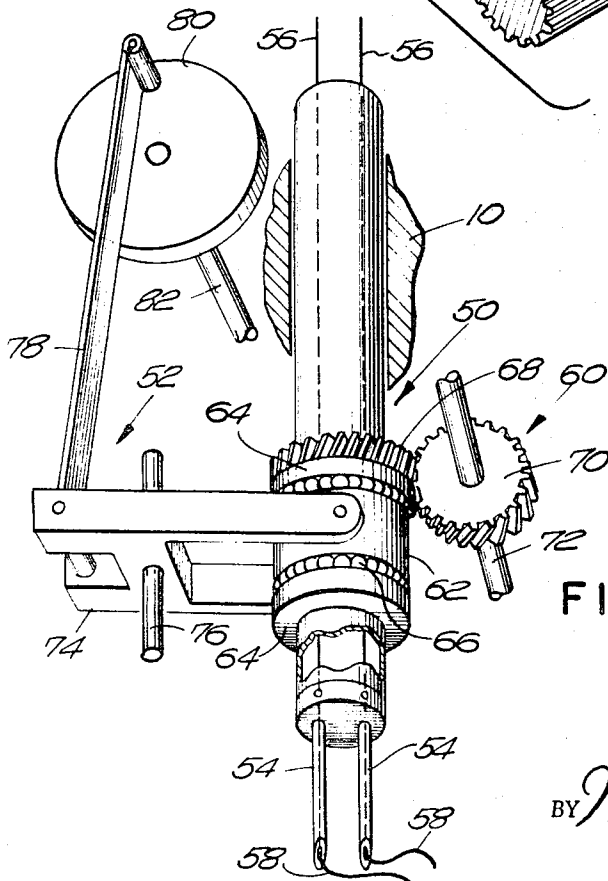


FIG. 3

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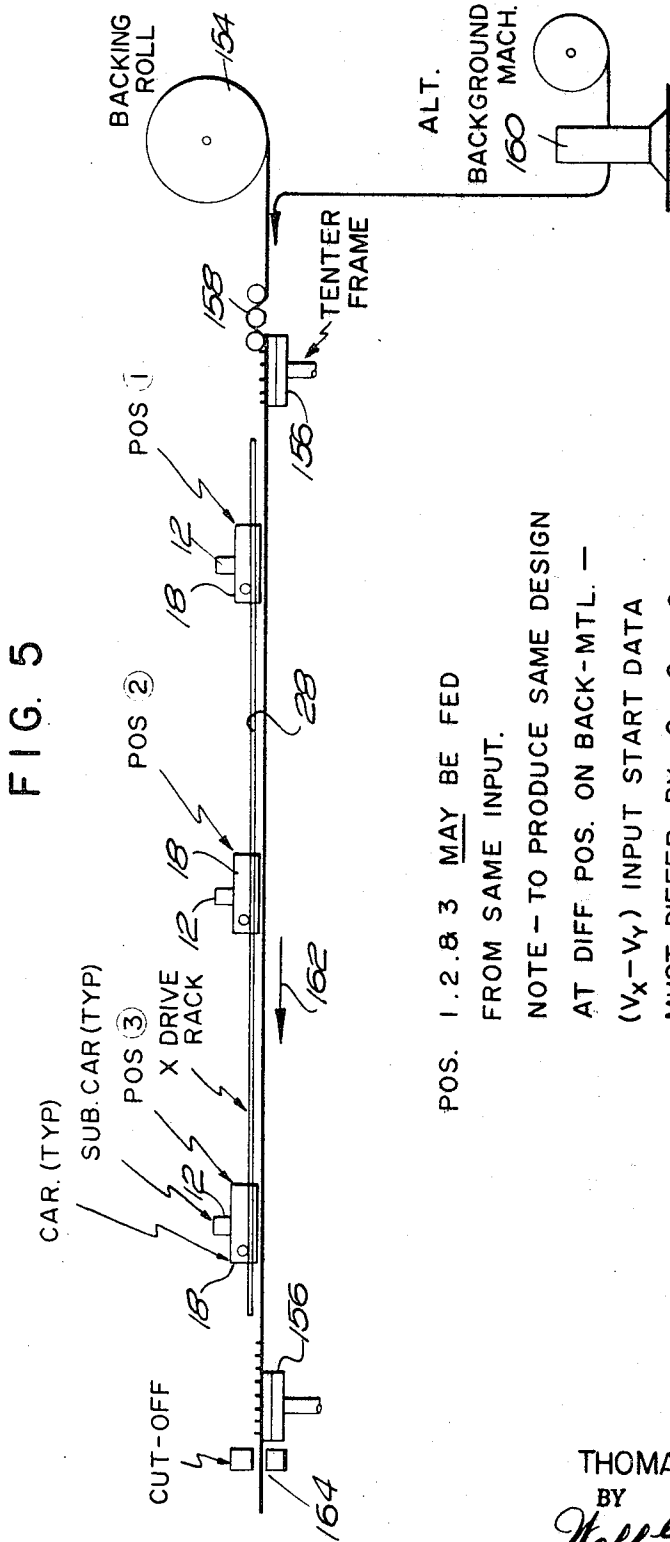


FIG. 5

POS. 1, 2, & 3 MAY BE FED FROM SAME INPUT.

NOTE - TO PRODUCE SAME DESIGN AT DIFF POS. ON BACK-MTL. - (V<sub>x</sub>-V<sub>y</sub>) INPUT START DATA MUST DIFFER BY C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>. (C<sub>x</sub> & C<sub>y</sub> - POTS)

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3,450,076  
**STITCHING, TUFTING AND CARVING MACHINE**  
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 Filed Oct. 7, 1966, Ser. No. 585,043  
 Int. Cl. D05c 15/12; D05b 23/00  
 U.S. Cl. 112-79 **13 Claims**

### ABSTRACT OF THE DISCLOSURE

A tufting machine having a needle head supported on a carriage with drive means connected to the head causing the needles to stitch. An analogue system moves the carriage while the drive means is operative, and means operatively connect the drive means and the analogue system for automatically causing the drive means to achieve a stitch rate bearing a selected functional relationship to the velocity of the carriage.

This invention relates to stitching, tufting and carving machines and more particularly comprises a new and improved automatic control assembly for such machines, which will enable them to produce complex patterns of the type that are now formed essentially only by hand operated machines. This invention has particular application in the tufting industry, and is described hereinafter in terms of such application.

Tufting machines used in the manufacture of carpets, bedspreads, and other tufted fabrics are fed backing material which moves at a controlled rate over a needle plate. A bank of needles which may include as many as 1,500 or more individual needles, arranged in a row, pierce the fabric to form a row of cut or looped tufts. In the most modern tufting machines the individual needles in the row may be spaced as close together as every  $\frac{3}{32}$  inch, and the backing material may be moved at an adjustable rate of perhaps  $\frac{3}{16}$  inch for each stroke of the needles. The  $\frac{3}{32}$  inch spacing of the needles is used when no special pattern is to be formed, and generally the needle spacing is  $\frac{3}{16}$  inch or even  $\frac{3}{8}$  inch when a pattern is to be produced.

By the use of automatic pattern attachments, different textures and designs may be tufted in the backing material but the intricacy of the pattern that may be formed is limited to those patterns which may be drawn from the maze of individual tufts spaced generally  $\frac{3}{16}$  inch apart. Because of the inability of such machines to stitch at a greater density, the resolution is very poor. Even in the  $\frac{3}{16}$  inch gauge it is apparent that they cannot automatically produce the more delicate designs including floral arrangements which have very precise curves. Consequently, even in the most modern tufting factory, the most delicate and intricate of the designs are applied by hand operated machines. For example, in the manufacture of bedspreads, the ground pattern is applied by the large tufting machines but the more delicate designs and overlays are applied by hand. In one form of hand operation, the operator spreads the bedspread over a large hoop which is inclined slightly from the horizontal and which is supported for rotation about an axis intersecting its center, and perpendicular to the hoop plane. The operator carries a modified head of a sewing machine, driven by a flexible drive shaft typically of the type shown in McCamy Patent No. 2,112,219 dated Mar. 29, 1938 and Van Dyke Patent No. 2,527,163 dated Oct. 24, 1950. By hand the operator guides the machine so that it traces a pattern previously printed by chalk or other marking material on the fabric. The hand-held machine may have one or several needles, and the operator must skillfully track the pattern chalked on the

backing material. The number of needles on the hand operated machine is controlled not only by the density of the pattern but by the radius of the curves in the pattern and the allowable tolerance of inside to outside stitch sizes as well. It will be appreciated that when a number of needles are moved in parallel about a curve, the size of the stitches on the inside of the curve will be smaller than those on the outside. By rotating the hoop, the operator can move different portions of the spread into an accessible position, and in this way she is able to form the more intricate patterns including gentle curves, circles, small shapes, etc., which are not possible with the large automatic equipment.

One important object of this invention is to provide a machine which will automatically control relative movement of a work head with respect to a backing material so that the relative movement of one with respect to the other forms any desired pattern on the material.

A more specific object of the present invention is to provide an automatic control which may guide a work head over any pattern and maintain a stitch rate proportional to the velocity of the head over the backing material so as to achieve uniformity of stitch size throughout a pattern.

Another important object of this invention is to provide a control to guide a work head automatically over any intricate pattern while maintaining the proper heading direction when more than one needle is carried by the head.

To accomplish these and other objects, this invention includes a support for a work head which may be guided freely over the backing material in any direction and which has an input for positioning the head, which may introduce control through Cartesian coordinates, polar coordinates, cylindrical coordinates or other forms of coordinates so that the head may be guided along any desired path. The resultant velocity of the head as it moves along a prescribed path is fed as a stitch rate control to the head so that the stitch rate and resultant velocity are maintained proportional to one another. The input may be guided from any form of memory device or from a tracking system that operates from a pattern so that the work head may move along a path without the attention of an operator.

These and other objects and features of this invention along with its incident advantages will be better understood and appreciated from the following detailed description of one embodiment thereof, selected for purposes of illustration and shown in the accompanying drawing, in which:

FIG. 1 is a diagrammatic view of the mechanical support for the needle head and suggests control of the position of the needle head along X and Y coordinates;

FIG. 2 is a schematic diagram showing the control system for the work head and support;

FIG. 3 is a perspective view showing the needle head assembly and the controls therefor;

FIG. 4 is a fragmentary perspective view showing one form of mechanical coupling from the control motors to the needle head; and

FIG. 5 is a diagrammatic view suggesting the entire system for making tufted goods on an in-line conveyor system.

The assembly shown in FIG. 1 is arranged horizontally to support the needle head 10 in a vertical position so that the backing material upon which the tufting is to be applied is arranged in a horizontal plane also. However, it is to be understood that the assembly shown in FIG. 1 could be arranged vertically or in any other plane so long as the needles are substantially perpendicular to the plane of the backing material.

The head 10 is mounted on a subcarriage 12 between a pair of side panels 14 and 16 which in turn define a main carriage 18. The subcarriage 12 is movable along the Y axis, suggested at arrow 20, by means of a screw drive shaft 22 that extends between the panels 14 and 16 of the main carriage. The screw drive 22 is in turn driven by a hydraulic motor 24 which will be described in greater detail below in connection with FIG. 2.

While the subcarriage 12 may move back and forth in the direction of arrow 20, on the carriage 18, the carriage 18 in turn may move back and forth along the X axis (suggested by arrow 26), on the racks 28 that form part of the main frame of the machine. The racks 28 are stationary and support the carriage above the backing material. Their relationship to the rest of the assembly will be described in greater detail below.

The carriage 18 is driven on the racks 28 by the pinions 30 (one is shown) which in turn are driven by the pinion shaft 32. The pinion shaft 32 is driven through suitable gearing by the hydraulic motor 34. That motor will also be described with greater particularity in connection with the description of the control circuits shown in FIG. 2.

From the foregoing brief description of the assembly shown in FIG. 1, it is evident that the hydraulic motors 24 and 34 are able to control the movement and position of the needle head 10 along X and Y coordinates established by the racks 28 and the screw shaft 22, respectively. Two other hydraulic motors 36 and 38 are shown in FIG. 1 to control the rotation of spline shafts 40 and 42, respectively. The spline shafts 40 and 42 control the speed of operation of the head 10 and its orientation or heading direction with respect to the X and Y coordinates. The manner in which that control is exercised over the head 10 by the spline shafts 40 and 42 will be described in detail in connection with FIGS. 3 and 4. Suffice it to state at this time that the spline shaft 40 controls the speed of operation or stitch rate of the head 10, and the spline shaft 42 controls the heading direction.

In the introduction the reason for controlling the stitch rate of the head 10 with respect to the velocity of the head in the X and Y planes was suggested. It is evident that if the head 10 moves at a varying velocity over the backing material and the stitch rate is maintained constant, the size of the stitches will be larger at those locations over which the head moved more rapidly, and conversely, the stitches will be smaller over those portions where the head moved at a slower rate. Only by making the stitch rate directly proportional to the resultant velocity of the head 10 in the plane of the carriage 18 may the stitches be kept at a uniform size.

The reason for maintaining control of the direction of heading of the head 10 is less obvious. If a single needle is used, heading direction may not be a concern, and the control may be eliminated. However, where two or more needles are carried by the head, heading direction does become an important factor. If the heading direction is maintained constant so that the line passing through the two needles and parallel to the carriage 18 maintains the same angular relationship to the X and Y coordinates, when the head 10 is moved along a curved path, the two rows of tufting made by the two needles would not be spaced equidistant from one another along their entire length. In fact, if the head was directed over a circular course, in one complete circle the two lines of tufting would cross each other twice. In order to maintain the lines in parallel relationship, the line passing through the two needles and parallel to the plane of the carriage 18 must remain perpendicular to the direction of movement of the head 10. Thus, when it is directed about a circular course, in one pass of the circle the head must rotate about its own axis 360 degrees.

Having described the carriage assembly of FIG. 1, some details of the head 10 and its control mechanism as shown in FIGS. 3 and 4 will be described along with the mechanical connections between the head and the spline

shafts 40 and 42. In FIG. 3 the needle bar 50 adapted to be vertically reciprocated in the head 10 by the needle bar driving mechanism 52 shown in part in FIGS. 3 and 4 carries a pair of hollow tufting needles 54. The yarn 56 is shown to extend through the bar 50 and through the hollow needles 54 with the yarn ends 58 extending out through the inclined lower ends of the needles.

A sleeve 62 is shown to surround the needle bar 50, and the needle bar is free to rotate in the sleeve. The sleeve 62 is supported by a pair of collars 64 and a set of bearings 66 separate them so that the sleeve 62 exerts little resistance to needle bar rotation, although the collars are secured to and rotate with the needle bar 50. Adjacent the upper collar 64 is a spiral gear 68 which meshes with a second spiral gear 70 that rotates with a shaft 72 substantially perpendicular to the axis of the needle bar. When rotated the spiral gear 70 serves to turn the needle bar 50 within the sleeve 62. The needle bar is splined within the spiral gear so that the bar may move axially within the gear while the gear maintains its driving contact with it.

While the gear 70 serves to rotate the needle bar 50, the sleeves 62 serves to reciprocate the bar 50 to cause the needles to actually stitch. The sleeve 62 is connected to an H-shaped bracket 74 that is mounted to slide vertically up and down on post 76. The bracket 74 is actuated by the crank arm 78 connected at its upper end to the periphery of the disc 80. Thus, rotation of the disc 80 causes the bracket 74 to reciprocate on its post 76, and this in turn causes similar motion to be imparted to the sleeve 62 which carries the needle bar 50 with it. Note that the sleeve is in its raised position with the collar 64 against the special gear 68.

In FIG. 4 the disc 80 is shown to be rotatably carried by a shaft 82 that carries a spur gear 84 in turn driven by a second spur gear 86 on shaft 88. The shaft 88 is rotated by the spline shaft 40 through gear 90. Thus, it is seen that rotation of the spline shaft 40 causes reciprocation of the needle bar 50. The faster the shaft 40 rotates, the faster the reciprocation or stitch rate.

The second spline shaft 42 drives the spiral gear 70 that controls heading direction of the needles 54, through gear 92, shaft 94, and spur gears 96 and 98. It is evident that angular displacement of the spline shaft 42 causes angular displacement of the needle bar 50 about its vertical axis. It is further evident that the ratio of the angular displacements of the spline shaft 42 and needle bar 50 is determined by the number of teeth on the different gears which connect the two.

Having described in detail the mechanical assemblies of FIGS. 1, 3 and 4, the control system for governing the movement of the subcarriage 12 along the X and Y axes, the stitch rate of the needle assembly, and the heading direction of the needle assembly will now be described. Reference throughout this portion of the description is made to FIG. 2.

The hydraulic motors 24 and 34 which control the rotation of the screw shaft 22 and the pinion shaft 32 are shown in FIG. 2 to form part of closed loop servo systems 100 and 102, respectively having their own separate inputs 104 and 106, that provide the coordinate information for displacement of the subcarriage 12 along the X and Y axes. The inputs are schematically represented as (X) input and (Y) input and position input potentiometers having slides that may be controlled by a wide variety of sources. Typically, the signals (X) input and (Y) input could be furnished by any one of a number of memory storage devices. Alternatively, the slides could be controlled "live" by a tracking system following a pattern representing the pattern to be stitched by the needles. The (X) input and (Y) input could be taken from "Mosley-Autograph" equipment such as Type F-3B line follower and related equipment such as Type F-1A curve follower adapter. Such line following equipment could be employed to trace patterns on 1:1 scale or

any other scale desired and/or directly from the stitched item to reduce stretch error.

The (X) input and position input potentiometer 106 is shown in FIG. 2 to provide a signal to a comparator 108 whose output signal is in turn amplified and directed to the hydraulic motor 34. Typically, the hydraulic motor 34 shown to include a servo valve 110, could be a Moog valve and servo motor assembly Type 84 manufactured by Moog Servo Controls, Inc., E. Aurora, N.Y.

The output shaft 32 which is the pinion shaft in FIG. 1, is mechanically coupled to a potentiometer 112 that produces a response signal which is compared with the input signal fed to the comparator, which signal is the combined (X) input signal and the bias from position potentiometer. Thus, a closed loop is provided to control the pinion shaft 32 that in turn moves the subcarriage with respect to the X axis.

The movement of the subcarriage with respect to the Y axis is controlled by a substantially identical closed loop servo system that includes comparator 114, amplifier 116, servo valve 118 and potentiometer 120. Thus, the displacement along the X and Y coordinates is controlled through the respective closed servo systems by difference signals issued by the comparators 108 and 114.

In the foregoing description it was indicated that the velocity of the subcarriage 12 or head 10 carried by it, determines the stitch rate. The stitch rate must be proportional to the velocity of the head if uniform spacing of the tufts is to be maintained. The hydraulic motor 36 which may be identical in operation to the motors 24 and 34 also includes as a part thereof, a servo valve 122, and the motor 36 drives the spline shaft 40 that controls stitch rate. The signal controlling the operation of the servo valve 122 emanates from the comparator 124 connected to amplifier 126. The comparator 124 compares the signal fed to it by resolver 128 with the feedback signal from tachometer 130 mechanically connected to the spline shaft 40 as part of the closed loop system. The resolver 128 receives two velocity signals  $DX/DT$  and  $DY/DT$  from the tachometers 132 and 134 mechanically connected to the shafts 32 and 22, respectively, of the hydraulic motors 34 and 24. The signal from the resolver 128 is fed through stitch rate potentiometer 136 which allows for the manual setting of the stitch rate. It will be noted in FIG. 2 that the output of the resolver is shown to be a  $DR/DT$  signal which is the result of the velocity signals  $DY/DT$  and  $DX/DT$  fed to the resolver. The resolver may be any component capable of solving the equation

$$\frac{DR}{DT} = \sqrt{\left(\frac{DX}{DT}\right)^2 + \left(\frac{DY}{DT}\right)^2}$$

The output of the stitch rate potentiometer is modified by a factor K which is the manual setting introduced by the operator.

The heading direction controlled by the hydraulic motor 38 and spline shaft 42 forms part of another closed servo system 140 composed of the resolver 128, hydraulic motor 38 including its servo valve 142 and amplifier 144.

The resolver 128 as pointed out above receives voltage signals  $DX/DT$  and  $DY/DT$  from the tachometers 132 and 134, respectively. The resolver in turn performs the mathematical computation to produce a signal  $DR/DT$ . The resolver feeds one signal to the stitch rate potentiometer and the second and similar signal is fed to the  $\theta$  amplifier 144, which comprises servo error voltage. Thus the servo valve 142 responds to the error signal and the hydraulic motor 38 responds such that the angle  $\theta$  is tracked as a solution to the mathematical problem solved by the resolver. The mechanical feedback to the resolver from the motor spline shaft 42 drives the resolver shaft to maintain a null and supplies power for the heading.

In FIGS. 2 and 4 a time pick-off 146 is shown connected to the spline shaft 40, which controls the stitch rate of the head 10. This pick-off is essential to insure

that the needle or needles carried by the head 10 is out of the backing material when the head is moved to a new area; that is, when the X and/or Y coordinates are changed with a break in a particular pattern. The time pick-off may control a switch which stops the hydraulic motor 36 with the needles in a raised position. This is also suggested in FIG. 2 wherein switches 150 and 152 are shown in series in the power circuit and which are respectively controlled by the time pick-off and an on/off signal input. When either of the switches 150 or 152 open, it will deenergize the relay 151 that controls the relay switch 153 to break the circuit between the tachometer 136 and the comparator 124.

FIG. 5 diagrammatically suggests how the present invention may be used in a system for producing tufted goods. In that figure, a roll of backing material 154 is shown to feed the material onto a tenter frame 156 that stretches the fabric firmly so that it will not sag excessively. The backing material is shown to be fed to the tenter frame by feed rollers 158. Disposed above the fabric held by the tenter frame 156 are the racks 28 (one is shown) along which the carriages 18 move. The three carriages 18 are shown to support their subcarriages 12 that carry the heads 10. Positions 1, 2 and 3 may either represent three units which are slaved to a single source, or alternatively they may represent three different positions in which a single carriage 18 may be moved to from three different or the same tufted patterns on the backing material. If they are three units slaved together to produce the same design, potentiometers are provided in the circuits of each to add X and Y factors to the basic information (X) input and (Y) input fed to the individual X and Y comparators 108 and 112. The position input potentiometers could be added as an electromechanical pattern tracing system which could follow cams, grooves, etc. to provide a "live" control.

In the system described above, the tufting made by the heads on carriages 18 will be produced on the ground material that was previously subjected to the normal tufting operation to produce the background. The background pattern alternatively, may be produced in an in-line operation as suggested by the alternative showing on the right side of FIG. 5. In that alternative, the roll of backing material may first be fed to a conventional tufting machine 160 which produces the background, and subsequently, the material may be fed to the tenter frame 156 above which one or a number of carriages 18 is positioned to produce the special designs.

The direction of feed of the backing material 154 is suggested by arrow 162, and a cutting tool 164 is suggested to the left of the tenter frame 156. It is evident that the fabric may be cut after the carriages 18 have produced their particular designs and when the next length of the backing material is placed on the tenter frame beneath the carriages.

It will be appreciated that numerous modifications may be made of this invention without departing from its spirit. For example, while rectangular coordinates have been described in connection with the apparatus shown in the drawing, any system of Cartesian coordinates may be used. Alternatively, polar or cylindrical coordinates may be used to position the head above and/or below the fabric to produce any particular pattern. It will also be evident that while FIG. 1 may suggest that the carriage moves horizontally, that is, the X and Y coordinates could define a vertical plane in which the carriage moves. In such an arrangement, the ground or backing material would also be oriented vertically at the location of the head. Moreover, the closed loop systems used to control each of the hydraulic motors could take a variety of different forms and the motors themselves could be of different types to include all clutch controlled servo mechanisms. Moreover, the resolver described may be replaced by other forms of computers to perform the function required.

Further, while the (X) and (Y) inputs are used to control the position of the head, it will be appreciated that these inputs could be used to control the positions of both the frame and the head or the position of the tenter frame alone while the head remains stationary. In such an arrangement the fabric rather than the carriage would move, and it would only be necessary to rotate the head in place to determine heading direction. It would of course, in such an arrangement, be necessary to control the stitch rate so as to provide uniform tufting.

It will also be evident to those skilled in the art that while in the illustrated embodiment X and Y data is fed to the control system and velocity and heading direction are computed by the system, the velocity and heading direction could be fed to the system and the X and Y inputs could be internally computed. Moreover, all of the data, X, Y, R and  $\theta$ , could be fed to the machine to simplify the system and reduce its cost by eliminating many of the components. It should also be appreciated that while the invention is described as controlling a sewing machine or needle head, the head may be other types of work heads such as are used to carry carving tools that carve the pile of tufted articles to create different levels in the pile that provide designs in more or less solid backgrounds.

What is claimed is:

1. A stitching machine comprising a needle head for carrying one or more needles, a frame for supporting fabric upon which the machine is to stitch, a carriage disposed adjacent the frame carrying the needle head with the head substantially perpendicular to the area of the fabric upon which the stitching is to be made, means connected to at least one of the carriage and the frame enabling one to move with respect to the other, actuating means connected to the one of the carriage and frame for causing that one to trace a preselected pattern with respect to the other, drive means for oscillating the head causing the needle or needles to stitch, means operatively connecting the actuating means and the drive means for maintaining a preselected relationship between the stitching rate and the relative velocity of the carriage and head, and an adjusting device forming part of the means for operatively connecting the actuating and drive means for varying the preselected relationship.
2. A stitching machine as defined in claim 1 further characterized by said head being oriented to move substantially vertically with the frame supporting the fabric horizontally below the head.
3. A stitching machine as defined in claim 1 further characterized by more than one needle carried by the head, second drive means for rotating the head about its axis, and means operatively connecting the actuating means and the second drive means for maintaining a heading direction for the head bearing a preselected relation to the direction of relative movement of the carriage and frame.
4. A stitching machine as defined in claim 2 further characterized by said carriage being movable in a horizontal plane over the frame, said actuating means including an analogue system for controlling said carriage along mutually perpendicular coordinates.
5. A stitching machine as defined in claim 4 further characterized by more than one needle carried by the head, second drive means for rotating the head about its axis,

and means operatively connecting the actuating means and the second drive means for maintaining a heading direction for the head bearing a preselected relation to the direction of movement of the carriage over the frame.

6. A stitching machine as defined in claim 4 further characterized by said system including means for producing signals which are functions of the desired movement of the carriage along the mutually perpendicular coordinates, said actuating means further including motor means for moving said carriage along the coordinates, means including a computing device operatively connected to the motor means for producing a resultant signal which is a function of the resultant of the velocity of the carriage along the coordinates, said resultant signal being fed to the drive means for maintaining the relationship between stitching rate and resultant velocity.
7. A stitching machine as defined in claim 6 further characterized by second drive means for rotating the head about its axis, means for directing the resultant signal to the second drive means for maintaining a heading direction of the head bearing a preselected relation to the direction of movement of the carriage and frame.
8. A stitching machine comprising a needle head carrying one or more needles and a carriage supporting the head, drive means connected to the head for oscillating said head causing the needles to stitch, an analogue system for moving said carriage while the drive means is operative whereby one or more lines of stitching may be made on a fabric, and means operatively connecting the drive means and the system automatically causing the drive means to oscillate the head at a stitch rate bearing a selected functional relationship to the velocity of the carriage.
9. A stitching machine as defined in claim 8 further characterized by an adjusting device forming part of the means for operatively connecting the drive means and system for varying the functional relationship of the stitch rate and carriage velocity, second drive means for rotating the head on the carriage for changing the heading direction of the head, and means operatively connecting the second drive means and the system for automatically maintaining a heading direction for the head bearing a selected relationship to the direction of movement of the carriage.
10. A stitching machine comprising a head carrying one or more needles and a carriage member supporting the head, a frame member for carrying fabric to which stitching is to be applied, an analogue system for moving one of the members with respect to the other with two degrees of freedom in a plane perpendicular to said other members, actuating means for producing a signal directed to the system for automatically causing said one member to trace a preselected irregular path in a plane parallel to the plane of said other member, and drive means connected to the head causing the needles to stitch as said one member moves with respect to the other.
11. A combination comprising, a tufting machine, means for feeding fabric through the machine to apply tufting to the fabric, a head carrying one or more work pieces for engaging the tufted fabric to create a pattern in the tufted fabric,



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means for directing the tufted fabric from the tufting machine to the location of the head, actuating means for moving said head along a preselected path on the fabric, means for driving the work piece, and means for maintaining the heading direction of the head tangent to the preselected path.

12. In the combination of claim 11, said means for driving the head establishing a work rate for the work piece, and means operatively connecting the said means to the actuating means for maintaining a work rate proportional to the velocity of the head along the preselected path.

13. In the combination of claim 11,

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means for feeding a work rate to the means for driving the work piece.

References Cited

UNITED STATES PATENTS

2,528,392	10/1950	Self	-----	112-79
2,649,064	8/1953	Dürschmidt	-----	112-98 XR
3,083,580	4/1963	Carson et al.	-----	74-113
3,224,393	12/1965	Adams et al.		
3,329,109	7/1967	Portnoff et al.		

JAMES R. BOLER, *Primary Examiner.*

U.S. Cl. X.R.

112-2