

[54] **FABRIC CUTTER AND METHOD**

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234/42; 83/49, 71, 215-217, 925 CC, 650, 255

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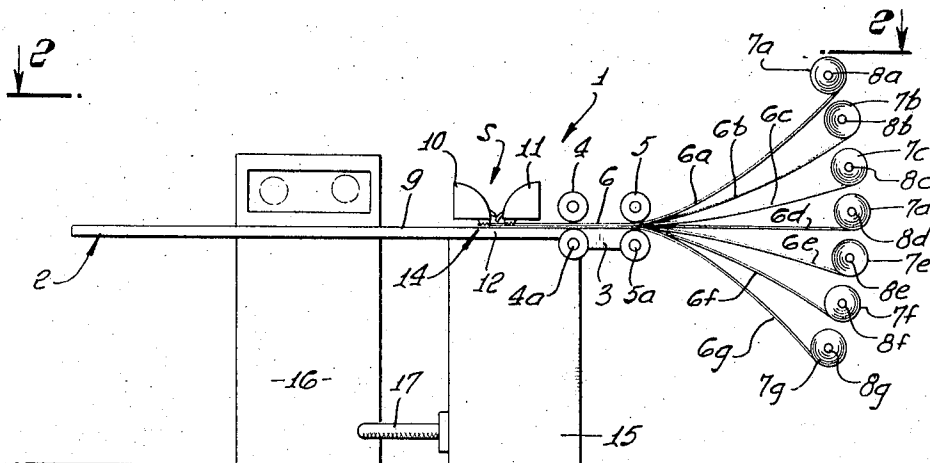
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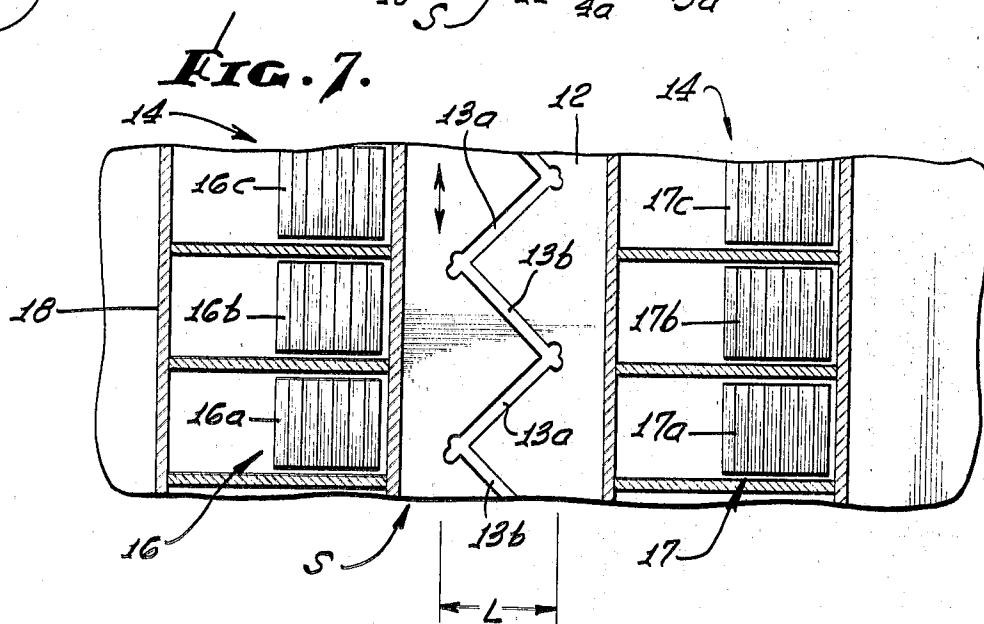
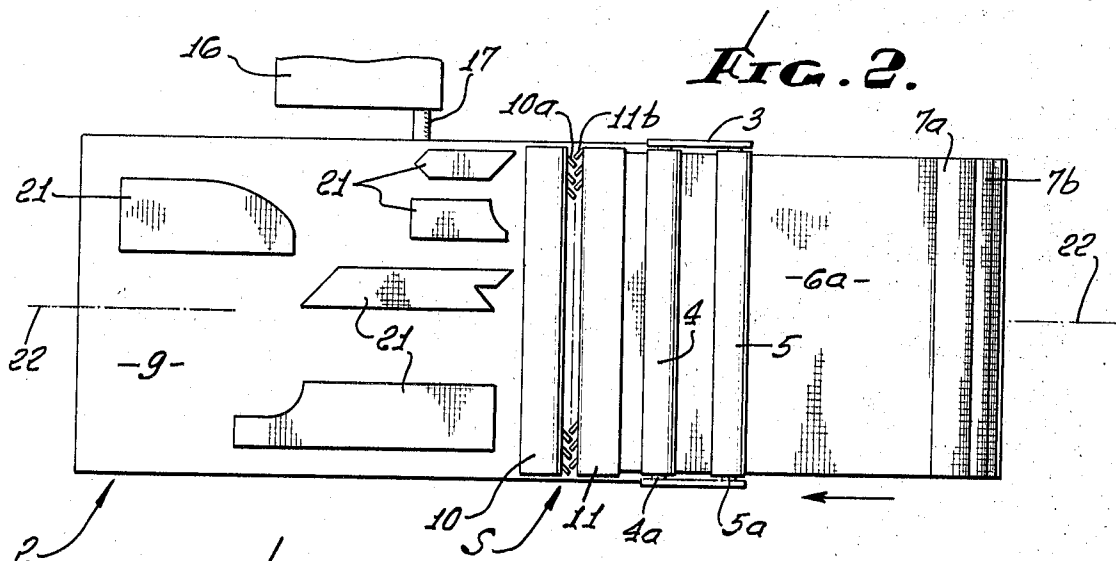
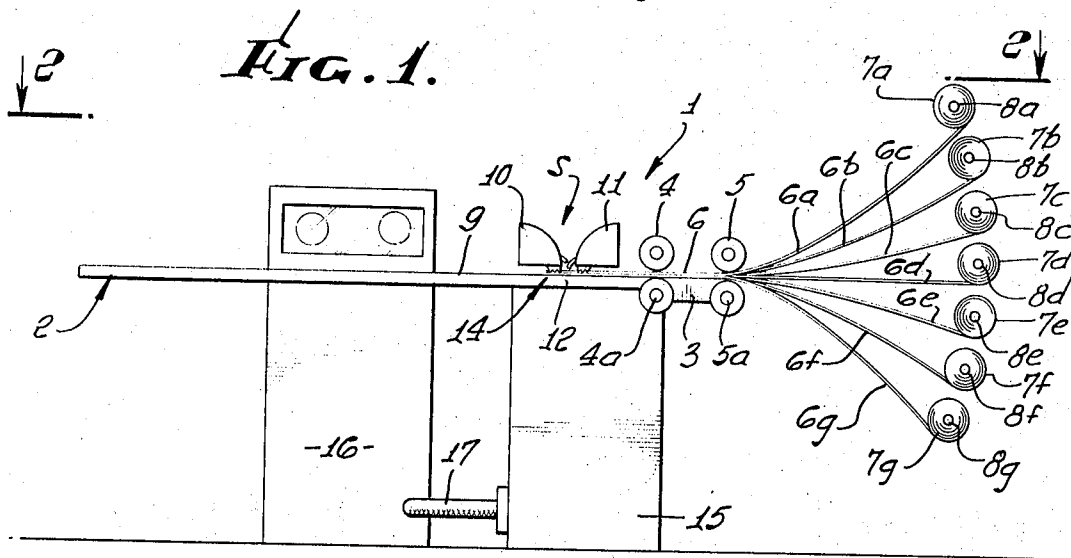
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[57] **ABSTRACT**

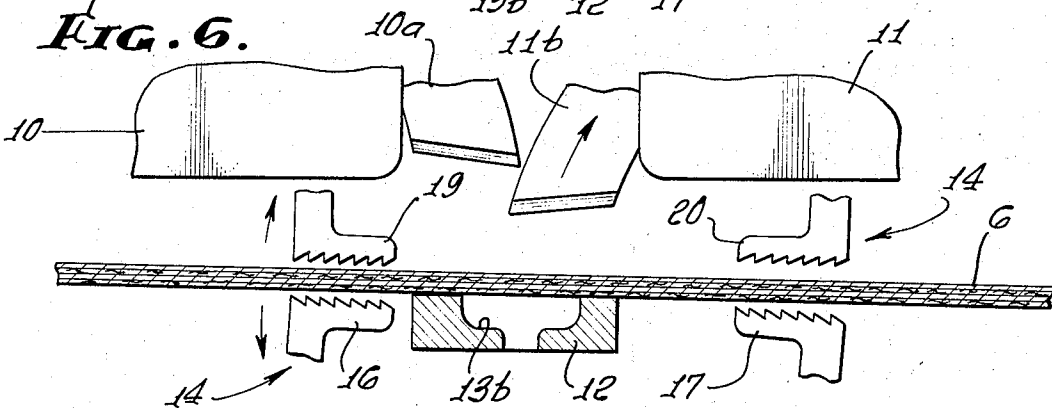
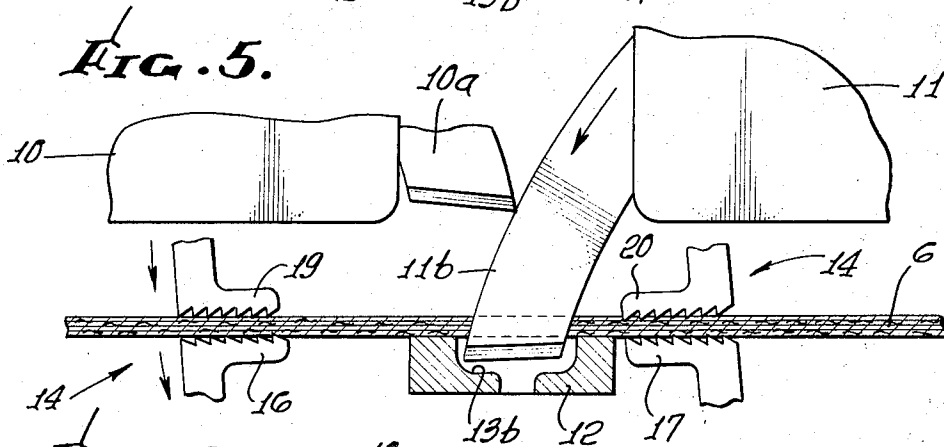
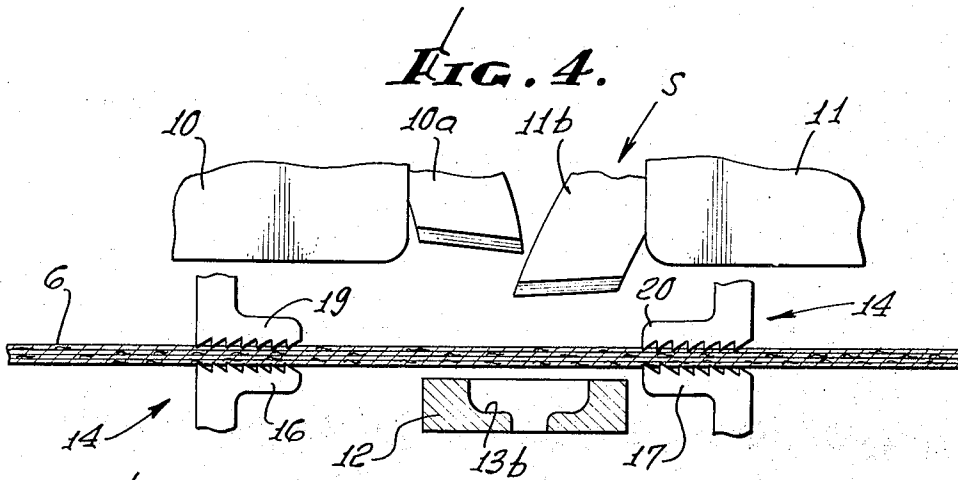
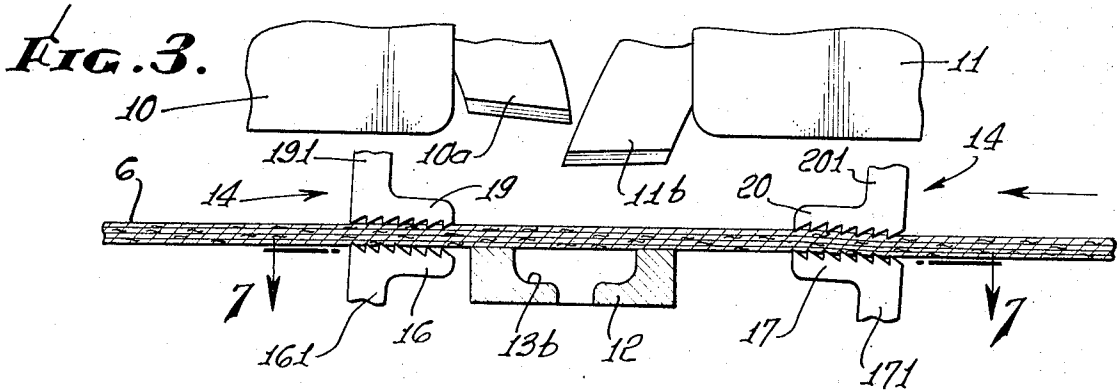
Fabric cutting by means of multiple individually and independently actuatable cutting blades selectively operable to sequentially effect pinking cuts in successive increments of fabric, to progressively cut a piece therefrom according to a predetermined pattern.

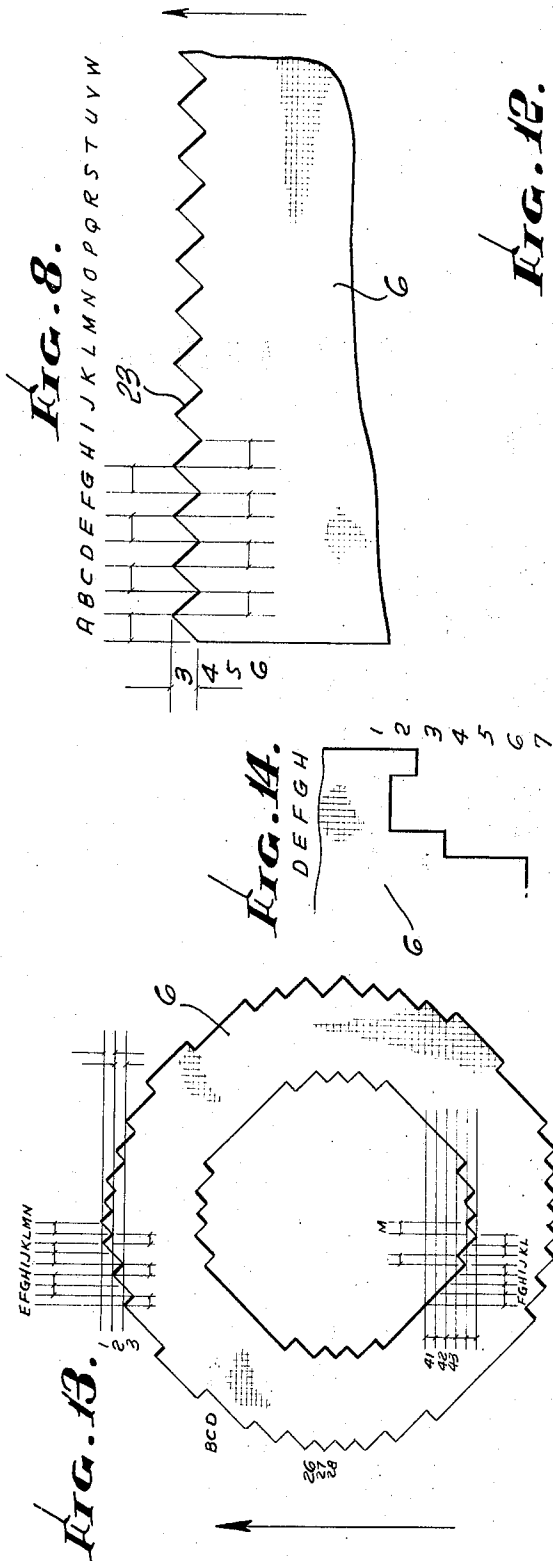
20 Claims, 14 Drawing Figures





SHEET 2 OF 3





FABRIC CUTTER AND METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

This invention has to do with cutting pieces to a pattern from a length of fabric. More particularly, the invention is concerned with method and apparatus for repeatedly, rapidly cutting garment pieces of like or varying shape sequentially or simultaneously with perfect replication in single or multiple layers of fabric and with bias cut edges on all pieces against unravelling.

Garments and like assemblies of fabric are made by sewing together specifically shaped fabric pieces such as, in a coat: arms, left and right front panels, left and right back panels, collar, pocket, and lapel pieces and the like. Each piece must be cut to the proper shape. Each shape varies somewhat with the intended size of the garment. Virtually all garments are made in numerous sizes. With all these variables which can be planned for, there are problems of accurate execution of the plans. And inaccurate cutting can waste fabric.

Initially, a paper layout of pieces to be cut is made, each piece being carefully fitted to minimize unused areas of fabric, within the constraints of presently usable fabric lengths, e.g. 6-8 yards in length. The paper is pinned to a prearranged stack of fabric layers which have been rolled to wrinkle-free smoothness.

Present cutting techniques are high in labor content. A highly paid cutter guides a power driven saw through the stack of fabric, e.g. 10 layers high, tracing the perimeter of patterns representing various pieces of a particular garment. If the saw is not kept perfectly on pattern lines or if the stacked fabric is misaligned or the fabric is somehow wrinkled within the stack, despite smoothing, undersize or oversize or otherwise miscut pieces result. In these cases, the replication of the pattern is imperfect in one or more of the pieces cut, even if the cutter perfectly executes the pattern in the top fabric layer. And cutter accuracy is not always to be relied upon.

Attempts to eliminate one or more of the delineated disadvantages have centered on more efficient cutting in terms of speed and/or precision. Multiple dies, each of a particular size, have been used to punch out pieces. Capital investment is high and piece size is limited, however. Most recently, publicity has been given the adaptation of the laser to "cut" (actually, burn through) fabric. Advantages claimed are increased accuracy, higher speed and more faithful replication of the pattern tracing because the laser beam is guided by computer. The number of fabric layers simultaneously cuttable in this manner is limited to practically a single layer, so, although cutting is faster, fewer pieces are turned out in a given time. The use of the laser, moreover, is basically only a substitution, and at tremendous capital investment, of one cutting means for another, comparable to a power saw being substituted for the scissors formerly used, and merely an improvement in degree.

SUMMARY OF THE INVENTION

It is the purpose of the present invention to provide fabric cutting having a difference in kind from what has been known. In fabric cutting according to the invention, fabric pieces of any shape or size, and in any number fitting across the width of the fabric, are accurately,

simultaneously and rapidly cut, in multiple layers, and in any desired mix of shapes or sizes.

The previously required steps of fabric cutting to length, doing a paper layout, careful stacking and tedious rolling of fabric to be free of wrinkles are all obviated by the present invention.

The foregoing advantages are realized in accordance with the method of the invention for cutting a piece to a predetermined pattern out of a relatively longitudinally extended fabric, which method includes advancing said fabric lengthwise and in like increments to a cutting station, and within the station cutting the piece perimeter into each increment according to said pattern and in response to presentation of the increment to the station and in timed relation with the fabric advance to have cuts in successive increments intersect, to progressively free the piece along its perimeter from the fabric.

The cutting station typically includes a series of individually actuatable cutting edges arrayed transversely of the path of fabric advance, and the method further includes selectively actuating certain cutting edges to locally slice the fabric in accordance with the piece pattern. Other features of the method include maintaining the fabric taut within the cutting station during cutting, cutting the fabric from one side and supporting the fabric at the opposite side and maintaining the fabric stationary in the cutting station between successive incremental advances thereof and cutting the fabric while stationary.

The method further contemplates unrolling the fabric from a supply roll for the mentioned incremental feed and feeding multiple fabric layers to the cutting station from supply rolls thereof and maintaining the layers together and taut within the fabric cutting station during cutting.

The fabric may be woven and, if so, a considerable advantage over known cutting methods is realized according to the method by bias cutting the fabric along pattern lines, e.g. by effecting adjacent cuts at complementary angles to define a saw tooth edge on the piece perimeter, the saw tooth ramps cutting across the weave in the known manner of bias cutting of woven goods, to prevent unravelling.

The cutting edges may be arranged into pairs of opposed left and right hand members (looking across the fabric width) disposed normally to each other; the method then including operating in sequence on a single fabric increment selected ones of the right hand members and then selected ones of the left hand members (or vice versa) to be actuated for cutting the fabric increment, to effect a corresponding number and arrangement of cuts therein. The cutting edge pairs may be indexed back and forth within the cutting station responsive to presentation at the cutting station of successive fabric increments, the indexing equalling one-half the parallel cutting edge-to-cutting edge spacing, and prior to actuating the edges in the cutting step.

Apparatus is provided for carrying out the method, comprising in a first aspect apparatus for cutting a piece out of longitudinally extended fabric according to a predetermined pattern defining the piece perimeter, which comprises means to advance the fabric lengthwise in like increments, cutting means extending transversely of the advancement path of the fabric including plural individually actuatable blades relatively disposed to cut a closed figure in the fabric, and means actuating

the cutting blades responsive to fabric advance selectively and in timed relation therewith to make individual cuts in varying sequence according to the pattern to cut the piece out of the fabric.

In another aspect the apparatus comprises a cutter series carried to cut the fabric, means advancing the fabric past the cutters and means individually and independently actuating selected cutters in timed relation with the fabric advance and in varying progression according to said pattern to cut the piece out of the fabric. The cutter series typically extends transversely of the fabric and from edge-to-edge thereof.

Among other features, the apparatus may include a support bed for the fabric opposite the cutter series adapted to receive the cutters in passing relation, and means holding the fabric taut upon the support bed during cutter actuation.

The fabric advancing means typically includes a drive operable to incrementally advance the fabric lengthwise past the cutter series, drive control means controlling fabric advance relative to actuations of the cutters to have successive fabric cuts intersect, and first and second sets of feed dogs mounted before and after the cutter series respectively. The feed dogs each comprise jaws adapted to releasably grip the fabric in opposed relation and for progressive movement of the fabric past the cutter series. The support bed for the fabric may be mounted opposite the cutter series and between the sets of feed dogs, the support bed having individual cutter receiving slots formed therein.

Means is provided carrying the feed dog jaws for cyclical movement relative to the support bed in sequenced gripping and releasing relation to the fabric and timed to incrementally advance the fabric between cutter actuations and in a manner to maintain the fabric increment taut during cutter actuations. The jaws may be so carried for both vertical and horizontal movement, sequentially or simultaneously, with the fabric and relative to the support bed.

The cutter series typically comprises plural rows of multiple cutting blades, the rows being longitudinally spaced along the path of fabric advance and disposed transversely thereof, with cutter blades in successive rows being disposed in common planes parallel to the path of fabric advance and relatively aligned within the planes to effect successive intersecting cuts in the fabric and at complementary angles. The cutter blades are typically mounted for individual and independent reciprocating movement through the fabric and in certain embodiments the cutter blades are mounted above the support bed for and carried for cammed movement through the fabric and into support bed slots.

The cutter blades in successive rows may be at normal angles one to the other and paired between rows in coplanar relation parallel to the path of fabric advancement and means provided to actuate one and the other of the pair members in a pattern determined sequence or successive fabric increments to correspondingly cut the fabric in saw tooth relation. One member of each of the cutter blade pair may be carried to cut the fabric at an angle normal to the fabric advancement path and the other cutter blade pair member to cut the fabric parallel to the advancement path, or both blades may be carried to cut the fabric at a relative (+ or -) 45° angle to the fabric advancement path.

In certain embodiments the cutter blades are mounted for lateral indexing responsive to presentation

of successive fabric increments to the cutter series and the apparatus may include means to actuate together certain blade pair members of one row selectively, and in sequence to actuate together certain pair members of another row in timed relation with the advance of fabric to have laterally and longitudinally adjacent cuts intersect.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described as to an illustrative embodiment thereof in connection with the attached drawing wherein:

FIG. 1 is a side elevation, partly schematic view of apparatus according to the invention;

FIG. 2 is a plan view thereof taken along line 2—2 in FIG. 1;

FIG. 3 is a fragmentary detail view of the cutting station showing the cutters and feed dogs prior to a fabric advance for cutting;

FIG. 4 is a view like FIG. 3, showing the feed dogs in the fabric advance mode;

FIG. 5 is a view like FIG. 3 showing the cutting blade stroke following fabric advance;

FIG. 6 is a view like FIG. 3 showing withdrawal of the cutting blades and reverse travel of the feed dogs for the next increment of fabric;

FIG. 7 is a plan view of the lower feed dog jaws and support bed taken along line 7—7 in FIG. 3.

FIGS. 8—14 are plan views of fabric cut to various patterns according to the invention, the direction arrows indicating the path of advancement of the fabric relative to the cutters.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is noteworthy that, in the present invention, the speed of fabric cutting is independent of the complexity or number of pieces being cut. One piece, or tens of small pieces, are cut at the same rate into successive increments of a length of fabric by keeping the rate of incremental advance of the fabric constant, and the rate of actuation of the cutters constant, and varying which and how many cuts are made in the fabric by controlling individual cutter actuations.

General Arrangement of the Apparatus

Referring now to the drawings, in FIG. 1 a cutting apparatus is shown at 1 sized to occupy a floor space of about 7 feet by 15 feet. The apparatus includes a horizontal table 2 having an extension 3 carrying guide roller pairs 4, 5 carried by spindles 4a and 5a to guide forward, (leftward in the drawing), fabric 6 in multiple layers 6a—6g supplied from rolls 7a—7g supported by spindles 8a—8g. The rear roller pair 5 gathers the fabric layers 6a, etc. from their respective rolls 7a, etc. and with roller pair 4 presses the fabric layers together and guides the pressed layers onto the upper surface 9 of the table 2. The number of fabric layers 6a, etc. can range from 1 to 18 or more with 6 to 10 layers being most commonly employed, the number depending on the fabric. Hereinafter, "fabric" and numeral 6 will refer to single or multiple layered fabric interchangeably.

Along the table 2, a cutting station S is provided, shown in the form of opposed cutting heads 10 and 11 carrying cutting blades series 10a and 11b respectively, in opposed relation, the series extending transversely across the table 2 and also transversely of fabric 6

which is being guided down the table by roller pairs 4, 5. The table 2 is opposite the cutting blades 10a and 11b to accommodate bed 12 for fabric support during cutting. As best shown in FIG. 7, bed 12 is provided with slots 13a and 13b and is mounted to be movable laterally (up and down in the Figure) for indexing movement with the cutting blades as described hereinafter.

Apparatus 2 further includes plural feed dogs generally indicated at 14 and hereinafter more fully described in connection with FIGS. 3-7, cutting blade drive means in housing 15, drive control means in the form of computer 16 of a known type for repetitively sequencing mechanical movements, connected to the drive by cable 17 and suitably programmed to operate the several moving parts of the apparatus in timed sequence to effect cutting of fabric pieces according to the present invention.

Fabric Advancing Mechanism

With reference, particularly, to FIGS. 3-7, one means of incrementally advancing the fabric is depicted. In this embodiment, the feed dog mechanism comprises first and second, multiple, laterally spaced, opposed upper and lower feed dog jaws which cooperate to grip the fabric, at their rearward position, lift, and advance the fabric to a forward position and release, and then retract to repeat the cycle. In FIG. 3 the cutters 10 and 11 with the corresponding blade series 10a and 11b are shown located over an increment of fabric 6 to be cut at the cutting station, corresponding approximately to the longitudinal extent L of the slots 13a and 13b in bed 12 shown in FIG. 7.

The feed dog mechanism generally indicated at 14 comprises plural transversely arrayed upper and lower, front and rear sets of jaw members. Each set comprises plural laterally spaced jaw members, best shown in FIG. 7, commonly mounted for united movement, by means not shown. Desirably, the jaw members are spaced to grip the fabric from edge-to-edge for advance without puckering between jaw members. Thus in FIG. 7, front lower jaw member set 16 includes jaw members 16a, 16b, 16c and so on across the width of the cutting station. Similarly, in FIG. 7 rear lower jaw member set 17 includes jaw members 17a, 17b, 17c and so on across the width of the cutting station and opposite to the front set jaw members 16a, etc., and carried within machine frame 18. Upper front jaw members 19 and upper rear jaw members 20 are disposed opposite their lower counterparts.

In FIG. 3, the gripping alinement of the jaw members 16, 17, 19, 20 is shown. It will be noted that the jaw members are each carried by a corresponding actuating arm 161, 171, 191, and 201 respectively which is guided in its movement by a cam mechanism (not shown) which carries the arms and thus the jaw members through the cycle now to be described, e.g. a mechanism such as laterally spaced plates having cam slots receiving laterally extending trunnions supporting the arms and blades.

The jaw members 16, 17, 19 and 20 are tipped rearwardly at the onset of a cycle, vertically opposed members (16 and 19, and 17 and 20) being pressed together to firmly grip the fabric 6 therebetween at their most rearward position, with front jaws 16, 19 adjacent the front of support bed 12 and rear jaws 17, 20 spaced from the rear of support bed 12.

The jaw members 16, 17, 19 and 20 are then raised to lift fabric 6 from support bed 12 a clearance distance at the minimum, and simultaneously moved forward (right to left) with the fabric, the jaw members being in essentially vertical trim. The fabric is thus advanced the desired distance to define the increment of fabric to be positioned in the cutting station S above mentioned. The jaw members 16, 17, 19 and 20 are lowered at the forward end of the cycle, being tipped forwardly as they are lowered to rest the fabric 6 upon the support bed 12.

The fabric 6 is continued to be gripped by all of jaw members 16, 17, 19 and 20 to thereby be held taut for the cutting stroke. The cutting stroke per se is described hereinafter, it being sufficient to note here that various of multiple cutting blades 10a and 10b are actuated while the selected increment of fabric 6 is firmly held upon the support bed by jaw members 16, 17, 19 and 20. Following the cutting stroke, the vertically opposed jaw members 16, 19, and 17, 20 are moved apart, releasing the fabric 6, and moved rearwardly, without the fabric, which rests upon support bed 12 and table surface 9, to grip a further fabric increment to begin the cycle anew.

The cut fabric 6 is advanced by the multiple jaw members 16, 17, 19 and 20 beyond the cutting station for collection of pieces 21, as shown in FIG. 2.

Cutting Mechanism

It is to be noted that herein fabric pieces are progressively severed from fabric by a series of intersecting cuts effected sequentially. The cutting station S contains cutting blades in one or more series which together are adapted to sever the fabric edge-to-edge. The series are separately actuatable and each blade in a series is individually operable and independently, giving total flexibility in cutting.

In particular embodiments, the series blades are carried to be able to effect a closed figure cut in the fabric, e.g. each of four blades in one combination may cut one leg of a diamond, or one side of a square. Moreover, in certain embodiments, all cuts to be made in a given increment of fabric are made in that increment prior to making cuts in a subsequent increment, i.e. wherever the pattern lines intersect the cutting plane, cuts are made. Preferably all cuts are on the bias when cutting potentially ravelling fabric.

With reference again to FIGS. 3-7, the cutting blades 10a and 11b are representative ones of a series of blades, formed e.g. of hardened steel, extending transversely of the fabric width. Blades 10a comprise a forward series, successive blades being equidistantly spaced apart and each being parallel to the next, see blade receiving slots 13a in support bed 12, shown in FIG. 7. Blades 11b comprise a rearward series, successive blades being equidistantly spaced and each parallel to the next, see blade receiving slots 13b in the support bed 12, FIG. 7. The blades 10a and 11b are shown disposed at an angle of 45° to the longitudinal axis 22 (FIG. 2) of the fabric and thus lie at normal angles, i.e. 90° to each other. The blade receiving slots 13a, 13b are likewise disposed at normal angles and are extended to intersect as shown in FIG. 7. Blades 10a and 11b may be parallel and normal respectively to the axis 22, and thus normal to each other. See cuts made by such blades in FIG. 14. In either case, the angles of the blades 10a, 11b to the axis 22 are complementary, i.e. they sum to 90°.

The blades 10a and 11b are successively actuated in their vertical planes and traverse intersecting arcs to define cuts corresponding to the slots 13a, 13b, the support bed 12 surrounding the slots serving to support the fabric during the cutting strokes.

The blades 10a 11b are in opposed relation. Longitudinally opposite blades (along the path of fabric advance) are in a common plane, which plane is parallel to the axis 22 of the fabric. Each blade 10a or 11b in a common plane is a member of a pair of blades. Opposed pair members have a special interrelation as will be described.

Referring to FIG. 3, at the commencement of a cutting cycle, the feed dogs 14 are drawn rearward and the blades 10a and 11b retracted. In FIG. 4, the fabric is advanced a single increment as explained above, the blades 10a and 11b remaining retracted.

In FIG. 5, blade 11b is shown being actuated and cutting through fabric 6 into slot 13b. Blade 10a is then similarly actuated, if the pattern so determines, as hereinafter described. Following the fabric cutting, the blade 11b is again retracted. Blade 11b is of course representative of all blades in cutter 11 and blade 10a of all blades in cutter 10. Each of these blades is separately actuatable, independently and individually. In practice, all of the 11b blades to be actuated for a given increment are desirably actuated at once and all of the 10a blades to be actuated for that increment are then actuated (or vice versa), resulting in a series of cuts selectively placed and corresponding to the selective actuation of the cutting blades. In addition to vertical reciprocating motion, the blades are capable of lateral reciprocating or indexing motion, as will now be described. Similarly, the bed 12 is mounted for corresponding lateral motion to maintain slots 13a and 13b opposite their respective blades where bed slots will not accommodate the blades in both normal and indexed position.

Advancing, Cutting and Indexing Control

In the preceding sections, the cyclical motion of the feed dogs and the cutting operation of the cutting blades have been described. These movements are relatively timed and may be controlled in a manner to effect a pinking or bias cut along pattern lines. The control is achieved by electronic or electromechanical actuation of some or other of the cutting knives in response to incremental advance of the fabric by the incremental feed cycle. The selection of cutting knives for cutting a given increment is according to pattern and may be effected by a control device such as computer 16, which is programmed with the patterns to sequentially actuate various of the cutters through a drive, not shown. It is thus seen that paper patterns are unnecessary, the form of each piece is stored in the computer memory.

In addition to blade actuation and fabric advancement, the control is used to index, i.e. to shift cutting heads 10 and 11 left and right transversely relative to the fabric longitudinal axis 22. This transverse shifting laterally indexes the cutting blades 10a and 11b so that two successive strokes of a single blade intersect. This lateral shifting is an oscillating movement repeated with each successive advance of the fabric, so that the cutting heads 10, 11 shift left, then right and then left for each successive fabric increment. This transverse indexing motion is timed to be effected during the fabric advance above described. Where the blades are dis-

posed at 45° to the axis 22, the blades are laterally indexed one-half the spacing between successive parallel blades, e.g. one-half the distance between two adjacent 10a blades or between two adjacent 10b blades. In this way first and second cuts of a single blade will intersect and form a continuous cut. The third cut will be longitudinally aligned with the first cut. See FIGS. 8-13.

Operation

Having described the relative alinement of the opposed pairs of cutting blades and their indexing function and the successive advance of the fabric in incremental amounts not greater than the longitudinal cutting extent L of the blades, the method of cutting may now be described, keeping in mind that the several cutting modes shown are expected to be carried out simultaneously across any given fabric increment and sequentially through successive increments to cut according to pattern and are presented here separately merely to facilitate understanding each mode.

As mentioned, the support bed 12 is indexed with the cutting blade series, control of this movement being coordinated with the blade movement so that blade receiving slots are below the blades at all times. The support bed 12 movement may be dispensed with where a pattern of blade receiving slots is provided which accommodates the blades in their left and right displacement modes or where the blades are carried in further multiplied series, e.g. four series within the cutting station to provide all strokes necessary for complete fabric cutting, e.g. of blades providing sufficient strokes to define a closed figure, without the need of alternately indexing the blades between successive cutting strokes.

In FIGS. 8-14 a variety of differently shaped pieces are shown cut from fabric, including, in FIG. 13, a generally toroidal piece, not possible to cut with ordinary cutting saws and cutting tables.

Each fabric length may be considered to have a number of longitudinally extended rows A, B, C and so on. Each such row has a width corresponding to the cutting width of the blade. Where the blades are disposed at 45° to the fabric advancement path, the width of each row is equal to the base of a 45° right triangle having a hypotenuse H equal to the effective cutting edge length of the blade.

The fabric is advanced in increments as described. Each increment may be numbered 1, 2, 3 and so on.

Thus the fabric may be considered to correspond to a grid in which each square has a longitudinal coordinate 1, 2, 3, etc. and a transverse coordinate A, B, C, etc.

The invention enables selective cutting in one or another of these squares individually and indendently and in any pattern. The grid will typically be quite small, e.g. each blade length (=H) may be 1/8 inch and 220 blades may be arrayed in each cutter head series, extending over a 60 inch wide table. This is particularly important in cutting woven goods where the plentitude of blades provides a saw-tooth cut parallel and transverse to the fabric length and a straight cut between parallel and transverse axes, to always cut the fabric on the bias.

In the ensuing description of exemplary cutting forms, each cut is given a locator made up of the mentioned coordinates, e.g. C5 is a locator indicating a cut in the "C" or third row from the left in the 5 or fifth increment of the fabric, made by a blade in the normal, nonindexed relation.

In embodiments where the blades are alternately indexed for successive increments, blades may make cuts in alternately different rows. Such cuts are given the same locator with a prime, e.g. D6' indicates a cut in the "D" or fourth row from the left in the 6 or sixth increment of fabric, made by a blade in indexed relation, i.e. the same blade that made cut C5 in the just preceding fabric increment. Cut D6' intersects cut C5.

Referring now to FIG. 8, fabric 6 is cut transversely, from edge-to-edge across a single fabric increment. Using the dual opposed cutting head arrangement shown in the drawings, first these cuts are made, in fabric increment 3, using only blades in head 11: 3B, 3D, 3F, 3H, 3J, 3L, 3N, 3P, 3R, 3T, and 3V. Then these cuts are made using only blades in head 10: 3A, 3C, 3E, 3G, 3I, 3K, 3M, 3O, 3Q, 3S, 3U, and 3W. The result is a saw-tooth or pinked cut 23 of intersecting individual cuts across the width of the fabric.

In FIG. 9, a longitudinal cut in a single fabric now rather than a transverse cut in a single fabric increment (cf. FIG. 8) is shown. To make the saw-tooth cut 24 shown in FIG. 9, beginning e.g. at increment 6 of the fabric, initially a blade in head 10 is actuated, the fabric is advanced incrementally, to increment 7, and then the paired opposing table in head 11 is actuated; the blades of head 10 and 11 continue to be alternately actuated to effect cuts, in sequence: D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, and D16. In embodiments where the heads 10, 11 are alternately indexed for successive increments, the pattern of cuts is D6, D7', D8, D8', D9, D10', D11, D12', D13 and D14'. That is, the head 11 cuts are made by an indexed blade, normally above the C row.

In FIGS. 10 and 11, the transverse and longitudinal cuts are combined to make continuing diagonal cuts to the right and to the left respectively. Such cuts are made on the bias in a woven fabric. In FIG. 10, the fabric 6 is advanced in the direction of the arrow in successive increments, beginning e.g. at increment 12 and through increment 24. The first segment F12 of the rightward diagonal cut 25 in fabric 6 is shown to be made by a 10a blade. The next cut segment G13 and the next segment F14 each are also made by a 10a blade. If the blade head 10 is indexed (e.g. to the right on odd numbered increments) for successive cuts the cuts are, in sequence, F12, G13' and H14. In FIG. 11, a leftward diagonal line 26 is cut in these segments, 5Z, 6Y, 7X, 8W, and 9V, each cut being made by an 11b blade. If the blade head 11 is indexed (e.g. to the right on odd numbered increments), the cuts are, in sequence 5Z', 6Y, 7X', 8W and 9V' with 5 and 6 cuts in the Z and Y rows being made by successive strokes of the same 11b blade, the 7 and 8 cuts in the X and W rows being made by the same 11b blade, different from and adjacent to the blade making the Z and Y row cuts and the 9 cut being made by still another 11b blade.

In FIG. 12, the preceding types of cuts are combined to cut a more complex pattern into the cloth. The sequence of cuts is as follows, without indexing.

Increment No.	Cut(s) Made By	
	10a blade(s)	11b blade(s)
4	—	—
5	—	—
6	—	6Z
7	—	7Y
8	8Y	—
9	—	9Y
10	10X, 10Q	10S
11	11Q	11X, 11T
12	12Q	12X

With indexing one position to the right on odd number increments the sequence is as follows:

Increment No.	Cut(s) Made By	
	10a blade(s)	11b blade(s)
4	—	—
5	—	—
6	—	6Z
7	—	7Y
8	8Y	—
9	9Y	—
10	10X, 10Q	10S
11	11Q	11X, 11T
12	12Q	12X
13	13V	13W

In FIG. 13 a more complex pattern is executed, one including interior severing of fabric within a piece. The sequence of cuts is as follows, without indexing, some cuts in increments and rows being omitted for simplicity.

Increment No.	Cut(s) Made by	
	10a blade(s)	11b blade(s)
1 Top Cuts	1L, 1N	1M, 1K
2 Top Cuts	2I	2H, 2J
3 Top Cuts	3F	3E, 3G
25 Left Side Cuts	—	25C
26 Left Side Cuts	26C	—
27 Left Side Cuts	—	27C
28 Left Side Cuts	28C	—
41 Interior Cuts	41F	—
42 Interior Cuts	42G	—
43 Interior Cuts	43H	—
44 Interior Cuts	44I	44J
45 Interior Cuts	45L, 45N	45M

With indexing one position to the right on odd number increments, the sequence is as follows:

Increment No.	Cut(s) Made By	
	10a blade(s)	11b blade(s)
1 Top Cuts	1L', 1N'	1M', 1K'
2 Top Cuts	2I	2H, 2J
3 Top Cuts	3F'	3E', 3G'
25 Left Side Cuts	—	25C'
26 Left Side Cuts	26C	—
27 Left Side Cuts	—	27C'
28 Left Side Cuts	28C	—
41 Interior Cuts	41F'	—
42 Interior Cuts	42G	—
43 Interior Cuts	43H'	—
44 Interior Cuts	44I	44J
45 Interior Cuts	45L', 45N'	45M'

In FIG. 14, cuts are depicted made by blades which are normal to each other, but which are either normal or parallel to the longitudinal axis of the fabric, rather than at 45° angles to this axis. Assuming blades 10a to be parallel to the fabric longitudinal axis 22, and blades 11b to be normal thereto, the pattern of cut sections to make cut 27 are as follows, in the absence of indexing of the blade heads.

Increment No.	Cut(s) Made By	
	10a blade(s)	11b blade(s)
1	—	1F, 1G
2	2E, 2G	2H
3	3E	3E
4	4D	—
5	5D	—
6	6D	—
7	—	—

The foregoing cutting method and apparatus is suitable for cutting any fabric which can be sliced by a blade. Accordingly, fibrous fabrics woven or nonwo-

ven, impregnated, treated, colored or otherwise conditioned for repellency, decoration or strength may be cut; nonfibrous fabric such as foils of synthetic organic plastics or metals, formed by coating, extrusion or calendering or like sheeting processes may also be cut. Fabrics may be formed of numerous materials including naturally occurring materials such as silk, wool, jute, cotton, cellulose and like proteinaceous substances and synthetic materials such as nylon, Dacron, Orlon, Spandex, Dynel and like polyesters, polyacrylics, polyurethanes, vinyl polymers, and polyolofins, as well as metals, particularly aluminum.

In summary, method and apparatus is provided for cutting fabric into any configuration which is a multiple of the individual closed figures which may be cut into the fabric by appropriate selection of the knife actuation. If all blades are actuated for each increment, the fabric is cut corresponding to the grid above mentioned, e.g. into small rectangles. If the blade actuation is selective, portions of rectangles are formed at the pattern edges and no cuts are made of rectangles within the pattern. This gives a fabric piece with a saw tooth edge.

I claim:

1. Method of cutting a piece of a predetermined pattern out of a relatively longitudinally extended fabric which includes advancing said fabric lengthwise and in like increments to a cutting station, and within the station effecting a first series of parallel cuts at a 45° angle to the fabric advancement path, effecting a second series of parallel cuts at a 45° angle to said path, complementary to and intersecting said first series cuts, each of said cuts extending laterally and longitudinally in the fabric to cut the piece perimeter into each increment according to said pattern and in response to presentation of the increment to the station and in timed relation with the fabric advance to have cuts in successive increments intersect, to progressively free said piece along its perimeter from said fabric.

2. Method according to claim 1 including also maintaining the fabric taut within said station during cutting.

3. Method according to claim 1 including also cutting the fabric from one side and supporting the fabric at the opposite side.

4. Method according to claim 1 including maintaining said fabric stationary in the cutting station between successive incremental advances thereof and cutting the fabric while stationary.

5. Method according to claim 1 in which said fabric is woven and including also bias cutting said fabric along pattern lines.

6. Method according to claim 1 in which all of said first series of cuts are made simultaneously and all of said second series of cuts are made simultaneously and in sequence with said first series of cuts.

7. Method according to claim 6 including also alternately effecting first or second series cuts in laterally indexed relation relative to said fabric responsive to presentation at the cutting station of each successive fabric increment, said indexed relation equaling one-half the laterally adjacent cut-to-cut spacing.

8. Apparatus for cutting according to a pattern a piece out of a longitudinally extended fabric being advanced incrementally along a predetermined path, including cutter series comprising longitudinally spaced, opposing rows of multiple, individually and independently actuable cutting blades, said rows extending

transversely of the fabric path and the blades thereof from edge-to-edge of the fabric, said cutting blades being fixed within said rows at a + or - 45° angle to the path of fabric advance to be parallel with each other within a row and normal to each other in opposing rows for effecting complementary intersecting cuts in the fabric advancing past opposing rows; means advancing the fabric past the cutters, and means actuating selected cutting blades simultaneously within a row and sequentially in opposing rows in timed relation with the fabric advance and in varying progression from row to row responsive to said pattern to cut said piece from the fabric.

9. Apparatus according to claim 8 including also a support bed for said fabric opposite said cutting blade rows adapted to receive said blades in passing relation.

10. Apparatus according to claim 9 including means holding said fabric taut upon the support bed during cutting blade actuation.

11. Apparatus according to claim 8 in which said advancing means includes a drive operable to incrementally advance said fabric lengthwise past said cutting blade rows.

12. Apparatus according to claim 11 including also drive control means controlling fabric advance relative to actuations of said cutting blades to have successive fabric cuts intersect.

13. Apparatus according to claim 8 in which said advancing means also includes first and second sets of feed dogs mounted before and after said cutting blade rows, respectively, said feed dogs each comprising jaws adapted to releasably grip the fabric in opposed relation and for progressive movement of the fabric past the cutter blade rows.

14. Apparatus according to claim 13 including also a support bed for said fabric opposite said cutting blade rows and between said sets of feed dogs, said support bed having individual blade receiving slots formed therein.

15. Apparatus according to claim 8 in which said cutting blades are carried for cammed movement through the fabric.

16. Apparatus according to claim 8 in which cutting blades in successive rows are paired between rows and including also means to actuate one and then the other of the pair members in a pattern-determined sequence on fabric increments to correspondingly cut the fabric in saw tooth relation.

17. Apparatus according to claim 8 in which said rows of cutting blades comprise first and second rows, said rows being mounted for lateral indexing and including also means to actuate together certain pair members of the first row selectively, and in sequence to actuate together certain pair members of the second row in timed relation with advance of fabric to have pair member cuts intersect.

18. Apparatus according to claim 13 including also means carrying said jaws for cyclical movement relative to said support bed in sequenced gripping and releasing relation to the fabric and timed to incrementally advance the fabric between cutter blade actuations and spaced to maintain the fabric taut upon the support during cutter blade actuations.

19. Apparatus according to claim 8 including also a support bed for said fabric opposite said cutting blade rows, having individual blade receiving slots, said sup-

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port bed being carried for indexing laterally to maintain its slots opposite said cutting blades.

20. Apparatus according to claim 19 including also means to actuate certain pair members of one row responsive to presentation of immediately successive increments of fabric in timed relation with the advance

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of fabric and means to laterally index said cutting blade rows between successive actuations a distance equal to one-half the spacing of laterally adjacent cutting blades to have cuts of the same blade on selected immediately successive increments of fabric intersect.

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