United States Patent

Rovin

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[54] FEED GUIDE FOR SHEET MATERIAL

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[21] Appl. No.: **854,333**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 659,096, Aug. 8, 1967, abandoned.

[52] **U.S. Cl.**.....**112/121.11,** 112/153, 112/204, 271/53

[51] **Int. Cl.**.....**D05b 19/00,** D05b 27/14

[58] **Field of Search**.....112/121.11, 121.12, 121.15, 112/2, 204, 203, 205, 262, 121.24, 153; 250/227; 83/364, 365, 367; 271/53

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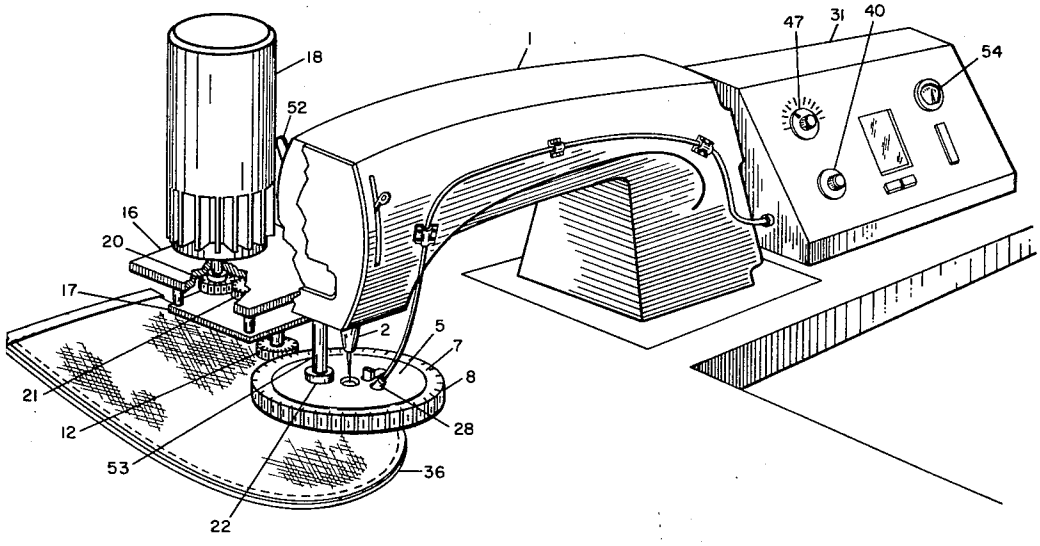
[57] **ABSTRACT**

Apparatus such as a sewing machine, having means, e.g., a feed dog cooperating with a presser foot, to pass sheet material over a work surface through a work point, is improved by adapting it to automatically steer or guide the sheet material through the machine. A rotatable gripping means such as a contact ring about the work point is arranged to intermittently engage the sheet material, synchronously with the action occurring at the work point. Associated therewith is means for actuating the gripping means into contact with the sheet material and for imparting a controlled rotational movement to the gripping means so that it moves arcuately with respect to the work point thus exerting a guiding action on the sheet material.

The gripping means can be located above or below the sheet material and can have opposed to it a cooperating surface to assist it in its clamping and guiding action. The rotational motion of the gripping means can be controlled by means of an optical edge sensor or it can be preprogrammed as by computer techniques.

The fact that the rotatable gripping means contacts the sheet material at least over a series of points, preferably over an area at least in part surrounding the work point, and the fact that the position of the gripping means in contact with the sheet material moves relative to the work point in the plane of the sheet material while it is exerting its guiding action, are considered distinguishing characteristics of the invention.

34 Claims, 12 Drawing Figures



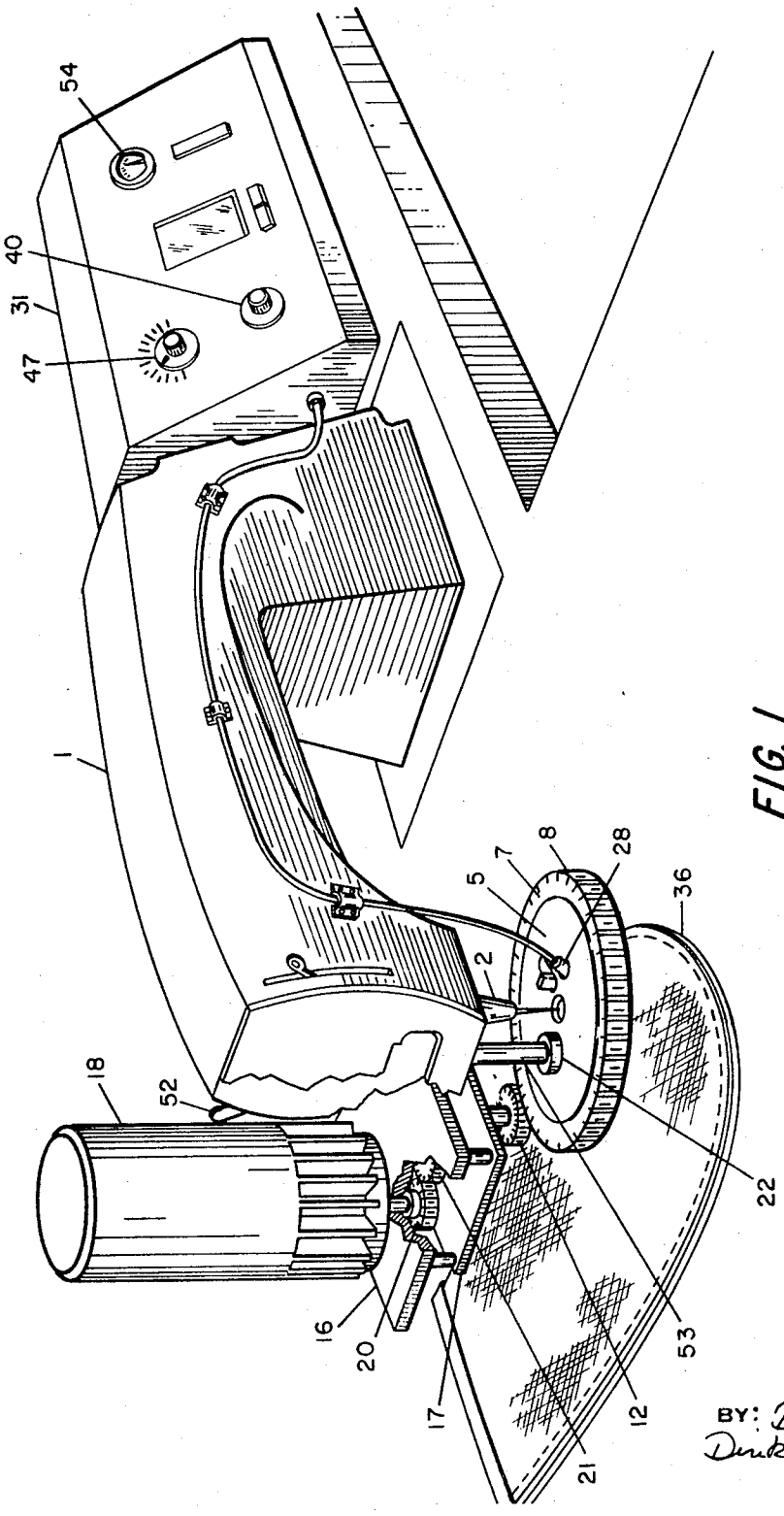


FIG. 1

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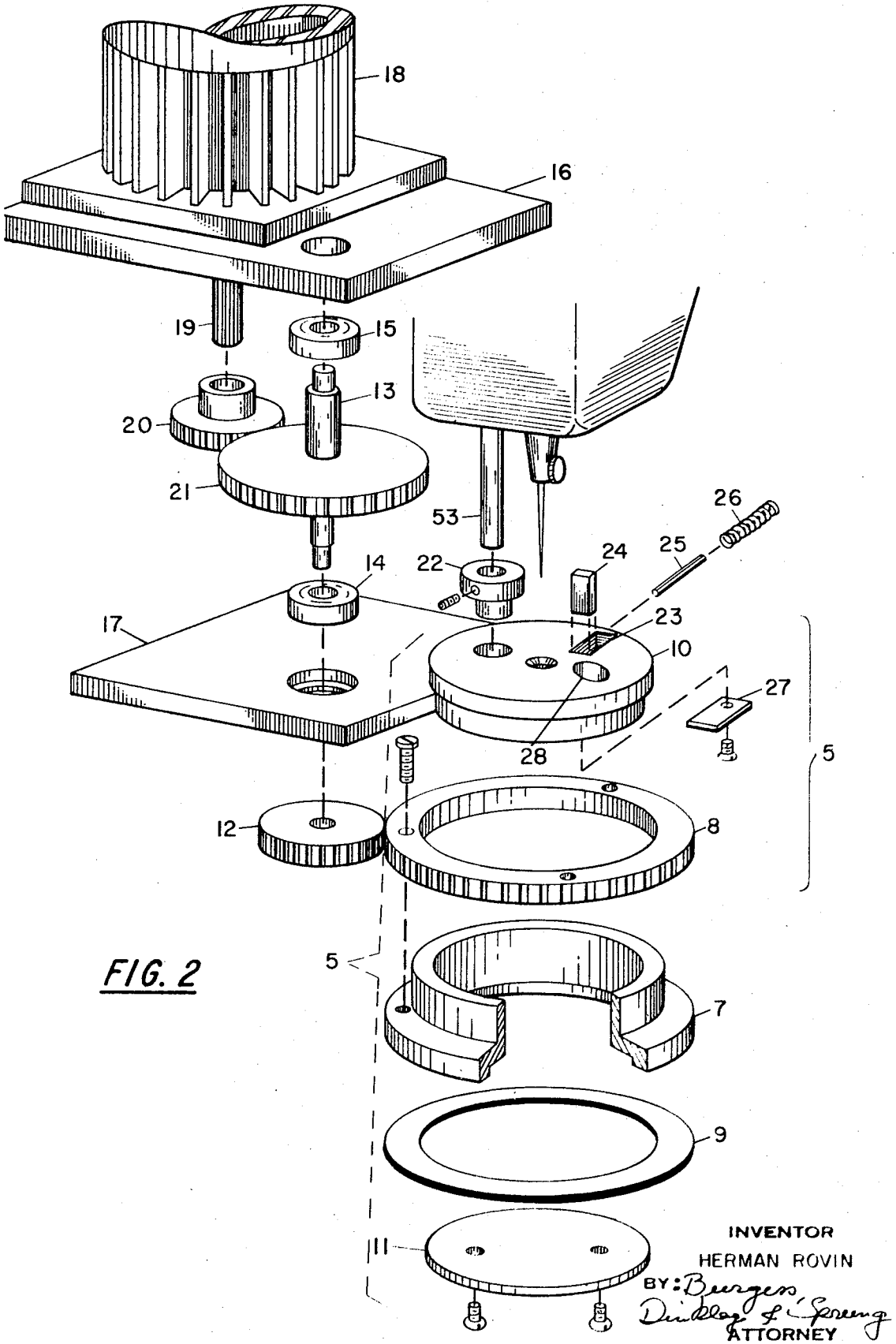


FIG. 2

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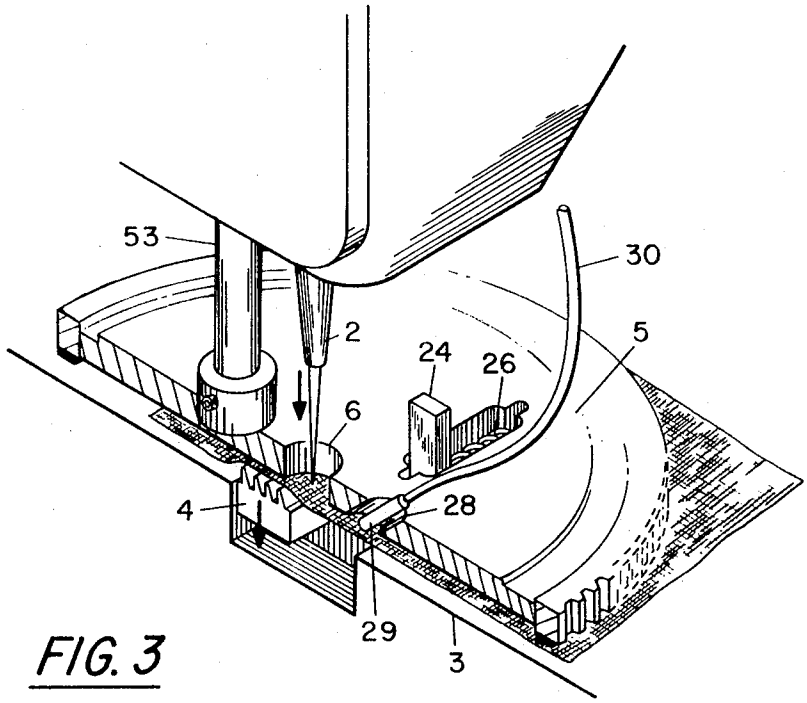


FIG. 3

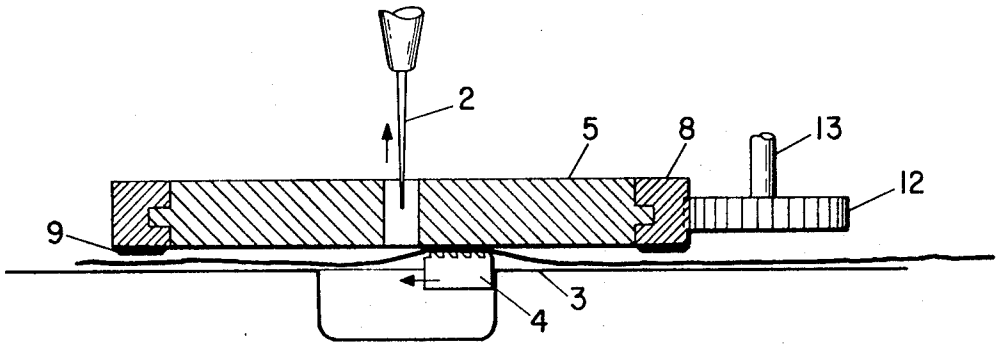


FIG. 4

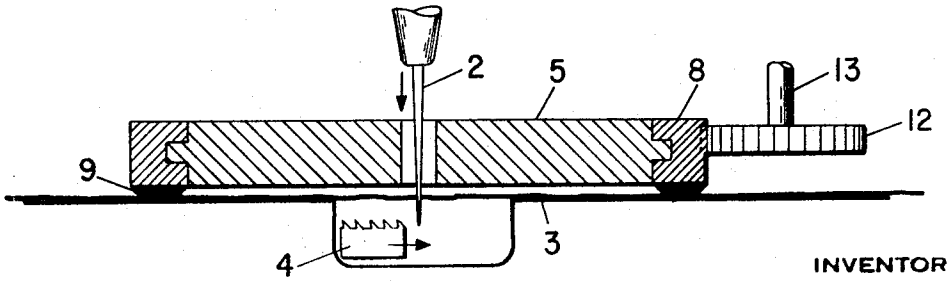


FIG. 5

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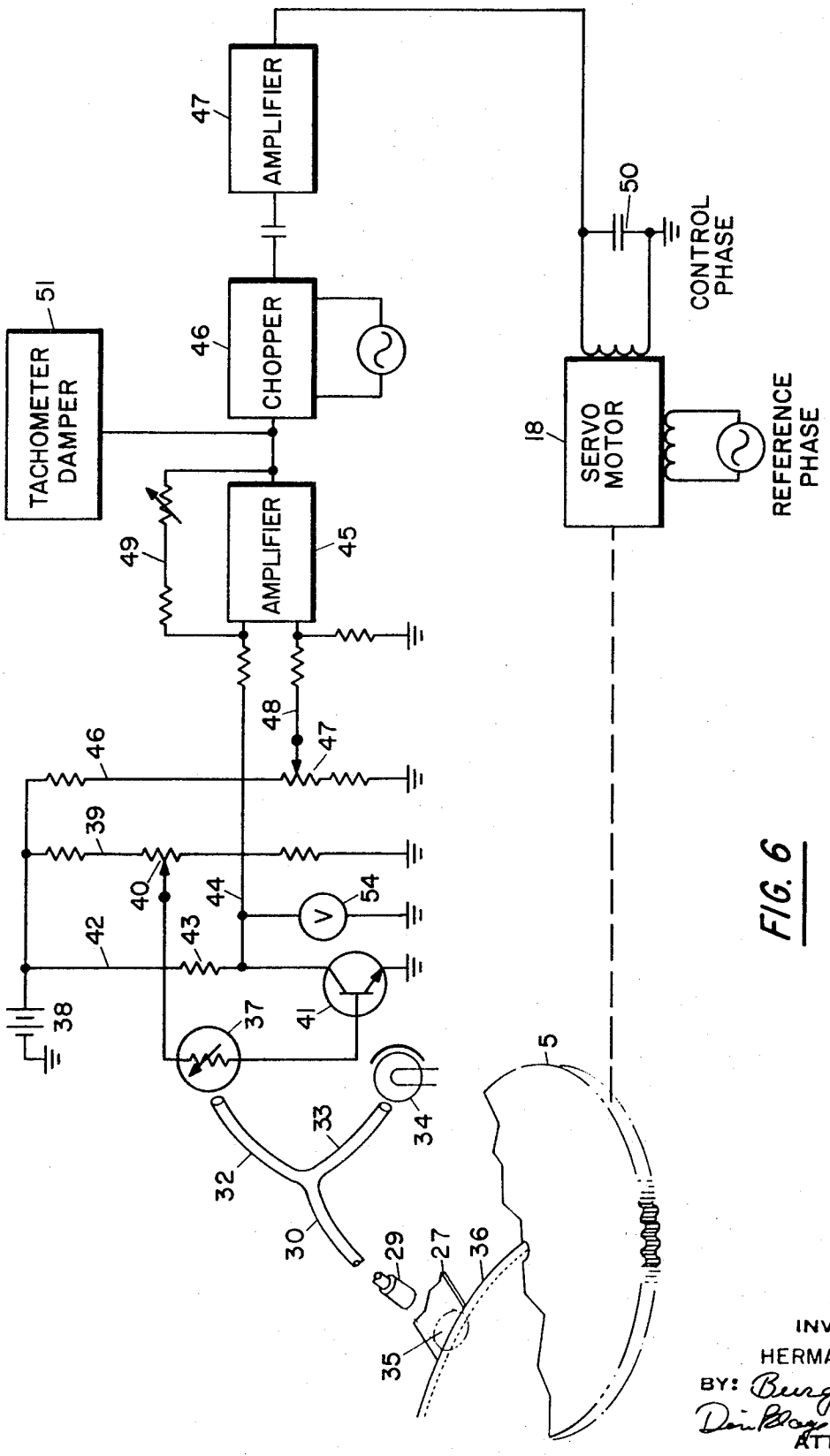


FIG. 6

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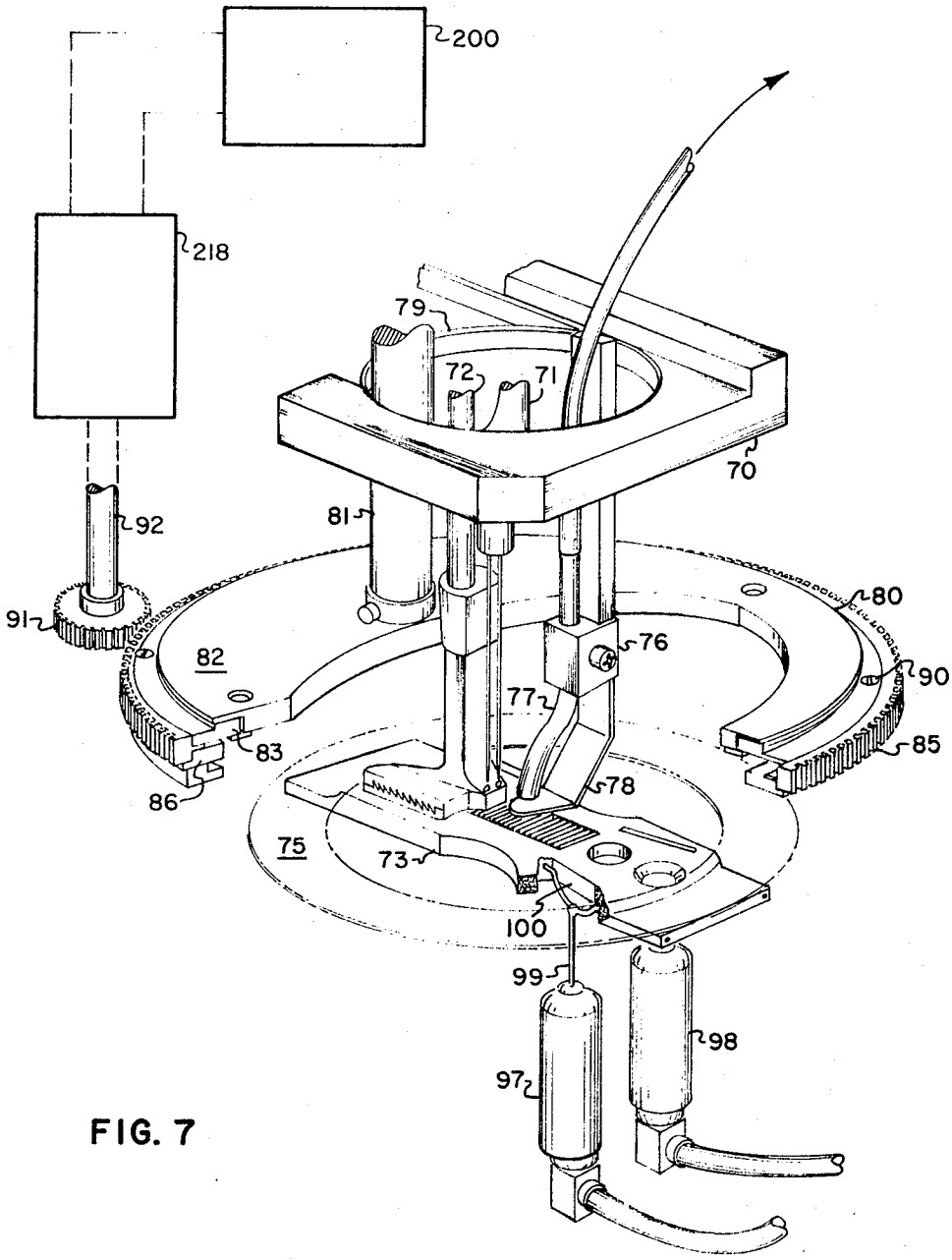


FIG. 7

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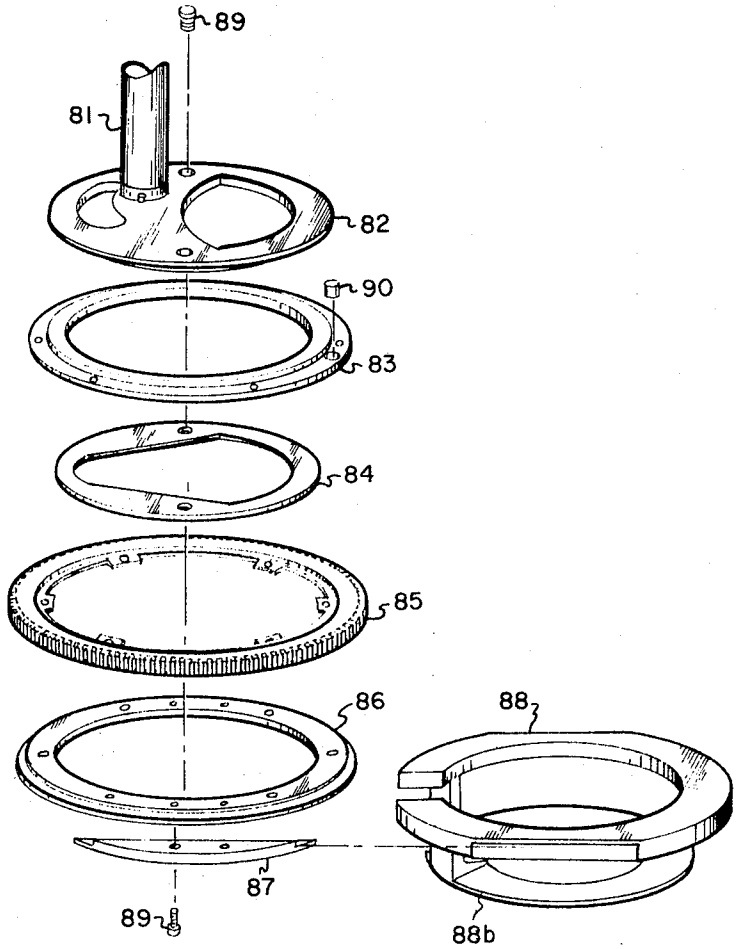


FIG. 8

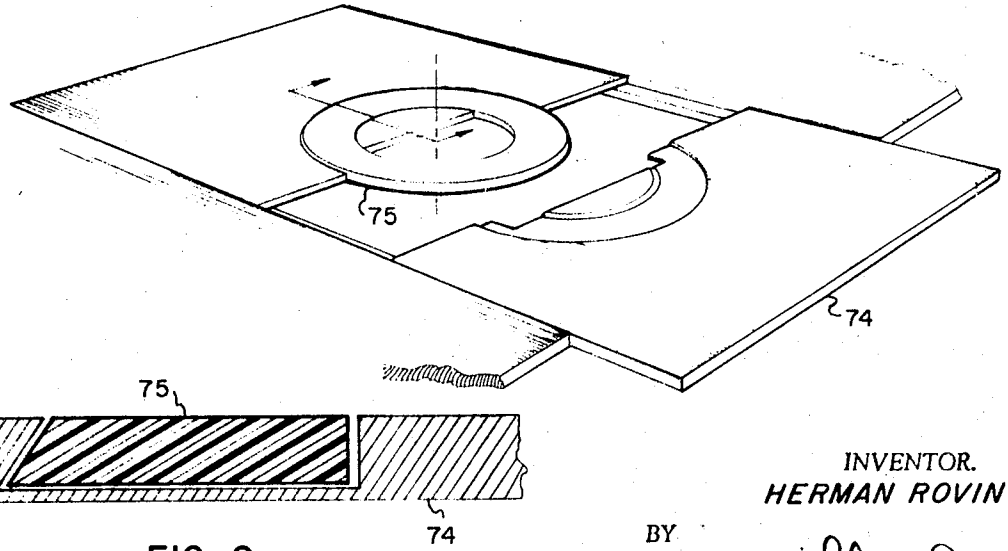


FIG. 9

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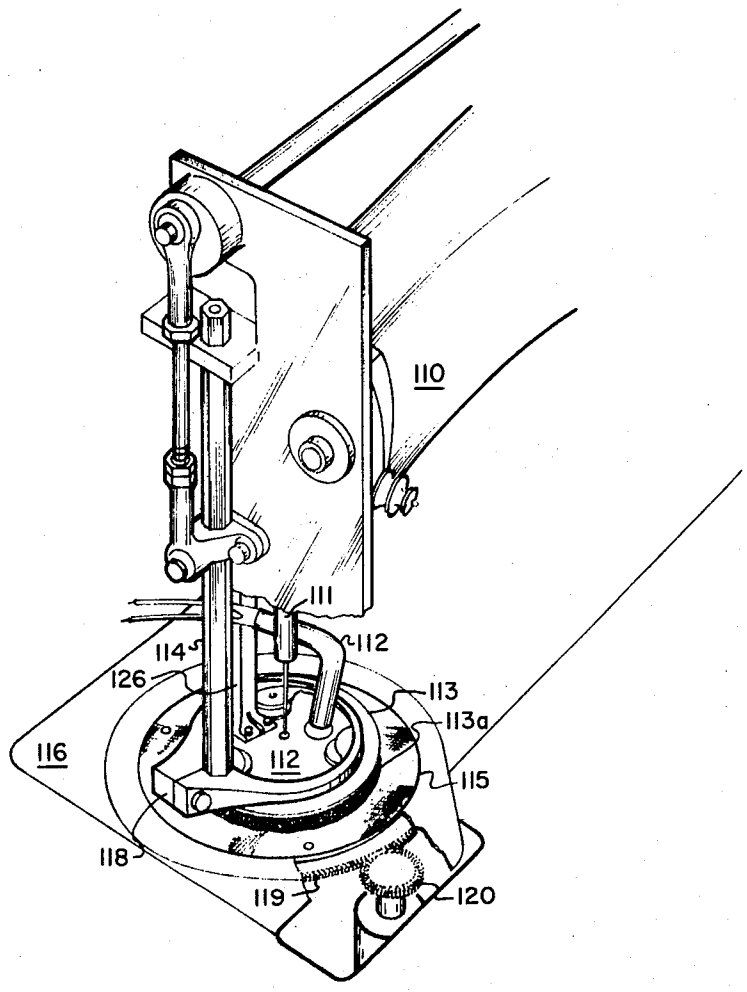


FIG. 10

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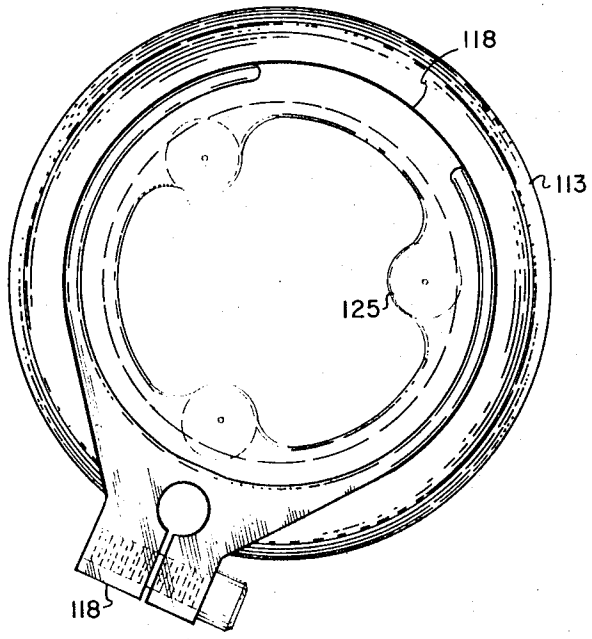


FIG. 11

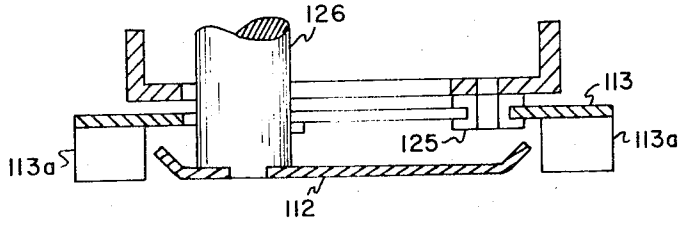


FIG. 12

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FEED GUIDE FOR SHEET MATERIAL

RELATED APPLICATION

This application is a continuation-in-part of application Ser. Number 659,096, filed Aug. 8, 1967, now abandoned, and entitled "Feed Guide for Sheet Material."

This invention relates to a feed guide for sheet material. The invention more particularly relates to an arrangement for controlling the course of sheet material being fed over a work surface past a work point, as for example, over the throat plate of a sewing machine beneath the needle thereof.

The invention furthermore relates to an optical edge sensing arrangement to control actuation of the guide or which can be used in connection with other guiding arrangements.

In many devices, sheet material is automatically fed over a work surface past a work point such as in the manufacture of leather goods, clothing and sails. While the feed is automatic, the course of the material must usually be manually varied or controlled as, for example, to follow the edge of the material, a pattern line, or the like. For instance, when cloth or leather is fed through a sewing machine, while the feed is effected automatically by the sewing machine feed dogs, an operator must guide the material in order to maintain the desired stitch line, or to follow the contour of the material edge. The same type of manual guidance is required in various other operations such as in certain perforation operations on sheet material, skiving operations on leather and the like.

This invention is directed to this and other problems, and proposes an improved apparatus with means for controlling the course of a sheet material being fed over a work surface past a work point, more particularly a guiding device which will automatically guide sheet material through a sewing machine.

THE DRAWINGS

FIG. 1 is a perspective view of a sewing machine provided with an embodiment of the guiding arrangement and sensor in accordance with the invention;

FIG. 2 is a partial exploded perspective view of the guiding arrangement of the device shown in FIG. 1;

FIG. 3 is a perspective view partially in section showing a portion of the device shown in FIG. 1;

FIG. 4 is a cross section through the presser disk of the guiding device shown in FIG. 1 showing one position of operation;

FIG. 5 is a cross section through the presser disk of the guiding device shown in FIG. 1 in another position of operation;

FIG. 6 is a circuit and block diagram illustrating the edge sensing and guide control device shown in FIG. 1;

FIG. 7 is a broken-away perspective view of another embodiment of this invention;

FIG. 8 is an exploded perspective view of the rotatable gripping means shown in FIG. 7;

FIG. 9 is a cross section of the floating ring 75 taken along the section line shown in FIG. 8;

FIG. 10 is a perspective view of a further embodiment wherein the rotatable gripping means of this invention is located below rather than above the sheet material;

FIG. 11 is a plan view of the clamping element 113 shown in FIG. 10 which assist the action of the gripping means; and

FIG. 12 is a cross-sectional view of element 113 and of the presser plate of the machine shown in FIG. 10.

DESCRIPTION

The device in one embodiment of this invention for guiding sheet material being fed over a work surface past a work point has a presser plate positioned opposed to the work surface for the passage of the sheet material between it and the work surface and is preferably biased to press the sheet material in sliding contact with it and the work surface. Gripping means are connected to the presser plate and are mounted for at least limited rotary motion about an axis substantially extending through the work point. The gripping means are selectively

adapted for holding engagement with the sheet material during rotary movement thereof without substantially impeding the feed of the material. Means are provided imparting rotary movement to the gripping means to vary the course of the sheet material being fed. Preferably the gripping means is in the form of a friction surface at the peripheral edge of the presser plate as for example, in the form of an annular friction ring rotatably mounted about the plate's periphery which allows the gripping action by differential friction, i.e., when effecting the gripping action exerts a greater friction force on the sheet material than does the work surface or presser plate.

The presser plate is preferably mounted for limited axial movement toward and away from the work surface and is preferably intermittently moved toward and away from the work surface so as to effect the gripping action when moved toward the work surface and to allow the feed to occur intermittently when moved away from the work surface.

An edge sensor is preferably provided for controlling the rotary movement imparted to the gripping means. The edge sensor is preferably an optical edge sensor having a photosensitive cell for receiving reflected light signals from a narrow area along the path of travel of the edge of material through the machine and effects rotation of the gripping means in one direction when the intensity of the reflected light signals exceeds a predetermined value and in the opposite direction when the intensity of the reflected light signal is below this value.

In accordance with an embodiment of the invention a fiber optic cable is provided which terminates directly at the area in question. A portion of the optic fibers of this cable are connected to the photosensitive cell and a further portion are connected to a light source for illuminating the area. The photosensitive cell is preferably so arranged that when the edge of the material bisects the illuminated area in question the signal produced is at its null or neutral point. The illuminated area in question is preferably beneath the presser disk and the presser disk is most preferably provided with a contrast plate, i.e., a plate having a contrasting reflectivity with respect to the sheet material, which is resiliently urged under the edge of the material.

Referring to the embodiment shown in the drawings, 1 represents a conventional sewing machine of the lock stitch type provided with a reciprocating needle 2, and a throat plate 3 (FIG. 3) over which the material to be sewn is passed and which is provided with an opening into which the needle extends on its stitching stroke. Below the throat plate a conventional bobbin (not shown) is provided as are the conventional feed dogs 4 (FIG. 3).

In accordance with the invention the conventional presser foot of the sewing machine is replaced with a presser plate in the form of the disk 5 which is attached to the end of the presser foot shaft 53 which may be raised and lowered in the conventional manner and when lowered in its operational position as shown, resiliently presses the disk 5 against the throat plate while allowing limited axial movement of the disk 5 away from the throat plate against a spring force in the same manner as conventionally occurs in connection with the presser foot. An opening 6 extends through the presser disk 5 through which the needle 2 may extend or be retracted. Rotatably mounted about the periphery of the presser disk 5 is the ring bushing 7. Secured to the periphery of this ring bushing is the ring gear 8 and secured to the lower surface of the ring bushing 7 is the annular rubber friction ring 9. The bushing 7 with its connected parts 8 and 9 is held against axial movement, while allowing rotary motion by means of the upper flange 10 on the disk 5 and the lower plate 11, the bottom surface of which constitutes the lower surface of the disk. This lower surface is preferably of a material having a low coefficient friction and may for example, be formed of the same material as the throat plate, as for example polished metal having a mirror finish, chrome plated, or the like. This surface may also be of a low coefficient friction plastic or coated with a nonstick plastic, or the like. The surface in any

event has a substantially lower coefficient of friction with the material to be passed through the machine than does the friction ring 9, so that there is greater friction between the material and the friction ring 9 than there is between the material and the throat plate and the material and the opposed surface of the presser disk. Movement of the friction ring 9 will thus cause the material to move in fixed contact therewith while sliding in contact with the throat plate 3 and lower surface 11 of the presser disk, by differential friction. Mated in engagement with the ring gear 8 is the drive gear 12. The ring gear 8 may slide a limited degree in its axial direction while being maintained meshed with the drive gear 12 as may be noted from FIGS. 4 and 5. The drive gear 12 is mounted at the end of the idler shaft 13 which rotates in the bearings 14 and 15, mounted between the plates 16 and 17 which in turn are mounted in spaced relationship on the end of the AC servo motor 18. The motor 18 has a drive shaft 19 provided with a gear 20 which is meshed with the gear 21 seated on the idler shaft 13 so that rotary motion of the servo motor and its drive shaft 19 will be transmitted to the ring gear 18 through the gear train 20, 21, 12. The presser disk 5 is connected to the presser post or bar 53 by means of the bushing arrangement 22. The presser disk 5 is provided with a slotted opening 23 in which is guided the finger bar 24 on the pin 25, which is springloaded by the spring 26. Connected to the lower end of the finger bar 24 is the contrast plate 27. This plate is so positioned that it will be resiliently forced under the edge of the sheet material being passed through the needle of the machine as hereinafter described. A further opening 28 extends at an angle through the presser disk 5 in front of the opening 6 in the normal direction of feed of material through the machine. Extending in this opening 28 is the end 29 of the fiber optic cable 30. The opposite end of the fiber optic cable 30 extends into the control box 31 which contains the photo sensor and electrical elements as shown in FIG. 6. In the control box 31 the fibers of the fiber optic cable 30 is split into two branches 32 and 33, either for example, randomly with about half of the fibers extending on each branch, or with, for example, the central fibers extending in branch 32 and the peripheral fibers extending in the branch 33.

The light from the incandescent bulb 34 is transmitted through the optic fibers of the branch 33 through the cable 30 and is projected from the end 29 as an illuminated spot 35 in the normal path of travel of the edge of the material 36 through the machine. The light is reflected back from this illuminated spot and picked up by the other optic fibers in the cable and is transmitted through the fibers of the branch 32 into the photosensitive cell 37 which is in the form of a conventional photoresistor, the resistance value of which varies inversely with the intensity of light striking the same. The photoresistor 37 forms a part of a circuit fed with direct current from the cell 38. Current from the cell 38 flowing through the central line 39 of the circuit is tapped off through the potentiometer 40 and flows through the photoresistor 37 to the base of the transistor 41. A further portion of the current from the cell 38 flows through the branch 42 of the circuit through the fixed resistor 43 and the collector and emitter of the transistor 41 to ground. The photoresistor 37 controls the base current of the transistor 41 and thus controls the collector-emitter current of the transistor so that the current flowing through the line 42 and the voltage drop across the resistor 43 will be directly controlled and amplified by changes in the resistance of the photoresistor 37. As an increasing amount of light strikes the photoresistor its resistance decreases and the voltage drop across the resistor 43 increases. In the same manner, as the intensity of light striking the photoresistor 37 decreases, its resistance increases causing a decrease in current flow through the line 42 and a decrease in the voltage drop across the resistor 43. The voltage between the resistor 43 and transistor 41 is fed by line 44 into the amplifier 45 as an input signal voltage. The value of this voltage will, of course, decrease as the intensity of light striking the photoresistor 37 increases.

The potentiometer 40 may be used as a scale control to adjust the response of the photoresistor 37 to produce a desired average output voltage between maximum and minimum light values striking the photoresistor 37 under given conditions and to prevent overloading of the transistor 41. A further line 46 is connected to the cell 38 and provided with the variable resistance 47 which is connected to the amplifier 45 as a reference input signal through the line 48. The amplifier 45 is a conventional differential amplifier which amplifies as a DC output signal the difference between the voltages of the lines 44 and 48. The value of the reference voltage may be adjusted by varying the resistance 47 through an external control knob as shown in FIG. 1. The gain of the amplifier 45 may be controlled by the gain control 49. The amplified DC signal from the amplifier 45 is passed into the chopper 46 which converts this signal to a square wave 60 cycle AC signal. The AC signal from the chopper 46 is then fed through the booster amplifier 47 where the same is amplified to a value suitable for the control phase of the servo motor 18 to which it is fed. A tuned capacitor 50 is provided for impedance matching. The servo motor 18 is a conventional two-phase AC servo motor which is provided in addition to the control phase with a 60 cycle reference or drive phase. The motor will rotate in one direction when the control phase is 90° out of phase with the drive phase, and in the opposite direction when 270° out of phase with the drive phase. If a positive signal is fed by the amplifier 45 into the chopper 46, the amplified control phase will be 90° out of phase with the drive phase causing rotation in one direction. If on the other hand, the amplified DC signal fed into the chopper 46 is a negative signal, the amplified AC signal from the amplifier 47 will be 270° out of phase from the drive phase causing rotation in the opposite direction.

In order to prevent excess control oscillation a tachometer damper 51 may be provided in order to create a viscous drag. The tachometer 51 may simply be constructed so as to provide a signal dependent on the speed or rotation of the servo motor 18, which signal opposes the signal of the amplifier 45 and cancels a portion thereof.

In operation the presser disk 5 is raised by raising the post 53 in the conventional manner, as for example, by means of the control handle 52. The material to be sewn is placed in the machine in the conventional manner. Assuming that a stitch line is to be sewn following the edge of the material as shown in FIG. 1, the material is positioned beneath the needle of the machine in its proper starting position and the disk 5 lowered into its operational position so as to hold the material between it and the throat plate. The disk 5 and the end 29 of the fiber optic cable 30 is adjusted so that the spot of light 35 projected from the cable is bisected by the edge of the material. If there is not a substantial difference in the reflectivity between the material being sewn and the area past the edge, as for example when two pieces of material are being sewn together, a contrast plate 27 being of substantially different reflectivity than the material may be used and may be inserted under the edge being sewn as shown in FIG. 6. The insertion of the contrast plate 27 so that the same extends under the edge, may be facilitated by manipulation of the finger lever 24. With the material in this position the potentiometer 40 is adjusted so that the output voltage for the line 44 into the amplifier 45 is at the desired value. This value may be ascertained, for example, by means of the voltage meter 54. The reference voltage fed into the amplifier 45 is then adjusted by means of the variable resistance 47 to equal this input signal voltage so that this constitutes the null or zero point and there is no output signal from the amplifier 45 and the servo motor 18 will be at rest. The sewing machine is then started and operated in its conventional manner and begins to stitch the material. Assuming that the material reflects less light than the contrast plate 27, and the material begins to move out of the desired path of travel so that for example, the edge 36 would move in a direction moving the stitch line too far from the edge, a greater area of the light spot 35 will be covered by the material cutting down the amount of light reflected and thus the light

signal passing through the branch **32** to the cell **37**. This will increase the resistance of the cell **37** decreasing the base current on the transistor **41** and thus decreasing the amount of current which the transistor will pass from the collector to the emitter and the amount of current passing through the line **42** to ground. This will decrease the voltage drop across the resistance **43** and thus will increase the voltage signal fed through the line **44** into the amplifier **45** so that this signal voltage is greater than the reference voltage fed in at **48** on the positive side. The amplifier **45** will amplify this positive DC signal which is converted by the chopper **46** to an AC signal 90° out of phase with the reference or drive phase fed to the servo motor **18**. This AC signal will then be amplified by the amplifier **47** and fed as the control phase to the servo motor **18** causing rotation in a counterclockwise direction which through the gear train **20**, **21** and **12** will cause rotation of the ring gear **7** in a clockwise direction rotating the friction ring **9** therewith.

As the needle **2** of the sewing machine retracts as shown in FIG. **4**, the feed dog **4** raises and begins its transport or feed stroke. This raising of the feed dog forces the presser disk **5** to raise, as shown in FIG. **5**, raising the friction ring **9** from contact with the sheet material. The sheet material may thus be transported in the conventional manner by the feed dog **4** in sliding contact with the throat plate and presser plate. When the feed dog **4** reaches the end of its transport or feed stroke as shown in FIG. **3**, it lowers, as shown in FIG. **5**, so that the presser disk **5** is forced downward by the springloaded presser foot post **53** and the friction ring **9** is pressed in friction contact with the material. At this point as shown in FIG. **5**, the sewing machine needle has begun its stitching stroke and begins to pierce the material. Rotation of the friction ring **9** will thus cause the material by differential friction to slide in contact with the throat plate and pivot about the needle **2**, steering and guiding the material so as to direct the stitching toward the edge. This change in the course of feed by rotating the material about the needle duplicates manual manipulation and guiding. The rotary guiding motion will continue throughout the stitching stroke and will only be interrupted when the feed dog again begins its feed or transport stroke and again raises the presser disk **5** so that the friction ring is out of contact with the material.

The actuation of the servo motor **18** so as to rotate the ring **8** and friction ring **9** in a clockwise direction will continue until the edge of the material again bisects the light spot **35** so that the amount of reflected light striking the photoresistor **37** is just sufficient so that the voltage in the line **44** again equals the reference voltage from the line **48** at which point there will no longer be an output signal from the amplifier **45** and the servo motor will not be actuated.

If the edge of the material moves out of line in the opposite direction so that the stitch line is too close to the edge, the amount of reflected light will increase causing a decrease in the resistance of the element **37**, and increase in the collector emitter transistor current of the transistor **41**, and an increase in the current flowing through the line **42**, with an increase voltage drop over the resistance **43** and thus a decrease in the signal voltage passing through the line **44**. With this decrease in signal voltage, the input of the reference voltage through the line **48** will exceed the signal voltage thus causing the amplifier **45** to produce a negative voltage which is converted by the chopper **46** to an AC signal 270° out of phase with the drive voltage of the servo motor **18**. This AC signal amplified by the amplifier **47** is fed as the control phase to the servo motor **18** causing rotation in the opposite direction which in turn rotates the friction disk **9** counterclockwise directing the stitch line away from the edge.

Not only is the direction of rotation of the servo motor **18** controlled in dependence on the signal voltage exceeding or falling below the reference voltage fed to the amplifier **45**, but the amplitude of the control phase signal varies with the magnitude of this difference so that the speed of the servo motor will increase in proportion to the variation of the reflected signal from its zero or null value. Thus, when the entire edge of the material covers the light spot **35**, the difference will be at a maximum and the motor speed at its greatest. In the same manner when the entire edge is out of the light spot, the difference will be at a maximum on the other side of the null or zero value and the motor speed at a maximum in the opposite direction.

The tachometer damper **51** will tend to slow the motor down after it has reached its maximum speed and when it is thus again moving the material so that it is approaching the desired position and will tend to prevent overshooting and oscillations.

The edge follower in accordance with the invention will not only follow an actual edge, but will follow any line having a boundary of different reflectivity thereacross and as used herein and in the claims, an edge is intended to designate not only a physical edge, but such a visual edge.

In place of the photo resistor **37**, any photosensitive element may be used and any control circuit drive combination in which the direction of drive is reversed when the sensed reflective light value exceeds or falls below a predetermined value. Thus, a simple photosensitive cell may be used to receive the reflected light from the area of the edge and the light generated electrical signal may be used to control the motor or drive so that the drive is reversed as the signal exceeds or falls below a predetermined value, the value being determined by the signal produced when the edge is in its desired position.

In place of an AC servo motor any known or conventional reversible drive may be used or the drive may be magnetically or hydraulically reversed, the reversal controlled by the signal as described. The edge sensor may be used for controlling the drive of any known or conventional guiding arrangement.

In the same manner, the guiding arrangement in accordance with the invention need not be controlled by the edge sensor as described, but may be controlled in any other desired manner. Thus for example, the same may be used in connection with any known or conventional edge sensor or control device. For example, the servo motor may be driven by a programming device so that the machine will follow prearranged programmed patterns. The program signals may be on magnetic tape, punch tape, or the like. The device may also be programmed in conjunction with a stitch counter so as to follow a course or pattern dependent on the number of stitches so that, for example, increments of rotation are imparted to the servo motor **18** in sequence after predetermined numbers of stitches have been sewn by the machine.

The device may also be controlled mechanically, as for example, through a cam actuated drive which rotates the ring gear **8**, or mechanically guided by a mechanical follower, as for example, which follows the edge and mechanically, hydraulically or electrically causes rotation of the ring gear **8** in accordance with variations of its position.

If the device is to be used with a walking needle type sewing machine, i.e., a sewing machine in which the feed dogs move on their feed stroke at the same time that the needle pierces the material on its sewing stroke with the needle and generally the presser foot moving or "walking" along with the feed dogs, then a sufficiently large opening or slot should be provided in the presser plate to allow for this walking movement of the needle. When the presser foot of the machine also moves or "walks," the presser disk cannot be attached to the presser foot shaft, but should be secured to the machine so that it will not be imparted any linear motion and will only be provided the rotary motion required. Most preferably with this form of machine the presser plate is in the form of an annular ring surrounding the walking needle and presser foot of the sewing machine. This annular presser plate is reciprocated up and down by a mechanical connection to the sewing machine drive effecting its down stroke in gripping engagement when the needle of the machine is retracted, and effecting its up-release stroke when the needle of the machine penetrates the fabric, and is maintained in this released position until the needle and feed dogs complete their walking motion.

While the device has been shown in combination with a sewing machine, the same may be used in connection with any other device in connection with which sheet material is fed over a work surface past a work point and in connection with which the material should be guided through the work point. Thus, the device may be used in connection with skiving machines for leather, engraving machines, marking machines, perforating machines, riveting machines, cutting devices, nibblers for leather or sheet metal, embossing machines, or the like.

In place of the friction ring **9**, any other gripping device may be used, as for example, pins, dogs, or the like, which may be actuated in synchronization with the feed so as to intermittently move or retract out of gripping engagement on the feed stroke. When used in conjunction with a continuous feed machine, the gripping means should be such as to provide sufficient grip on the material to impart rotary motion thereof, without interfering with the feeding action. Thus, the gripping means may be in the form of a friction ring which provides sufficient friction between it and the material to rotate the material while allowing sliding actuation in the feed direction.

When two overlapping pieces of sheet material are being fed, care should be taken that the gripping device will not solely grip the top piece and move the same relative to the lower piece. If this is likely to occur and it is not possible to at least temporarily secure the two sheets together, a gripping arrangement may be provided which will simultaneously grip both sheets. Thus, in connection with fabric and other sheet material which is easily perforated the gripping means may be in the form of pins which will penetrate the upper sheet into gripping engagement with the lower sheet.

FIGS. **7**, **8** and **9** illustrate four additional embodiments of this invention, namely: (1) the rotatable gripping means is mounted from the head of sewing machine independently of the presser foot, (2) a floating ring is placed in the throat plate opposed to the annular gripping means to assist the rotational movement of the material being processed over the throat plate, (3) the contrast plate is adapted for "right" or "left" positioning, and (4) fluid actuated-lifting means associated with the throat plate are present to assist lifting of the material off the throat plate and the insertion thereunder of the contrast plate.

Referring to FIGS. **7**, **8** and **9**, a support bracket **70** is mounted to the head of a sewing machine (not shown). Through it extends the reciprocating needle shaft **71** and the presser foot shaft **72**, both of which are conventional. Opposed to the presser foot and needle is the feed dog arrangement **73**, also conventional, supported of course in a suitable throat plate **74**. The throat plate contains a floating ring **75** that is free to rotate about the axis of the needle and has a diameter and width about equal to that of the revolving gripping means or manipulator **80**, explained infra.

The optical edge sensor **77** and contrast plate **78** are supported from the support bracket **70** by means of a vertically adjustable guide **76**. The upper end of guide **76** is attached to a rotatable ring **79** within bracket **70**, that has suitable stops (not shown) so that it can be rotated 180° from the right position, illustrated, to a reverse or left position.

The manipulator or rotatable gripping means is generally indicated at **80**. A shaft **81** supports it from the head of the machine, and can raise or lower manipulator **80**, as previously described. The manipulator consists of a stationary pivot plate **82** affixed to the end of shaft **81**, a bearing ring **83**, a securing ring **84**, a gear **85**, a stiffener ring **86**, a manipulator guide segment **87**, and the manipulator ring proper **88**, all of which are held together by fastening means **89** and **90**. The manipulator is driven or controlled by gear **91** which attaches to the servomechanism, previously explained, through shaft **92**.

It can be seen that the manipulator ring **88** consists of a lower working ring **88*b*** supported by a strut which permits ring **85**–gear **91**, etc. to be positioned somewhat up and out of the way. Preferably the lower surface of the working ring **88*b*** provides a high friction area, with respect to the material being guided.

Since the manipulator is not connected to the presser foot it can operate independently of the presser foot, as might be desired with a walking needle machine, or the presser foot as such can be done away with entirely.

In operation, the manipulator **80** will usually descend and grip the fabric in conjunction with floating ring **75**, and exert its fabric guiding action during periods the needle is in the up position, free of the fabric. Because the manipulator exerts its gripping action over an area, in this case a full 360°, it is independent of any need to have the fabric restrained at a pivot point, such as about a needle penetrating the fabric as was the case with some earlier prior art machines.

Floating ring **75** is used to assist the fabric's swiveling over the throat plate. It may in some cases be slightly raised above the level of the throat plate.

Items **97** and **98** in FIG. **7** are simply hydraulic lifters that can be actuated when desired to lift the edge of the fabric being processed so that the contrast plate **78** can be inserted thereunder. A lifter rod **99** extending through a suitable clearance hole **100** is illustrated.

FIGS. **10**, **11** and **12** illustrate another embodiment of the invention wherein the manipulator is inverted and associated with the throat plate, which means that a lesser number of operating pieces have to be associated with the head and the work area is less obstructed.

The head of the sewing machine is generally indicated at **110** and dependent from it is the needle shaft, **111** and the optical edge sensor **112**, which need not be further explained.

Since the manipulator ring, **115** is in the throat plate **116**, it is desirable to have a rotatable floating ring positioned on the upper side of the fabric being worked on to urge the fabric against the manipulator during the periods it is to exert its guiding action. To this end, a floating ring **113**, about the presser foot **112**, is positioned from the head of the machine by means of a reciprocating shaft **114**, the driving mechanism for which while illustrated, need not be explained. The floating ring is loosely rotatably mounted on a bracket **118** which in turn is clamped to shaft **114**. The under side of floating ring **113** can have a resilient material **113*a*** affixed thereto, such as a sponge for accommodating variation in thickness of material, although this is not necessary. The floating ring **113**–**113*a*** serves to urge the material into pressing engagement with the manipulator ring **115**. Preferably the upper surface of the manipulator ring **115** provides a high friction area, with respect to the material being guided.

Since the periodic gripping action effected between the floating ring **113** and manipulator **115** for guiding the material results from the downward pressing action of the reciprocating floating ring **113**, it is not necessary for the manipulator **115** to reciprocate as in the earlier embodiments. A gear ring **119**, suitably and simply mounted in throat **116** and attached to the manipulator ring **115**, can be driven by a drive gear **120** associated with the servomechanism or control means.

With particular reference to FIGS. **11** and **12**, the floating ring **113** is shown in greater detail. The bracket **118** supports three supporting grooved nylon bearings **125** which hold in their grooves ring **113** for free rotation. Presser foot **112** is located below and free of ring **113**, with its supporting shaft **126** extending through the opening in bracket **118**. As in the embodiment shown in FIG. **7**, with some types of sewing machine designs, presser foot **112** can be eliminated.

It can be appreciated that instead of using an edge sensor to control the course of the fabric through the machine, the servo mechanism or controller can just as well be programmed to direct the fabric along a predetermined path. For example, in the manufacture of sails the apparatus of this invention can be used to mark out on the sailcloth a predetermined pattern. A programmed computer can be used to control the action of the manipulator to scribe or mark the complicated contours of each piece of the sail on a bolt of sailcloth rather than using the conventional method of lofting the design by hand.

Thus, with reference to FIG. **7**, a servo mechanism **218**, similar to item **18** of FIG. **1**, can be used to drive shaft **92**.

Servo 218 can be a DC mechanism, which usually is more sensitive, and chopper 46 of FIG. 6 can therefore by eliminated. The servo mechanism can be controlled by a computer-controller 200 that is programmed as by punched tape or magnetic tape to cause the manipulator 80 to undergo a predetermined series of movements in conjunction with or independently of the use of an edge sensor. Controller 200 could also embody the equivalent of a stitch-counter so that after a predetermined number of stitches had been made, the manipulator 80 would alter the course of the material through the machine.

It will be appreciated that the particular edge sensor described in conjunction with FIG. 1 can be replaced with other sensing means. For example, a photoelectric cell can be placed on one side of the material and a light source on the other, and the fiber optic bundle and the reflectance plate can be done away with. The position of the edge of the material would then directly affect the amount of light falling on the photoelectric cell.

Having described this invention, what is sought to be protected by Letters Patent is succinctly set forth in the following claims.

I claim:

1. In combination with a sewing machine having a throat plate, a reciprocating needle and a synchronized feed dog; a presser plate mounted opposed said throat plate for the passing of material to be sewn between it and said throat plate, gripping means connected to said presser plate and mounted for at least limited rotary motion about substantially the axis of said needle, means for intermittently actuating said gripping means in holding contact with material being passed between said presser and throat plate in synchronization with stitching action of said needle, and means for imparting rotary movement to said gripping means to vary the course of material being passed through the sewing machine.

2. Combination according to claim 1 in which said gripping means comprises a friction surface at a peripheral portion of said presser plate, allowing gripping action by differential friction, said presser plate being mounted for limited axial movement toward and away from said throat plate, and in which said means for intermittently actuating said gripping means is means for axially moving said presser plate.

3. Combination according to claim 2 in which said presser plate is resiliently biased against said throat plate for the gripping of material passed through the machine by said friction surface and is mounted to be axially forced away from said throat plate by said feed dog upon its intermittent feed actuation, whereby the gripping action of said friction surface is released.

4. Combination according to claim 3 in which said presser plate is in the form of a disk having an annular friction ring rotatably mounted about its periphery and extending past the plane on its surface, said friction ring comprising said gripping means.

5. Combination according to claim 4 in which said means for imparting rotary movement to said gripping means comprises a servo motor.

6. Combination according to claim 5 in which said friction rings is coaxially connected to a ring gear driven by said servo motor.

7. Combination according to claim 6 including edge sensing means controlling said servo motor.

8. Combination according to claim 7 in which said edge sensing means comprises an optical edge sensor having photosensitive means for receiving reflected light signals from a narrow area along the path of material travel through the machine, and means for actuating said servo motor for rotation in one direction when the intensity of the reflected light signal received by said photosensitive means exceeds a predetermined value and in the opposite direction when the intensity of the received reflected light signal is below said value.

9. Combination according to claim 8 in which said photosensitive means is connected for receiving reflected light signals from a narrow area adjacent the sewing machine needle and includes means for illuminating said area.

10. Combination according to claim 9, including a fiber optic cable terminating adjacent said area, a portion of the fibers of said cable leading to said photosensitive means, a further portion leading to a light source for illuminating said area.

11. Combination according to claim 10 including a contrast plate connected to said presser plate and positioned to extend under the edge of material passing through said area.

12. Combination according to claim 11 in which said area immediately precedes the sewing machine needle along a path of travel of material through the machine.

13. Combination according to claim 12 in which said friction ring is a rubber ring allowing gripping action by differential friction.

14. Combination according to claim 13 in which said photosensitive means is a photoresistor connected in a circuit producing a signal voltage varying with change in the resistance of said photoresistor and including means for driving said servo motor in one direction at a speed increasing with an increase in said signal voltage when said voltage exceeds a predetermined null value, and in the opposite direction at a speed increasing with a decrease in signal voltage when said voltage is below said null value and including speed control dampening means for said motor.

15. A device for guiding sheet material past a work point comprising a work surface, transporting means for feeding a material over the work surface past the work point, a presser plate positioned opposed the work surface for the passage of the sheet material between it and the work surface, gripping means connected to said presser plate and mounted for at least limited rotary motion about an axis substantially extending through said work point, said gripping means being selectively adapted for holding engagement with sheet material during rotary movement thereof without substantially impeding action of said transporting means and means for imparting rotary movement to said gripping means to vary the course of the sheet material.

16. Device according to claim 15 in which said gripping means comprises a friction surface at a peripheral portion of said presser plate allowing gripping action by differential friction.

17. Device according to claim 16 in which said presser plate is in the form of a disk having an annular friction ring rotatably mounted about its periphery and extending past the plane of its surface.

18. Device according to claim 17 including an edge sensor controlling said means for imparting rotary movement to said gripping means.

19. Device according to claim 18 in which said edge sensing means comprises an optical edge sensor having photosensitive means for receiving reflected light signals from a narrow area along the path of sheet material travel over the work surface and means for rotating said friction ring in one direction when the intensity of the reflected light signal received by said photosensitive means exceeds a predetermined value and in the opposite direction when the intensity of the received reflected light signal is below said value.

20. Device according to claim 19 including a fiver optic cable terminating adjacent said area a portion of the fibers of said cable being connected to said photosensitive means, a further portion being connected to a light source for illuminating said area.

21. Device according to claim 15 including an edge sensor controlling said means for imparting rotary movement to said gripping means, said edge sensor comprising an optical edge sensor having photosensitive means for receiving reflected light signals from a narrow area along the path of sheet material travel over the work surface and means for controlling said means for imparting rotary movement to said gripping means

for rotation in one direction when the intensity of the reflected light signal received by said photosensitive means exceeds a predetermined value and in the opposite direction when the intensity of the received reflected light signal is below said value.

22. Device according to claim 21 including a fiber optic cable terminating adjacent said area a portion of the fibers of said cable being connected to said photosensitive means, a further portion being connected to a light source for illuminating said area.

23. Device according to claim 22 in which said photosensitive means is a photo resistor connected in a circuit producing a signal voltage varying with change in the resistance of said photoresistor said means for imparting rotary movement to said gripping means comprising a servo motor and including means for driving said servo motor in one direction at a speed increasing with an increase in said signal voltage when said signal voltage exceeds a predetermined null value and in the opposite direction at a speed increasing with a decrease in said signal voltage when said voltage is below said null value and including speed controlled dampening means for said motor.

24. Material feed guide system for use with a sewing machine having a throat plate, a reciprocating needle which intermittently moves toward the throat plate to pierce the material thereon during the stitching strokes of the needle and a synchronized feed dog which intermittently advances the material during the transport strokes of the feed dog, said material feed guide system comprising rotatable gripping means, support means, mounting said gripping means in opposed relationship with the throat plate to enable the material to be fed between said gripping means and said throat plate, said gripping means being movable toward and away from said throat plate for intermittently engaging the material in holding contact with the material against the throat plate, actuating means for intermittently actuating said gripping means into said holding contact with the material, said actuating means operating in synchronized relationship with the needle and feed dog, and means for imparting rotary movement to said gripping means to turn the material about the axis of the needle when said gripping means is in holding contact with the material against the throat plate to thereby guide the material being sewn.

25. Material feed guide system according to claim 24 wherein the feed dog and needle alternately come in contact with the material for alternately transporting the material, then piercing the material in the stitching stroke, then transporting the material, then again piercing the material in the stitching stroke, and so forth, said material feed guide system having actuating means which intermittently actuates said gripping means into holding contact with the material during the stitching strokes to turn the material about the axis of the needle while the needle is in piercing engagement with the material.

26. Material feed guide system according to claim 24 for use with a walking needle sewing machine wherein the needle and feed dog simultaneously come in contact with the material for transporting the material during the stitching strokes, said material feed guide system having actuating means which actuates said gripping means between the stitching strokes to turn the material relative to the axis of the needle while the needle and feed dog are withdrawn from the material.

27. Material feed guide system for automatically stitching along an edge of material for use with a sewing machine having a throat plate, a reciprocating needle which intermittently moves toward the throat plate to pierce the material thereon during the stitching strokes of the needle and a synchronized feed dog which intermittently advances the material during the transport strokes of the feed dog, said material feed guide system comprising rotatable gripping means, support means, mounting said gripping means in opposed relationship with the throat plate for allowing the material to be fed between said gripping means and said throat plate, said gripping means being movable toward and away from said throat plate for intermittently engaging the material in holding engagement with the material in slidable contact with the throat plate, the gripping engagement of said gripping means exerting a greater frictional force on the material than does the throat plate, actuating means for intermittently actuating said gripping means into holding engagement with the material, said actuating means being in synchronized relationship with the needle and feed dog, a servo motor connected to said gripping means for rotating said gripping means, edge means for sensing the position of the edge of the material relative a null position with respect to the axis of the needle, control means responsive to said edge sensing means for actuating said servo motor for rotating said gripping means in one direction when the edge of the material is displaced in one direction relative to the null position and for rotating said gripping means in the opposite direction when the edge of the material is displaced in the opposite direction relative to the null position to turn the material in sliding contact with the throat plate relative to the axis of the needle for guiding the material to automatically stitch along said edge.

28. Material feed guide system for automatically stitching along an edge of the material as claimed in claim 27 in which said edge sensing means continuously senses the position of the edge of the material relative to the null position and said control means is responsive to said edge sensing means for actuating said servo motor whenever the edge of the material is displaced from the null position for rotating said gripping means while said gripping means is intermittently in holding engagement with the material intermittently to turn the material in sliding contact with the throat plate relative to the axis of the needle thereby to steer the material with control means being effectively continuous in operation while the rotatable gripping means intermittently engages the material.

29. Material feed guide system for guiding sheet material past a work point comprising a work surface, transporting means feeding the sheet material over the work surface past the work point, rotatable gripping means, support means mounting said gripping means in opposed relationship with said work surface for the material to be fed between said gripping means and said work surface, said gripping means being movable toward and away from said work surface for intermittently engaging the material in holding contact, actuating means for intermittently actuating said gripping means into holding contact with the material, and means for imparting rotary movement to said gripping means to turn the material in sliding contact with the work surface about the work point to steer the course of the material past the work point.

30. In combination with a sewing machine having a throat plate defining a working area, a needle, means for reciprocating said needle between a work engaging position and a retracked position and a feed dog means for intermittently moving said feed dog from a retracked position, means for synchronizing the actuation of said needle reciprocating means and said feed dog actuating means to feed the work when the needle is in said retracked position, manipulator means mounted for at least limited rotary motion about said needle, means intermittently causing said manipulator means to engage material being passed over said working area and being synchronized with means for reciprocating said needle, and means for imparting a controlled rotary movement to said manipulator means when in engagement with the material to vary the course of material being passed through the sewing machine, said manipulator means being capable of causing rotation of said material independently of any pivotal fixing of said material at a point and comprising a friction surface above said throat plate and cooperating therewith to effect a guidance action by differential friction, means mounting said manipulator means for limited axial movement toward and away from said throat plate.

31. A sewing machine having a needle, means mounting said needle on said sewing machine for reciprocation between a work engaging position and a retracted position, a throat

plate defining a smooth work surface and a work area for said needle, manipulator means adapted to intermittently hold material to be sewn over an area thereof and to control the course of said material through said sewing machine and being synchronized with the means for reciprocating said needle, and a surface element, means rotatably mounting said surface element in mating relationship with said manipulator means, said surface element being adapted to pressurely contact the other side of said material when said manipulator means is exerting its action thereon and to allow rotation of said manipulator means and said surface element in unison, said machine including a pressure foot encompassed by said manipulator means but independent thereof, said manipulator means comprising a ring with a frictional undersurface mounted from above on said machine from a support member and adapted for controlled rotary motion, said surface element being a portion of said work surface.

32. In combination with a sewing machine having a throat plate defining a working area, a needle, means mounting said needle on said sewing machine for reciprocation between a work engaging position and a retracked position, and a feed dog synchronized to feed when said needle is in said retracked position, manipulator means mounted for at least limited rotary motion about said needle and adapted to engage material being passed over said working area, said manipulator means being synchronized with the stitching action of said needle, and means for imparting a controlled rotary movement to said means to vary the course of material being passed through the sewing machine, said manipulator means being capable of causing rotation of said material independently of any pivotal fixing of said material at a point and means resiliently biasing said manipulator means against said throat plate for the gripping of said material and being mounted to be axially forced away from said throat plate intermittently by said feed dog whereby the gripping action of said friction surface is released.

33. A sewing machine having a needle, means mounting said needle on said sewing machine for reciprocation between a work engaging position and a retracted position, a throat plate defining a smooth work surface and a work area for said needle, manipulator means adapted to intermittently hold material to be sewn over an area thereof and to control the course of said material through said sewing machine and being synchronized with the means for reciprocating said needle, and a surface element, means rotatably mounting said surface element in mating relationship with said manipulator means, said surface element being adapted to pressurely contact the other side of said material when said manipulator means is exerting its action thereon and to allow rotation of said manipulator means and said surface element in unison, said machine having an optical edge sensor and control unit for controlling the action of said manipulator means and a contrast plate adapted to extend under the edge of material being passed through said work area, said contrast plate being mounted on said machine independently of said manipulator means and being adapted (a) to be rotated from a right to a left work position and (b) to be inserted under the edge of the upper layer of material when more than one layer of material is being processed.

34. In a device adapted to guide sheet material over a work surface having a work surface including a work point and having transporting means for feeding sheet material over the work surface past said work point, the improvement comprising:

manipulator means mounted for at least limited rotary motion substantially about an axis extending through said work point, said manipulator means being positioned to make guiding contact with said sheet material during rotary movement thereof without substantially impeding the action of said transporting means, means for imparting a predetermined rotary movement to said manipulator means to guide the course of the sheet material past said work point, and a presser plate, means mounting said presser plate opposed to said work surface, said manipulator means comprising an annular friction ring and means connecting said annular friction ring about its periphery on said presser plate for rotation about the axis of said work point.

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