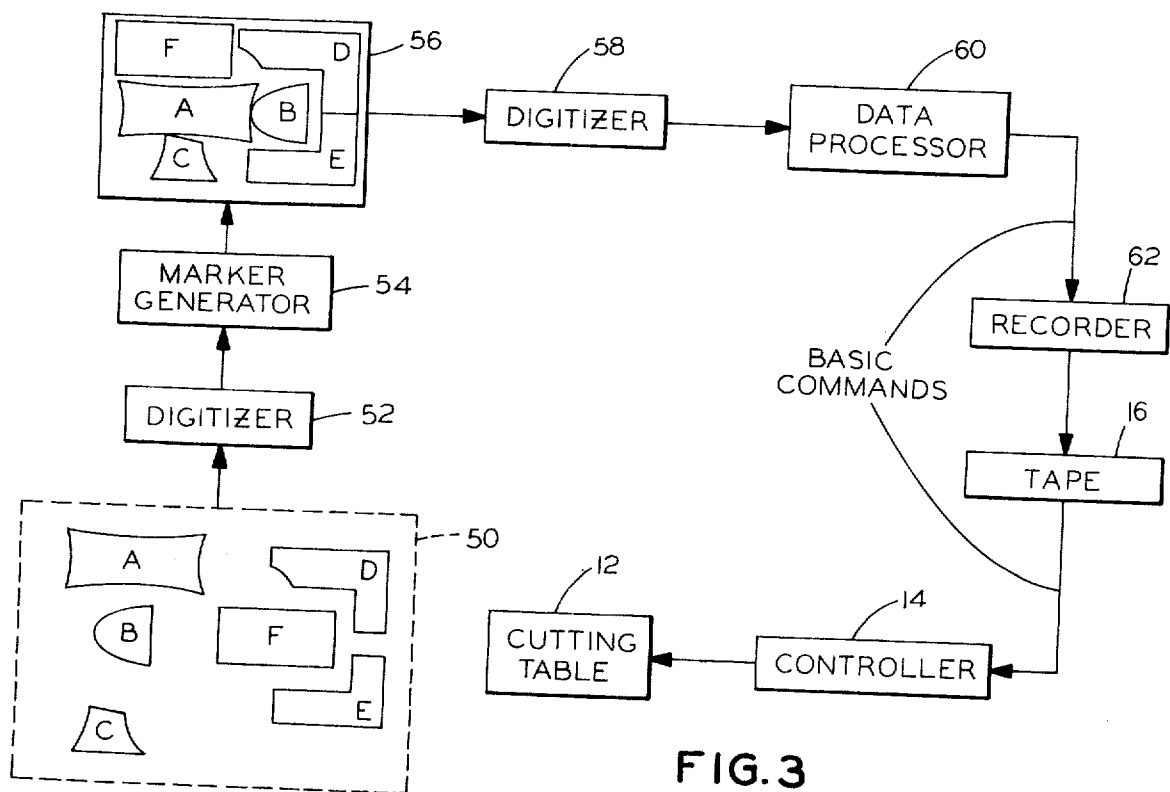
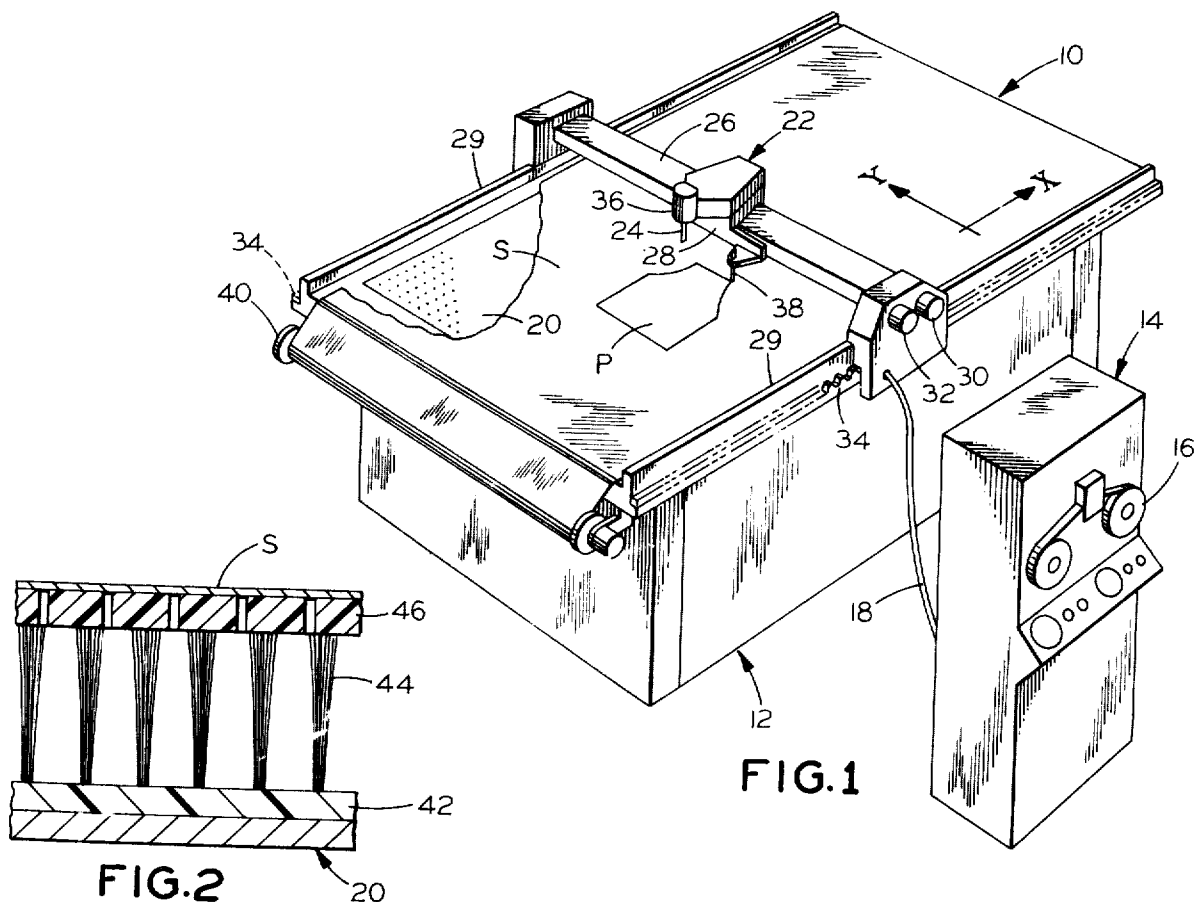




METHOD OF REPRODUCING A MARKER

BACKGROUND OF THE INVENTION

The present invention relates to a method of reproducing a marker or marker pattern in plotted form on the same cutting machine that cuts the pattern pieces in the marker from a layup of fabric, vinyl, paper or other limp sheet material.

In the garment, automotive and other industries in which both large and small quantities of limp sheet material are cut into pattern pieces that are subsequently assembled in finished products, an item referred to as a marker or marker pattern is usually produced. A marker is an array of pattern pieces defining their positional relationships with respect to one another as cut from the sheet material. By packing the pattern pieces closely and in a selected manner in the marker, it is possible to minimize the quantity of wasted material between pieces and to also minimize the overall yardage of material needed to produce a given number pattern pieces.

For many years, it has been customary to arrive at a marker configuration manually in a trial-and-error process. More recently, however, markers have been generated automatically through the use of specific or reiterative computer processes. In industry, both manual and automatic processes are currently employed.

The user of the marker, that is the party who cuts the marker is sheet material, has a need for reproducing the marker pattern in graphic form before the marker is actually cut in sheet material. For example, automatic pattern grading equipment can produce a series of markers for the same general article, such as a man's suit, in many different sizes, each size having the same general pieces but varying relative to the other markers in that the pieces are of slightly different shape for assembly as suits of different sizes. Since the pattern grading equipment is concerned primarily with producing a marker program in a numerical form intelligible to the numerical control equipment which operates a cutting machine, a graphic presentation of the marker defined by the program must normally be produced by a numerically controlled plotting machine. Obviously, it may be impractical and too expensive to have a numerically controlled plotting machine for occasionally displaying a new marker. But, if the new markers are not suitable and a graphic display of the marker is not available, large quantities of sheet material may be wasted before the unsuitability of marker is detected. With the present invention, it is possible to check the marker as it appears in a graphic representation by reproducing it before cutting on the same machine that will cut the pieces from limp sheet material.

In other instances, it may be desirable to produce individual paper patterns of the pieces in the marker for use in subsequent hand- or other cutting operations. Specially adapted plotting equipment for cutting has been developed in the past as shown, for example, U.S. Pat. No. 3,477,322. But for occasional use, the specially adapted equipment is expensive. Manual cutting from a plotted marker may be quite acceptable provided that the plotted marker can be inexpensively obtained. Since the cutting machine has the capability of tracking the contours of the pattern pieces in the marker, the machine offers an inexpensive means for the user to obtain markers in plotted form.

Accordingly, it is a general object of the present invention to disclose a method for reproducing a marker by plotting or cutting on an automatically controlled cutting machine.

SUMMARY OF THE INVENTION

The present invention resides in a method of reproducing a marker in graphic or plotted form on an automatically controlled cutting machine that is also utilized to cut the marker in limp sheet material. The cutting machine includes a cutting table having a blade translated by a moveable carriage relative to a support surface of the table on which the sheet material is spread prior to being cut.

The method comprises the steps of generating a marker program defining the positional relationship of the pattern pieces with respect to one another in the same geometric relationship that the pieces have when they are cut from sheet material supported on the surface of the cutting table. Typically, a marker program takes the form of digital information defined in a deck of cards or a magnetic tape which may or may not be the same deck or tape read by the cutting machine in a cutting operation. A plotting material is spread over the support surface of the cutting table and a writing instrument is attached to the moveable carriage of the machine for writing upon the plotting material spread on the table. The machine is then operated to drive the moveable carriage and attached writing instrument relative to the plotting material in accordance with the marker program to plot the marker in graphic form on the material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an automatically controlled cutting machine in which the method of the present invention is employed.

FIG. 2 is a fragmentary cross-sectional view of the table in the cutting machine of FIG. 1 and illustrates one manner in which the cutting surface of the table is converted to a plotting surface.

FIG. 3 is a block diagram illustrating the manner in which a marker program for the cutting machine is generated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates an automatically controlled cutting machine of the type in which the method of the present invention can be employed. The cutting machine, generally designated 10, is comprised of a cutting table 12 and a numerical controller 14. Typically, the controller 14 receives from a program tape 16 digital information defining basic machine commands which are transmitted to the cutting table through a cable 18. Information concerning the operation of the table may also be fed back through the cable 18 to the controller to coordinate the operations of the machine with the desired operations defined by the program tape 16.

The cutting table 12 is a vacuum table having a bed 20 defining a support surface on which sheet material is spread and held fixedly in position due to vacuum generated between the support surface and the sheet material. The vacuum is generated by drawing air through the bed in a manner such as that shown and described in U.S. Pat. No. 3,495,492, issued to Gerber et al. and having the same Assignee as the present inven-

tion. Reference may be had to the patent for a more complete description of the table.

A cutting head 22 having a motor driven cutting tool shown as a reciprocating blade 24 is supported over the bed 20 by means of an X-carriage 26 and a Y-carriage 28. The X-carriage 26 is guided for movement relative to the table in the illustrated X-direction by rails or ways 29 at opposite lateral sides of the table and is controllably driven in the illustrated X-direction by an X-drive motor 30 which rotates pinions (not shown) engaging racks 34 at each side of the table. The Y-carriage 28 is mounted on the X-carriage 26 and moves relative to the X-carriage and the table in the illustrated Y-direction. A Y-drive motor 32 is connected in driving relationship to the carriage 28. A θ -drive motor 36 orients the blade 24 about a θ -axis perpendicular to the support surface of the bed 20 to position the blade tangentially of the cutting path.

Machine commands transmitted to the cutting table from the controller 14 control the operation of the drive motors 30, 32 and 36 and the carriages 26 and 28 to translate the cutting blade 24 parallel to the X-Y plane of the table and tangentially along a cutting path. Another control motor (not shown) on the cutting head 22 moves the blade in and out of cutting engagement with the sheet material on the table and this motor is also operated by commands received from the controller 14 to selectively cut the sheet material on the table.

The bed 20 of the table 12 is preferably penetrated by the cutting blade 24 during a cutting operation. It is accordingly constructed of a suitable material, such as foamed plastic blocks or inverted bristled mats, so that the blade is not damaged and suitable support for the sheet material being cut is provided. U.S. Pat. No. 3,495,492 also describes this feature of the cutting table in greater detail.

In accordance with the present invention, a writing instrument 38 which is one form may be a plotting pen from which fluid flows or is sprayed is attached to the cutting head 22 for movement parallel to the support surface of the bed 20 with the carriage 28 on which the cutting head 22 is mounted. A motor or preferably a solenoid (not shown) is connected to the writing instrument and moves it toward or away from the support surface of the bed to, correspondingly, move the instrument 38 in and out of writing engagement with sheet material on the surface of the bed 20. Writing instruments of this type are in common use today on numerically controlled plotting equipment such as that shown and described in U.S. Pat. No. 3,293,651.

In order to reproduce the marker in the plotted rather than the cut form with the cutting machine 10, plotting paper or material is spread upon the support surface of the bed 20 and the instrument 38 is then lowered into writing engagement with the paper. In order to facilitate the spreading of the plotting paper, it may be mounted on a reel 40 which is translated over the bed 20 during a spreading operation or, as illustrated, is fixed to the one end of the table.

With cutting tables which have a bed 20 formed of foamed plastic through which air channels are either drilled or inherently provided to draw a vacuum between the surface of the table and the supported plotting material, a relatively heavy plotting material may be spread directly on the foamed plastic. However, if the support surface of the bed is not smooth and con-

tinuous and if the plotting material is relatively thin and limp such that it cannot support the minimum stylus pressure required to operate the writing instrument 38, a reinforcing sheet may be provided between the plotting paper and the support surface as illustrated in FIG. 2.

In FIG. 2 the bed 20 of the table 12 is illustrated in cross-section and is shown to be comprised of an inverted mat 42 having bristles 44 which define the support surface at their upper, free ends. A bed 20 of this type is readily penetrated by the reciprocating cutting blade 24 during a cutting operation but may not provide adequate support for the plotting material spread over the surface during a plotting operation. Accordingly, the surface defined by the bristles is reinforced by laying on the bristles a relatively rigid backing material 46 which in one form may be a perforated vinyl having a thickness of approximately 0.060 inch. The plotting material S is spread on top of the backing material 46 and a suitable stylus pressure may then be supported to operate the writing instrument on the material S.

The backing material 46 is preferably air-pervious to permit both the plotting material and the backing material to be held fixedly in position by drawing a vacuum at the support surface of the cutting table 12. The plotting material S seals the pervious backing material 46 after the material S is spread over the table and the differential pressure generated across the plotting and backing materials by the vacuum holds them both in position on the upper ends of the bristles 44 in the same manner that the layup of sheet material is held during a cutting operation.

To reproduce a marker pattern after the plotting material S has been spread on the bed 20, a marker program tape for plotting is loaded into the controller 14 and the carriages 26 and 28 are driven relative to the plotting material in accordance with the machine commands transmitted to the cutting table in response to the program. The program, in addition to controlling the motions of the carriage, also moves the writing instrument 38 into engagement with the plotting material S to draw the pattern pieces as the piece contours are tracked. Only one pattern piece of the marker is illustrated on the material S in FIG. 1; however, it will be understood that a plurality of such pieces in a closely packed array are reproduced on the material.

The generation of the marker program for plotting is accomplished in basically the same manner as the generation of the program for cutting. The principal information defining the contours of the pattern pieces is the same for cutting and plotting and, therefore, the marker programs for the cutting and plotting processes have a common origin.

FIG. 3 illustrates generally in a block diagram the procedure by which the marker programs are prepared for use in the controller 14 of FIG. 1. Exemplary pattern pieces to be cut and plotted are illustrated within the panel 50 and identified by letters. The contours of the pattern pieces are first reduced to point data by a digitizer 52 which may be either a manually operated digitizer or a line following device such as shown in U.S. Pat. No. 3,529,084. The raw point data is then fed to a marker generator 54 which automatically determines an optimum arrangement of the pattern pieces within an area that can be cut on the cutting table 12 in FIG. 1. The output of the generator 54, therefore, is

the completed marker 56 which may be represented at greatly reduced scale on a cathode ray tube or as digital information in a memory device. It is also contemplated within the scope of the present invention that the markers be manually generated by an individual. In either case, the patterns are placed in a closely packed array that optimizes the usage of material from which the pieces will later be cut on the table 12.

If the marker 56 is represented on a cathode ray tube, the locations of the pattern pieces within the marker are reduced to point data by the digitizer 58. If the marker has been manually generated directly from the pieces in panel 50, the digitizer 58 also reduces the contours as well as the locations of the pattern pieces to point data so that a complete definition of the marker is supplied to the data processor 60. The data reduction process performed by the digitizer 58 may be omitted altogether if the marker generator 54 provides information defining the marker in a form directly readable into the data processor.

In the data processor 60 the point data is converted into a program of basic machine commands defining the relative movements of the blade 24 and bed 20 which are necessary to track the contours of the pattern pieces in the marker 56. The data processor develops appropriate tool commands for either the cutting blade 24 or the writing instrument 38 or both depending upon whether separate or combined marker programs are desired for cutting and plotting.

The operation of data processors is not new although special forms of the processor, such as shown in U.S. application Ser. No. 314,144 filed Dec 11, 1972 and having the same assignee as the present application, may be utilized. The processor employs standard curve algorithms for the cutting machine to obtain basic commands for the plotting and cutting tools. In this respect, it will be understood that a marker distinctly for cutting will not be precisely identical to a marker program for plotting because the reciprocating blade 24 has a characteristic orientation which must be controlled in accordance with the direction of movement of the blade in order to maintain a condition or tangency at each cutting point along the contours of the pattern pieces cut. On the other hand, the marker program distinctly for moving the writing instrument 38 along the contours in the marker omits orientation information since the writing instrument is basically omni-directional. The programs for cutting and plotting may also differ due to the offset of the cutting and plotting tools. If the offset is sufficiently significant to require compensation, however, such compensation may frequently be made simply by nulling position error when the appropriate tool is centered at the desired origin of the marker. It is feasible to plot with a marker program for cutting by simply ignoring or omitting the orientation commands and lowering the writing instrument instead of the cutting blade. This operation might be accomplished directly at the cutting table by means of a single switch which directs up/down commands to the writing instrument instead of the cutting blade. Also, the switch may shunt the orientation commands and feedback for the blade if it is desirable to prevent carriage motions in the X- and Y-directions from being inhibited by delays in the orientation or θ -drive motor 36.

Once the marker program has been generated by the data processor 60, it is transmitted to a recorder 62 where a permanent record is made of the program on

a program tape 16 or other memory device. As shown above in FIG. 1, the tape 16 is then installed in the controller 14 to reproduce the basic commands generated by the data processor and those commands are transmitted by the controller to the cutting table 12 for either a cutting or plotting operation.

It will thus be seen that a method of reproducing a marker has been disclosed in which the machine which normally cuts the marker in a layup of sheet material is also employed to graphically illustrate the marker on plotting material. The method includes the generation of a marker program for plotting by means of the same point data from which the program for cutting is produced. After a plotting operation, the plotting material is removed from the table 12 and limp fabric material is spread in a layup for a cutting operation. Hence, both cutting and plotting operations based upon the same original data are carried out by substantially the same equipment and, consequently, at greatly reduced cost to the cutting machine user.

While the present invention has been described in a preferred form, it will be understood that numerous modifications and substitutions can be had without departing from the spirit of the invention. As mentioned above, the manner in which the marker pattern is generated, can be either manual or automatic. Cutting and plotting of the marker on the cutting table can be performed with different software, that is separate marker programs for cutting and plotting, or with the same program from which the basic commands are modified by the hardware. Where the cutting program is used for both cutting and plotting, the basic machine command signals for engaging either the cutting or plotting tool may be manually directed to the desired tool by the machine operator. Writing instruments other than pens and including pencils, brushes and light-heads may be employed for plotting. Accordingly, the present invention has been described in several forms by way of illustration rather than limitation.

I claim:

1. A method of reproducing a marker on an automatically controlled cutting machine including a cutting tool translated by a moveable carriage relative to the support surface of a penetrable bed of a cutting table, the penetrable bed being capable of withstanding multiple penetrations by the cutting tool without destruction when the tool cuts through a layup of sheet material and the support surface of the bed, comprising the steps of:

generating a marker program defining the positional relationship of the pattern pieces with respect to one another as the pieces are to be cut from a layup of sheet material spread on the support surface of the cutting table;

spreading a plotting material over the support surface of the penetrable bed;

attaching a writing instrument to the moveable carriage for writing upon the plotting material on the support surface of the table;

driving the moveable carriage and the attached writing instrument relative to the plotting material on the support surface of the table in accordance with the marker program;

deactivating the cutting tool on the moveable carriage during the step of driving with the tool out of engagement with the penetrable support bed and material spread thereon; and

engaging the writing instrument periodically in writing relationship with the plotting material in response to the marker program during the step of driving without penetrating the instrument through the plotting material and the support surface into the penetrable bed to plot the marker on the material.

2. A method of reproducing a marker as defined in claim 1, including the additional step of:

laying a relatively rigid backing material between the plotting material and the penetrable support surface of the cutting table.

3. A method of reproducing a marker as defined in claim 2 wherein:

the step of laying comprises laying an air-pervious backing material over the penetrable support surface; and

an additional step comprises drawing a vacuum under the plotting material through the air-pervious backing material.

4. A method of reproducing a marker as defined in claim 1 wherein the step of generating includes:

placing the patterns for the pattern pieces to be cut in a closely packed array;

reducing the contours of the patterns in the array to point data form; and

processing the point data by standard curve algorithms for the cutting machine to obtain a program of basic machine commands defining relative movements of the carriage and table which movements track the contours of the pattern pieces in the marker in accordance with the point data.

5. The method of reproducing as in claim 4 for an automatically controlled cutting machine having as a cutting tool a motor-driven cutting blade mounted on the moveable carriage and oriented about an axis perpendicular to the table support surface wherein:

the step of processing also includes processing the same point data to obtain basic cutting commands for moving the cutting blade in cutting engagement with sheet material on the support surface tangentially along contours defined by the point data.

6. The method of reproducing as in claim 1 including

the additional steps of:

removing the plotting material from the support surface of the cutting table;

spreading limp sheet material in a layup on the support surface of the cutting table when the plotting material is removed; and

cutting the layup with the cutting tool in accordance with basic cutting commands.

7. A method of reproducing a marker on an automatically controlled cutting machine employed for cutting pattern pieces from limp sheet material and having a reciprocating cutting tool, a penetrable cutting table including a bed of bristles having the free ends of the bristles defining the support surface for the sheet material to be cut and a tool carriage supporting the cutting tool for programmed movement over the table and to permit the tool to penetrate through limp sheet material on the support surface into the bristles in a cutting operation, comprising the steps of:

providing a marker program defining the positional relationship of the pattern pieces with respect to one another as they are cut from the limp sheet material on the support surface of the cutting table;

spreading a rigid backing material on top of the free ends of the bristles forming the support surface;

spreading a plotting material on the rigid backing material;

holding the rigid backing material and the plotting material in place on the support surface defined by the bristles;

attaching a plotting instrument to the tool carriage for movement with the carriage over the support surface and the plotting material on the surface;

driving the carriage and the attached plotting instrument relative to the plotting material on the support surface in accordance with the marker program; and

causing the plotting instrument to create indicia of the pattern pieces on the plotting material as the carriage is driven in accordance with the marker program.

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