United States Patent [19]

Pearl

[11] **3,766,813**

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[54] **METHODS FOR CUTTING SHARP CORNERS AND NOTCHES IN LAYUPS OF FABRIC AND OTHER SHEET MATERIAL**

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[73] Assignee: **Gerber Garment Technology, Inc.,** East Hartford, Conn.

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[21] Appl. No.: **169,264**

[52] **U.S. Cl.** ..... **83/56,** 83/561, 83/917, 83/925 CC

[51] **Int. Cl.** **B26d 3/14,** B26d 1/10

[58] **Field of Search** ..... 83/34, 56, 561, 562, 83/427, 428, 925 CC, 917; 30/272, 273, 275

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Primary Examiner—J. M. Meister

Attorney—Roger B. McCormick et al.

[57] **ABSTRACT**

A layup of sheet material is cut by a cutter having a reciprocating cutting blade with a sharp forward cutting edge. During cutting along a given line of cut the cutting blade extends through the layup during at least a portion of each of its strokes, and when a sharp corner or notch point is reached the blade is rotated while remaining in cutting engagement with the layup to turn the corner or to cut the notch without the blade being first withdrawn from the material or without being moved through a path departing from the desired line of cut.

6 Claims, 22 Drawing Figures

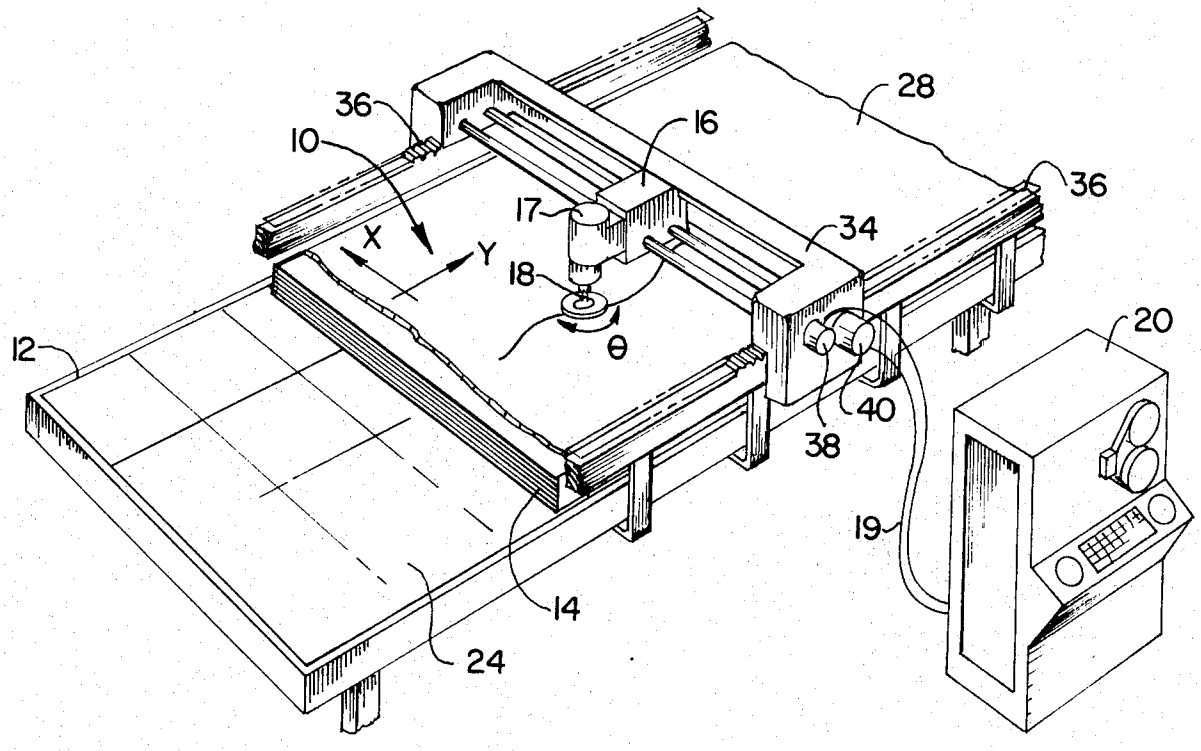


FIG. 1

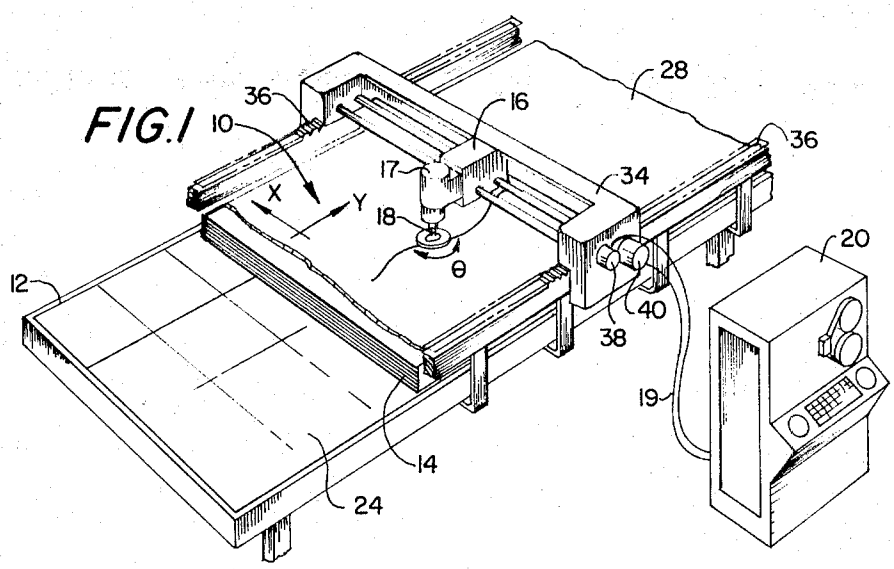


FIG. 2

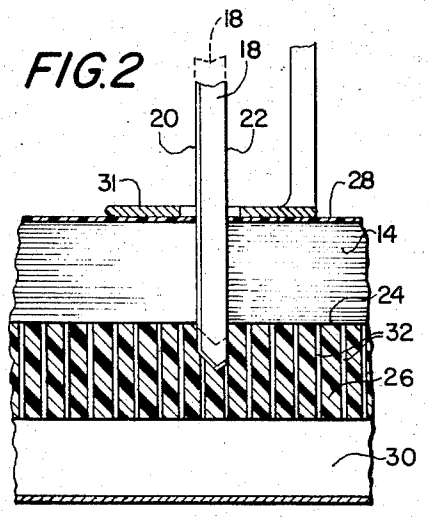
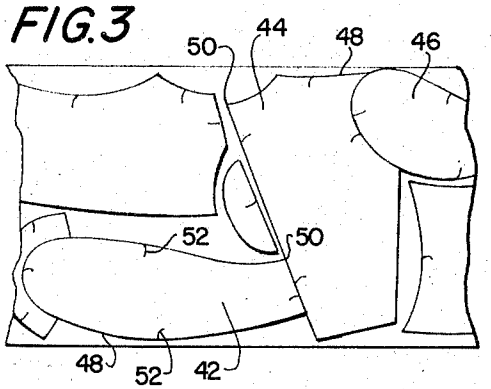


FIG. 3



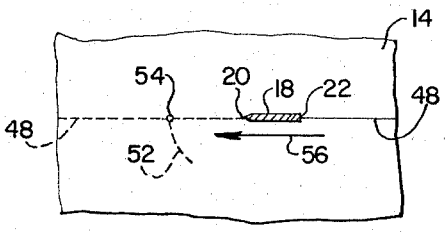


FIG. 4A

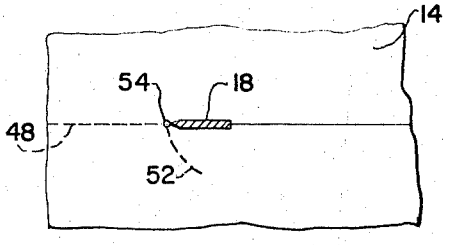


FIG. 4B

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FIG. 4C

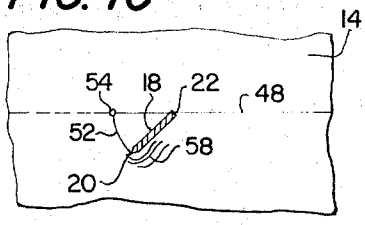


FIG. 4D

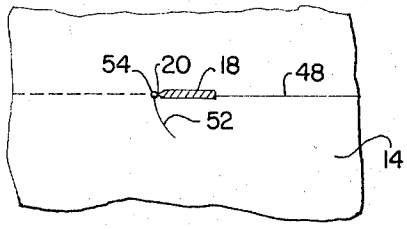


FIG. 4E

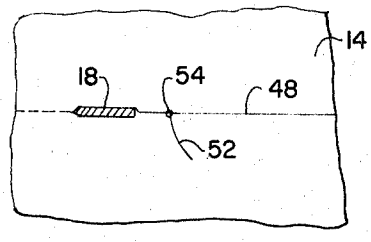


FIG. 5A

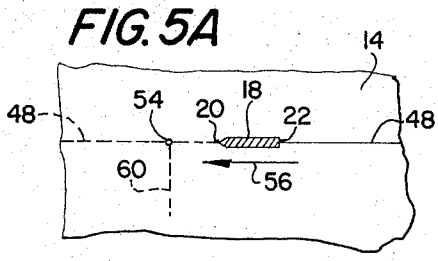


FIG. 5B

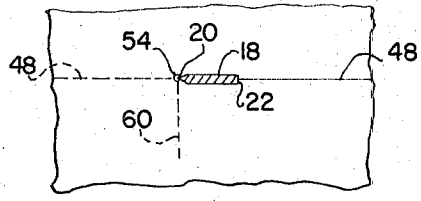


FIG. 5C

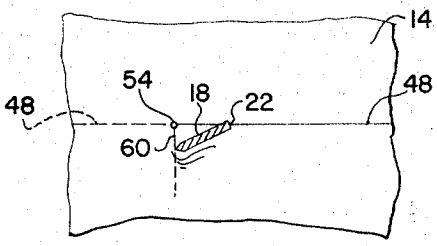


FIG. 5D

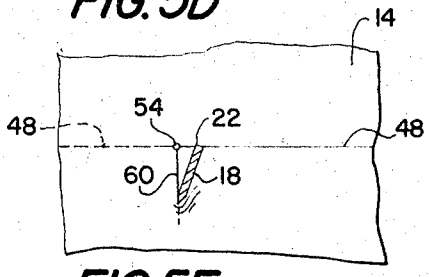


FIG. 5E

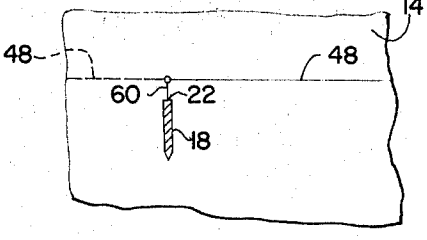


FIG. 5F

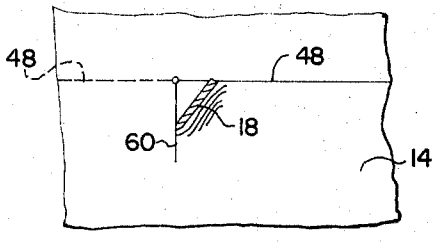


FIG. 5G

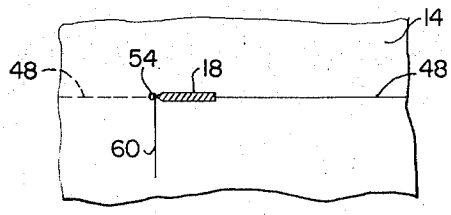


FIG. 5H

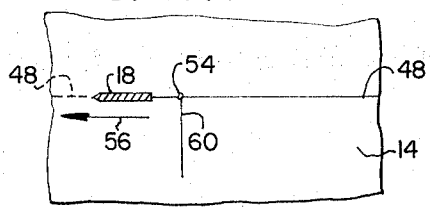


FIG. 6A

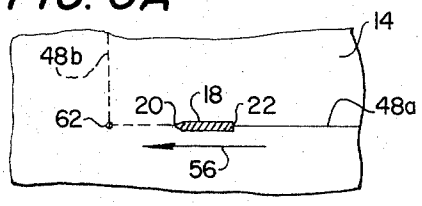


FIG. 6B

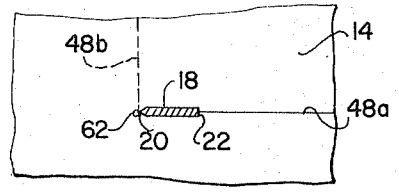


FIG. 6C

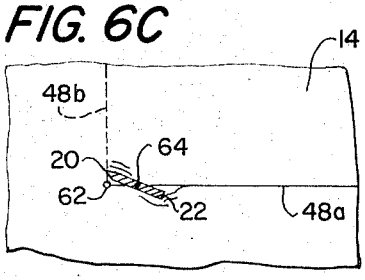


FIG. 6D

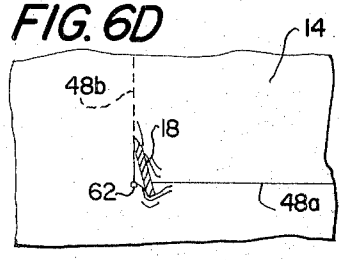


FIG. 6E

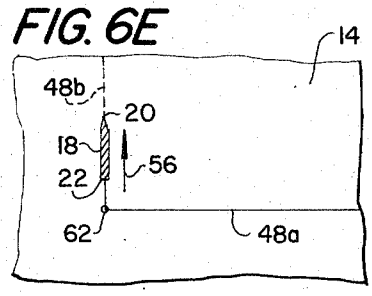
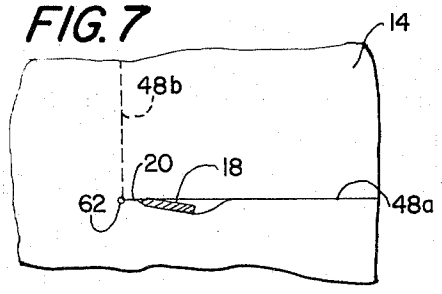


FIG. 7



METHODS FOR CUTTING SHARP CORNERS AND NOTCHES IN LAYUPS OF FABRIC AND OTHER SHEET MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to methods for use in cutting layups of sheet material by means of a cutter having a reciprocating cutter blade, and deals more particularly with such methods involving the cutting of layups along a desired line of cut including two line segments which meet at a relatively sharp corner which sharp corner may be a corner formed by two segments of the principal line of cut or a corner defined by the intersection of the principal line of cut with a marking notch.

In the cutting of fabrics and other sheet material to produce pieces for garments, upholstery and the like it is well known to lay up a number of layers of sheet material on a cutting table and to then cut all of the layers simultaneously by means of a cutter having a reciprocating cutting blade which during cutting extends entirely through the layup during at least a portion of each of its reciprocating strokes. The pieces cut from the layup are defined by principal lines of cut which quite often include one or more relatively sharp corners. The cutting blade has a sharp forward cutting edge and usually has a substantial front to rear dimension. Because of this substantial front to rear blade dimension it has been customary in the past when reaching a sharp corner to move the blade along a subsidiary path, departing from the line of cut and passing through a waste region of the layup or through a free area beyond the bounds of the layup, throughout which subsidiary path the blade is turned so that when it again approaches the corner it is aligned with the line of cut on the departing side of the corner. This not only requires the existence of some waste or free area adjacent each corner to allow for the maneuvering of the blade, but also is a time-consuming procedure. As an alternative, in cases where the cutting blade is of the cantilever type when reaching a corner the blade may be withdrawn from the material, rotated outside of the material, and then plunged back into the material at the corner point with the blade now oriented to follow the line of cut away from the corner. This eliminates the need for providing a waste or free area adjacent the corner but is still a time-consuming procedure.

In the cutting of pattern pieces from layups of sheet material, it is also often desired to produce marking or index notches, at various points along the principal desired line of cut, these marking notches being later used, for example, to align various different pattern pieces relative to one another in preparation for a sewing operation or the like. Generally the marking notches are relatively short lines or slits which are cut into the material generally perpendicularly to the principal line of cut. The problems involved in cutting these notches are substantially the same as those involved in cutting sharp corners, and in the past notches have usually been cut by maneuvering the cutting blade, outside of the pattern piece, to bring it into proper orientation for cutting a notch before it is moved inwardly of the piece beyond the principal line of cut to produce the notch. This may be done by either cutting the notch immediately upon reaching the notch point or by cutting along the principal line of cut past the notch point and later returning to cut the notch. Both procedures, however, involve a substantial amount of maneuvering of the blade and a substantial consumption of time. Furthermore, where two pattern pieces share a common boundary line it is usually impossible to cut a marking notch into either of such pieces without first entirely cutting at least one of the pieces from the layup and shifting it relative to the other piece so as to provide free space for manuevering the blade.

The general object of this invention, therefore, is to provide improved methods of cutting sharp corners and notches in layups of fabric and other sheet material whereby the necessity of allowing waste or free areas near sharp corners and common boundary lines is eliminated thereby allowing the pattern pieces to be laid out closer to one another with a resulting economy of material. A related object is to provide such methods whereby the time required for cutting sharp corners and notches is minimized. A more specific object of the invention is to provide a method for cutting notches substantially "on the fly" as the cutting blade is moved along a principal line of cut by merely momentarily rotating or flicking the blade away from the line of cut to swing its cutting edge into the pattern piece.

SUMMARY OF THE INVENTION

This invention resides in a method for cutting a sharp corner or a notch in a layup of sheet material by means of a cutter having a reciprocating cutting blade with a sharp forward edge and a rear edge spaced a substantial distance rearwardly from the sharp edge. During the cutting of the layup along a desired line of cut the blade is maintained at a fundamental cutting height relative to the layup, whereat it extends entirely through the layup during at least a portion of each stroke, and it is reciprocated and moved forwardly along the line. When a corner or notch point is reached the reciprocation of the blade is continued and the blade is maintained at its fundamental cutting height. The blade is further rotated about an axis parallel to the cutting edge in such a direction as to move the cutting edge away from the corner or notch point along the desired line of cut departing from such corner or notch point. In the case where the line departing from the corner or notch point is a straight line the blade is also advanced relative to the layup to cause the cutting edge of the blade to follow the desired straight line. In the case of cutting a notch the cutting edge of the blade is returned to the notch point after the notch line is cut and the blade is then again advanced forwardly away from the notch point along the principal line of cut. Preferably, when cutting a notch the rotational axis of the blade is held stationary relative to the layup as it is rotated so that the cutting edge cuts the material along a curved notch line.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary perspective view of a sheet material cutting apparatus with which the method of this invention may be used.

FIG. 2 is an enlarged fragmentary vertical sectional view taken through the layup of FIG. 1 in the vicinity of the cutting blade.

FIG. 3 is a fragmentary top view of a portion of the layup of FIG. 1 showing a number of pattern pieces to be cut therefrom.

FIGS. 4A to 4E are views showing progressively the movement of the blade of FIG. 1 as it cuts a notch in accordance with one embodiment of this invention.

FIGS. 5A to 5H are a series of views showing progressively the movement of the blade of the apparatus of FIG. 1 as it cuts a notch in accordance with another embodiment of this invention.

FIGS. 6A to 6E are a series of views which progressively show the movement of the blade of FIG. 1 as it cuts a corner in accordance with one embodiment of this invention.

FIG. 7 is a view showing the position of the blade of the apparatus of FIG. 1 at one point in its movement at it cuts a corner in accordance with still another embodiment of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1 a sheet material cutting apparatus of the type with which this invention may be used is indicated generally at **10** and consists of a table **12** providing support for a layup **14** comprising a plurality of sheets of fabric or other material arranged in vertically stacked relation. A carriage indicated generally at **16** is supported by the table for traversing the surface thereof in two coordinate directions as indicated by the arrows X and Y. A cutter **17** having a cutting tool in the form of a blade **18** is mounted on the carriage **16** so that it can be driven to and from any predetermined point relative to the table surface in response to position signals supplied to the apparatus through the cable **19** from an associated source such as, for example, a numerically controlled controller or computer **20.** The carriage **16** is capable of moving the blade **18** in cutting engagement with the layup **14** along any desired line which may be either straight or curved as required in cutting a garment or upholstery component or the like. The blade **18** has a reciprocating cutting stroke and is capable of being rotated, by positioning signals from the controller **20,** about a vertical axis, perpendicular to the generally horizontal layup **14,** as indicated by the arrow θ.

The blade **18** may be moved from a fundamental cutting height to a fundamental withdrawn height relative to the layup **14.** At the cutting height the blade during at least a portion of each stroke penetrates entirely through the material so that all the layers of the material are cut as the blade is advanced forwardly along a given line of cut. At its withdrawn height, the blade throughout its entire stroke is located above the material so that it may be moved to any point on the layup without cutting the layup during such movement. FIG. **2** shows the blade **18** in its fundamental cutting position, the solid lines showing it at the bottom of its stroke and the broken lines showing it at the top of its stroke. As shown in FIG. **2,** the blade has a sharp forward cutting edge **22** extending vertically parallel to the axis of reciprocation, and also has an unsharpened rear edge **22** located a substantial distance rearwardly from the sharp edge **20.**

The supporting surface **24** of the table **12** is made of a bed of penetrable material and the blade **18** during its reciprocation extends downardly beyond the lower layer of the layup so as to penetrate the supporting surface. The material of the layup is also preferably held in place during the cutting operation by a vacuum holddown means consisting of a sheet **28** of air-impermeable material overlying the layup and having a vacuum applied to its undersurface so that atmospheric pressure presses it and the layup toward the supporting surface. This vacuum may be applied from a vacuum chamber **30** located below the bed **26** and communicating with the layup **14** through a large number of openings, **32, 32** passing through the bed. U.S. Pat. No. 3,495,492 entitled "Apparatus for Working on Sheet Material" shows a suitable vacuum holddown system which may be used with the apparatus of FIG. **1,** and reference may be had to said patent for further details. A presser foot **31** attached to the cutter **17** may also be used in conjunction with the vacuum holddown to aid in holding the material of the layup **14** in place in the vicinity of the cutting zone.

The carriage **16** is carried by a larger main carriage indicated generally at **34** which transversely spans the table **12** and is supported at both ends by a pair of elongated racks **36, 36** on opposite sides of the table. A drive motor **38** through suitable drive mechanism drives the carriage **16** relative to the carriage **34** in the illustrated X-direction and another drive motor **48** through suitable drive mechanism drives the main carriage **34** in the Y-direction along the racks **36, 36.** Another drive motor in the cutter **17** rotates the blade about the θ axis.

Referring now to FIG. **3,** this figure shows an exemplary layout of pattern pieces to be cut from a layup of sheet material such as that shown at **14** in FIG. **1.** Several different pattern pieces are indicated by the reference numerals **42, 44** and **46.** Each of these pattern pieces is defined by a principal boundary line **48** which may include one or more sharp corners sch as indicated for example at **50, 50.** Also, along each principal line **48** may be one or more notches **52, 52** which extend inwardly a short distance from the boundary line so as to constitute essentially shallow slits in the edge of each pattern piece which may be used to later match the pattern piece with another one in making up a garment. It will be noted in FIG. **3** that the illustrated pieces **42** and **44** along parts of their lengths share a common boundary and that similarly the pieces **44** and **46** along parts of their lengths also share a common boundary. Along these common boundaries it is therefore necessary when cutting notches or sharp corners to make certain that the cutting blade does not depart from the principle line or from the notch line so as to cut an undesired line in one or the other of the neighboring pattern pieces. The methods hereinafter described for maneuvering the blade during the cutting of the pattern pieces avoids this problem and allow the sharing of common boundary lines as indicated in FIG. **3.**

In accordance with this invention the cutting blade **18** is maintained within the layup, is reciprocated, and is rotated, or rotated and advanced, when it reaches a corner or notch point so as to cuase the cutting edge of the blade to immediately follow the line departing from the corner or notch point without the blade having to first execute a turning maneuver through waste material or free space. FIGS. **4A** and **4E,** for example, show the manner in which the blade **18** is moved in cutting a notch **52** in accordance with one embodiment of this invention. In these figures the broken line **48** represents the principal line to be followed by the blade **18** and the solid line **48** represents that portion of such line already cut. Likewise, the broken line **52** represents the notch line to be cut and the solid line **52** represents such line after it is cut. The reference numeral **54** indicates the notch point at which the notch line **52** intersects the principal line **48.** FIG. **4A** shows the blade **18** as it ap-

proaches the notch point **54.** At this time, the blade **18** is at its fundamental cutting height, it is being reciprocated and it is being moved forwardly toward the notch point **54** in the direction of the arrow **56.** This activity is continued until the forward edge **20** of the blade **18** reaches the notch point **54** as shown in FIG. **4B.** When the position of FIG. **4B** is reached the movement of the blade in the plane of the layup is discontinued and then, while the blade remains at its fundamental cutting height and while its reciprocation is continued, the blade is rotated about a vertical axis to swing its cutting edge **20** away from the principal line of cut **48** and to cause it to cut along the notch line **52.** FIG. **4C** shows the blade **18** in the maximum extent of its rotation away from the principal line **48.** This rotation of the blade is accompanied by a displacement of the material on the side of the blade toward which the blade is rotated and is indicated by the wrinkles **58** in FIG. **4C.**

After the notch line **52** has been cut by rotating the blade to the FIG. **4C** position, the blade is rotated in the reverse direction to bring its cutting edge **20** back to the principal line **48** and notch point **54,** as shown in FIG. **4D.** Thereafter, the blade is again moved forwardly along the principal line **48** and away from the notch point **54** as shown in FIG. **4E.**

Throughout all of the movements represented by FIGS. **4A** to **4E,** the blade is maintained at its fundamental cutting height and is reciprocated, and it will be noted that the cutting edge **20** at no time departs from the lines desired to be cut. The method of notch cutting shown by these figures is one which allows for the cutting of the notches essentially "on the fly" since when a notch point is reached the notch may be cut very quickly by only momentarily stopping the forward advance of the blade along the principal line of cut and rotating it quickly back and forth in a fast flicking motion to execute the notch. In FIGS. **4A** to **4E** the blade **18** during its rotation is shown to be rotated about a rotational axis generally coincident with the rear edge **22.** This is preferred in that it allows a maximum depth notch with minimum radius of curvature. This is not essential, however, and if desired, the blade may be rotated about some other rotational axis located to the rear of the cutting edge.

In the notch cutting method of FIGS. **4A** to **4E** the blade is not advanced relative to the material as it is rotated, and as a consequence the notch **52** is of a curved shape as illustrated. This curved shape is usually acceptable, but in some instances it may be desired to have the notches cut along straight lines. Wen this is so the blade, in practicing the method of this invention, must be advanced as well as rotated while cutting a notch. FIGS. **5A** to **5H** show the cutting of a straight notch in accordance with another embodiment of this invention. In these figures the same reference numerals are used as in FIGS. **4A** to **4E** except that the notch is shown at **60,** in broken line form before cutting and in solid line form after cutting.

Referring to FIGS. **5A** to **5H,** FIG. **5A** shows the blade **18** as it approaches the notch point **54.** At this time the blade is at its fundamental cutting height and is reciprocated and is moved forwardly toward the notch point **54** as indicated by the arrow **56.** This activity is maintained until the cutting edge **20** of the blade reaches the notch point **54,** as shown in FIG. **5B.** As the FIG. **5B** position is reached the blade is maintained at it fundamental cutting height in the material and is continued to be reciprocated, and this maintenance of the cutting height and continuance of the reciprocation prevails throughout all of the other stages of the notch cutting procedure up to and beyond the stage represented by FIG. **5H.** At the point shown by FIG. **5B,** however, the normal forward travel along the principal line **48** is stopped and the blade is moved away from the line **48** to cut the notch **60.** Since the line of the notch **60** is straight rather than curved the notch cannot be cut merely by rotating the blade. Instead the blade is both rotated about a rotational axis parallel to the cutting edge and the rotational axis is moved in the plane of the layup to cause the cutting edge to follow the desired straight line.

In FIGS. **5A** and **5H** the rotational axis of the blade **18** is taken to be generally coincident with the rear edge **22** thereof. FIG. **5C** shows the blade **18** at a point representing a slight rotation away from the position of FIG. **5B.** Also, by comparing FIG. **5B** with FIG. **5C** it will be noted that the rear edge of the blade **22** has been moved relative to the layup **14** to a position closer to the notch point **54.** FIG. **5D** shows the blade **18** at a subsequent point whereat it has been rotated a still further distance away from the principal line **48** and whereat the rear edge of the blade **22** has been moved still closer to the notch point **54.**

FIG. **5C** shows a later position of the blade **18** at which it has been rotated to the point at which its rear edge **22** is in line with the notch line **60** and moved along the notch line **60** to cut the notch to it full depth.

After the blade is moved to the full depth notch position of FIG. **5E** it is then returned in a reverse manner to bring the cutting edge back to the notch point and the blade is then again advanced along the principal line **48** in the normal manner. FIG. **5F** shows the blade **18** returned partway to the notch point **54** and FIG. **5G** shows it fully returned. FIG. **5H** shows it after being advanced in the direction of the arrow **56** beyond the notch point **54,** and this advancing movement is continued until the next notch point or corner is reached.

One advantage of the methof of notch cutting shown by FIGS. **5A** to **5H** is that it allows for the cutting of any depth notch. That is, the length of the notch may be less than, equal to or greater than the front to rear dimension of the blade. In the illustrated case the notch **60** has been shown to be made slightly longer than the blade, but it obviously could be made longer, and it could also be made shorter by stopping the illustrated notch cutting procedure at any point and returning the blade to the notch point. Also, it will be understood that the amount by which the rotational axis is advanced in response to a given increment of rotation in order to keep the cutting edge of the blade on the desired line is a matter which may be easily calculated and stored in the controller or computer **20** as part of a notch cutting routine.

The general method for notch cutting illustrated by FIGS. **5A** and **5H** may also be used in part for cutting sharp corners, if desired. That is, the cutting of the notch **60** is basically a corner cutting operation except that after the corner is turned the blade is reversed to bring it back to the notch point and is then continued on along the principal line of cut. Considering the line **60** of FIG. **5A** to be a line defining a corner with the line **48,** the movement of the blade **18** to cut the corner would involve the steps shown by FIGS. **5A** to **5E** with

the blade continuing forwardly along the line **60** after reaching the point of FIG. **5E**.

In FIGS. **4A** to **4E** and FIGS. **5A** to **5H** the blade when rotated is rotated about a rotational axis generally coincident with its rear edge so that the rear edge remains on the principal line of cut **48** during the rotation process. This in turn means that practically all of the displacment of the material of the layup which occurs to accommodate the rotation of the blade occurs in that material which lies adjacent the side of the blade towards which the blade is turned. That is, the side of the blade towards which it is turned pushes away the material and the opposite side of the blade is substantially free of engagement with the material. In some cases it may be desirable to reduce the amount of material displacement required and this may be accomplished by rotating the blade about an axis located between its cutting edge and its rear edge. Such a manner of rotation is shown in FIGS. **6A** to **6E** from which it will be noted that the displacement of the material occurs on both sides of the blade.

Referring to FIGS. **6A** and **6E**, these figures show the blade as moved to cut a sharp corner. The corner point is indicated at **62** and is defined by two segments **48***a* and **48***b* of the principal line. Throughout all of the stages illustrated the blade **18** is maintained at its fundamental cutting height and is continuously reciprocated. FIG. **6A** shows the blade **18** advancing toward the corner point **62** at which time it is moving generally in the direction of the arrow **56.** This activity is maintained until the corner point **62** is reached by the cutting edge **20** of the blade as shown in FIG. **6B**. Thereafter, the cutting blade **18** is rotated about an axis **64** located between the cutting edge **20** and rear edge **22** to cause the cutting edge **20** to swing away from the corner point **62** along the line segment **48B** and to also cause the rear edge **22** of the blade to swing outwardly away from the previously cut line segment **48A**. Therefore, both side edges of the blade push against the material of the layup and displace it to accommodate the turning movement of the blade.

Following the point shown by FIG. **6C** the blade **18** is further rotated about its rotational axis and the rotational axis is moved relative to the layup **14** to move the cutting edge **20** further forwardly along the line segment **48***b* to the point shwon at FIG. **6D**, and then to the point shown at FIG. **6E** whereat the blade **18** has both its cutting edge **20** and its rear edge **22** aligned with the line segment **48***b* and is traveling away from the corner point **62.** From FIG. **6D** it will be noted that the rotational axis **62** does not necessarily remain on the line segments **48***a* and **48***b* and the exact course which such rotational axis follows as the blade rotates may be predetermined and stored in the controller **20** as part of the corner cutting routine. It will also, of course, be understood that the corner cutting method of FIGS. **6A** to **6D** may also be used as part of a notch cutting method, the notch cutting method merely requiring that the blade **18** be returned from the position of FIG. **6E** to the line segment **48***a* and then advanced again forwardly along the line segment **48***a* assuming that the segment **48***a* extends further to the left than shown in these figures.

In all of the notch and corner cutting methods discussed above the blade **18** has been driven with its cutting edge and its rear edge in line with the desired line of cut until the notch point or corner point is reached, and no rotation of the blade occurs until this time. In some cases, however, it may be desirable to initiate rotation of the blade slightly in advance of reaching the notch point or corner point, the cutting edge, however, remaining on the desired line of cut. FIG. **7,** for example, shows this condition. In this figure, the blade **18** is approaching the corner point **62** and as it nears said point its rear edge is swung away from the line segment **48***a* to head its cutting edge **20** slightly toward the line segment **48***b*, but the rotational axis of the blade is also moved away from the line **48***a* so as to maintain the cutting edge on the line **48***a*. It will, of course, be understood that after the corner point is reached by the cutting edge **20** the blade **18** is further rotated and translated in the plane of the layup to cause the edge **20** to move away from the corner point and follow along the line segment **48***b*.

I claim:

1. A method for use in cutting a layup of sheet material by means of a cutter having a cutting blade reciprocated along an axis generally perpendicular to the layup being cut and having a forward cutting edge and a rear edge both extending generally parallel to said axis of recirporocation, said method involving the cutting of the layup along a principal line of cut and along a notch line located at a given notch point along said principal line and extending to one side thereof at a relatively sharp angle thereto, said method comprising the steps of advancing said cutting blade, with its cutting edge directed forwardly along said principal line while reciprocating it and maintaining it at a fundamental cutting height relative to said layup wherein it extends entirely through said layup during at least a portion of each stroke, when said notch point is reached rotating said blade, while continuing its reciprocation and while maintaining it at said fundamental cutting height, in such a direction as to move said cutting edge away from said notch point along said notch line, thereafter rotating said blade in the opposite direction to bring said cutting edge back to said notch point, and then again advancing said blade forwardly along said principal line away from said notch point.

2. A method as defined in claim **1** further characterized by maintaining said rear edge of said blade on said principal line during said rotation of said blade.

3. A method as defined in claim **1** further characterized by said step of rotating said blade being accomplished by rotating it about an axis located rearwardly of said cutting edge.

4. A method as defined in claim **3** further characterized by holding said axis of blade rotation stationary relative to said principal line during said rotation of said blade.

5. A method as defined in claim **4** further characterized by said axis of rotation being generally coincident with said rear edge of said blade.

6. A method as defined in claim **1** further characterized by moving said axis of rotation relative to said layup during the rotation of said blade to cause said cutting edge to follow a substantially straight notch line.

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