

[54] **AUTOMATED SEWING APPARATUS**

[75] Inventors: **Frank Brauns**, Deerfield Beach;
James B. Jones, Lighthouse Point,
both of Fla.

[73] Assignee: **Novatronics, Inc.**, Pompano Beach,
Fla.

[22] Filed: Nov. 16, 1973

[21] Appl. No.: 416,419

[52] U.S. Cl. 112/121.12; 226/33

[51] Int. Cl.² D05B 21/00

[58] Field of Search 112/2, 121.11, 121.12,
112/121.14, 121.29, 121.15, 130, 131, 102,
118, 86, 262; 226/33

[56] **References Cited**

UNITED STATES PATENTS

3,033,140	5/1962	Horne et al.	112/2 X
3,115,999	12/1963	Wythe	226/33
3,515,080	6/1970	Ramsey	112/121.14

3,580,198	5/1971	Teed et al.	112/121.11
3,661,106	5/1972	Huddelston	112/130
3,670,679	6/1972	Campbell	112/262

Primary Examiner—Richard J. Scanlan, Jr.
Attorney, Agent, or Firm—Oltman and Flynn

[57] **ABSTRACT**

Automated sewing system in which upper and lower webs of fabric or the like are fed continuously from supply rolls at substantially constant speed and uniform tension past a web-driven printer, then past sewing machines on an X-Y table whose two dimensional, horizontal movement is programmed by a numerical control apparatus, and then past cutting equipment for cutting individual pieces out of the sewed-together webs. The remainder of the webs is taken up by a takeup roll. The timing of the beginning of the stitching and the piece-cutting operations is controlled by a reference mark printed on the upper web by the printer.

19 Claims 4 Drawing Figures

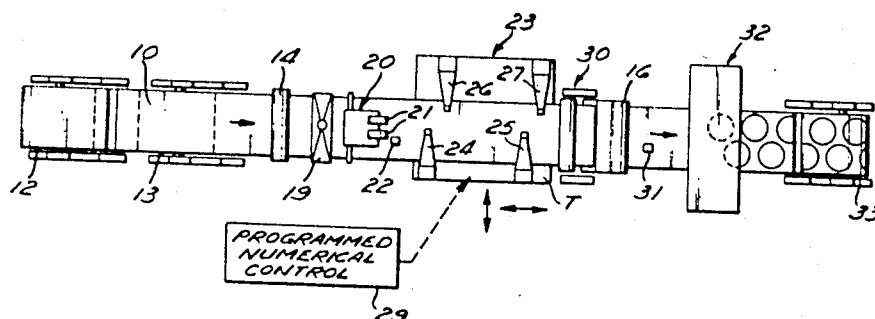
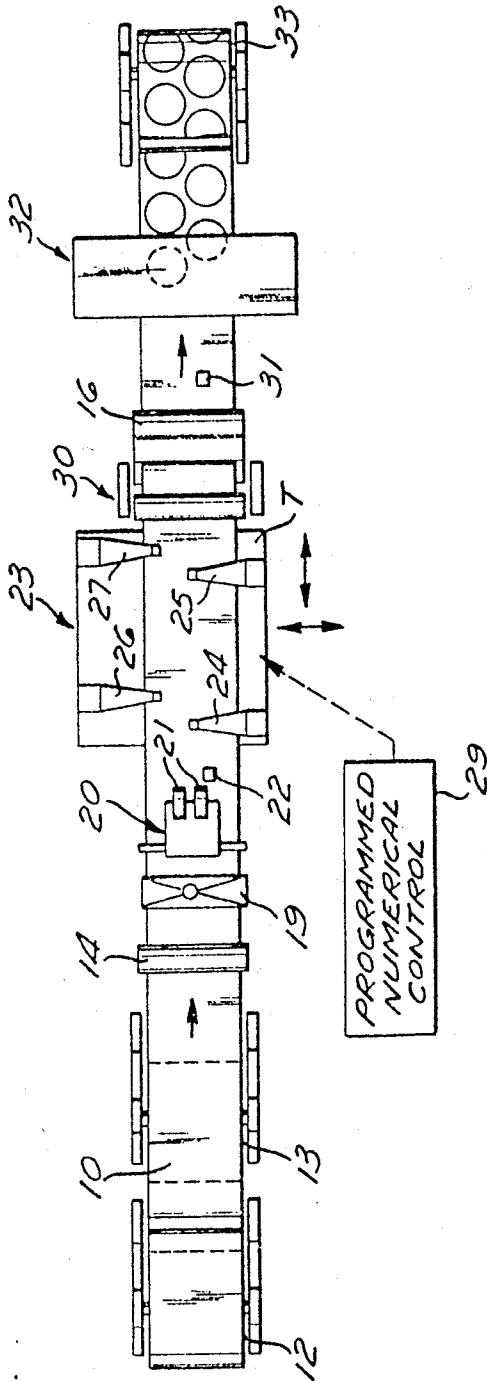
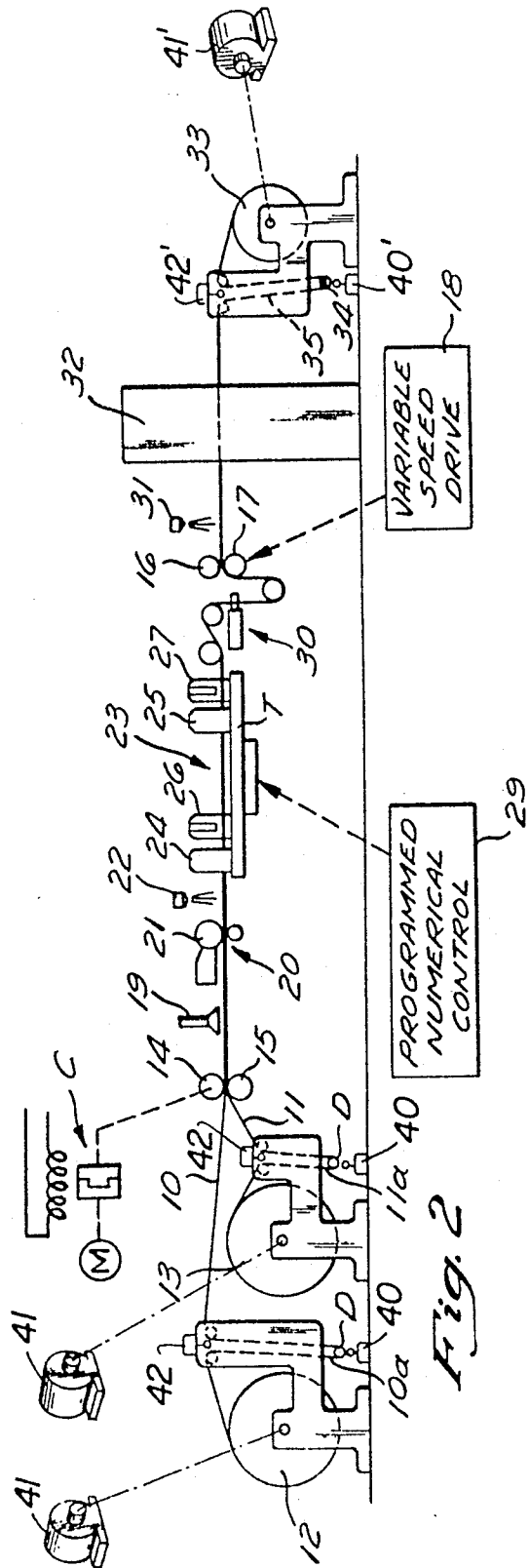


Fig. 1



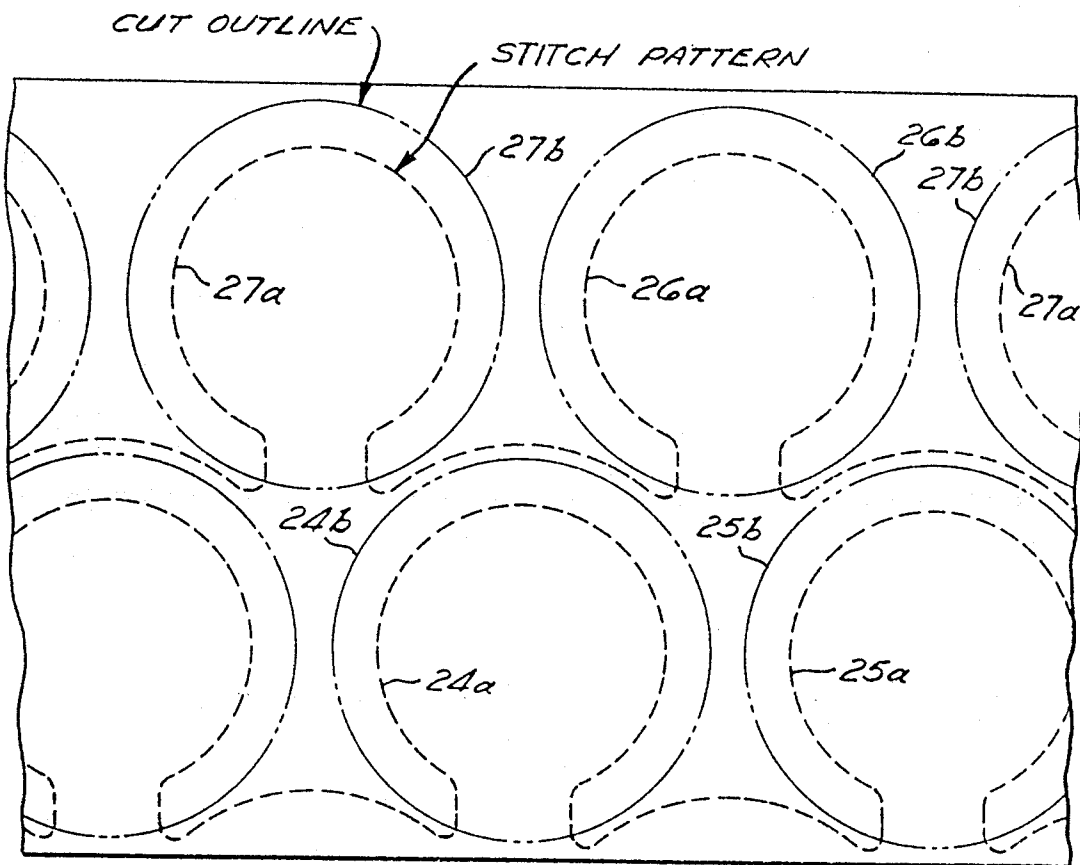


Fig. 3

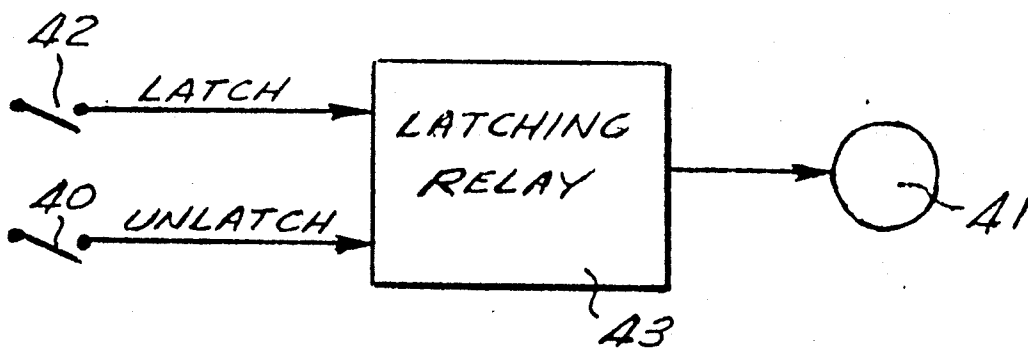


Fig. 4

AUTOMATED SEWING APPARATUS

BACKGROUND OF THE INVENTION

Various partly-automated sewing arrangements have been proposed heretofore in which one-dimensional, longitudinal stitching is performed by one or more sewing machines along one or more lines running in the direction in which the fabric is advanced.

Where the sewing operation itself is automated, the conventional practice has been to index the fabric to each operating station where a given operation (e.g., marking, sewing, cutting) is to be performed. These indexing operations increase the overall time required to process the material beyond the time taken by the processing operations themselves - e.g., marking, sewing, cutting.

There has existed a need for an automated sewing apparatus capable of performing two-dimensional stitching and other operations, such as printing and cutting, automatically at a speed that is determined by the operations of the sewing, printing and cutting devices themselves but is not limited by any need to index the material to each operating position and hold it there while that operation is being performed.

SUMMARY OF THE INVENTION

The present invention is directed to an apparatus for performing programmed, automatic two-dimensional stitching on overlapped, elongated webs of fabric or the like that are advanced continuously at constant speed and under controlled tension from a supply roll. After the sewing operation is performed, individual pieces are cut from the sewed-together webs as they continue to advance uninterruptedly. Preferably, before the stitching operation the upper web is imprinted by a web-driven printing roller, and a printed reference mark on this web is used to time the beginning of the stitching operation and, later, the beginning of the cutting operation. The overlapped webs are engaged by separate sets of rollers located, respectively, at the inlet side of the web-driven printer and at the outlet side of the sewing machines, and these rollers maintain the length of the webs between them under tension while it is advanced continuously at substantially constant speed. In effect, these rollers mechanically isolate or segregate this length of the webs from the web material at the supply and takeup mechanisms, where variable slack loops are provided in the webs.

A principal object of this invention is to provide a novel and improved automated sewing apparatus.

Another object of this invention is to provide such an apparatus in which the web material to be sewed is fed at a continuous, uninterrupted, substantially uniform speed and tension past one or more sewing machines that are programmed to execute automatically a two-dimensional stitching pattern.

Another object of this invention is to provide such an apparatus which minimizes the labor and skill required to sew a predetermined two-dimensional stitching pattern on successive segments of web material.

Another object of this invention is to provide a novel and improved apparatus for automatically sewing a two-dimensional stitching pattern on continuously moving webs and then cutting individual pieces from the sewed-together webs as they continue to advance.

Another object of this invention is to provide a novel and improved apparatus for automatically printing on

a tensioned, continuously moving web, and then sewing a two dimensional stitching pattern through this web and an underlying web that is advanced in unison with it, and then cutting individual pieces from the sewed-together webs.

Another object of this invention is to provide an apparatus as last-mentioned having a printer driven by the upper web itself and in which the beginning of the sewing operation and the beginning of the cutting operation are both controlled by a reference mark printed on that web by the printer.

Further objects and advantages of this invention will be apparent from the following detailed description of a presently-preferred embodiment thereof, which is shown in the accompanying drawings, in which:

FIG. 1 is a top plan view of the present apparatus, shown schematically;

FIG. 2 is a front elevational view of this apparatus;

FIG. 3 is a top plan view of a segment of the web material after the sewing operation has been performed and showing in phantom the outlines of the individual pieces that are to be cut from the sewed-together webs; and

FIG. 4 is a functional electrical block diagram of the drive arrangement for the supply rolls in the apparatus.

Before explaining the disclosed embodiment of the present invention in detail, it is to be understood that the invention is not limited in its application to the details of the particular arrangement shown, since the invention is capable of other embodiments. Also, the terminology used herein is for the purpose of description and not of limitation.

Referring to FIG. 2, two fabric webs 10 and 11 that are to be stitched together come off individual motor-driven supply rolls 12 and 13, respectively. The fabric webs pass into contiguous overlapping engagement with each other between upper and lower tension rollers 14 and 15. Preferably, the two webs have the same width and are coextensive laterally, i.e., perpendicular to their length and the direction in which they are advanced.

Individual dancer rollers D float on slack loops 10a and 11a in the respective fabric webs 10 and 11 between the supply rolls and the tension rollers. These slack loops are produced because the respective supply rolls 12 and 13 are driven by their respective motors at a speed effective to supply web material faster than it is advanced between rollers 14 and 15. Each of these dancer rollers D moves up and down with changes in the web slack between the respective supply roll 12 or 13 and the tension rollers 14 and 15.

When either fabric web is excessively slack between its supply roll and the tension rollers, the corresponding dancer roller D at the bottom of the slack take-up loop in that web will move down far enough to actuate a lower limit switch 40, which turns off the drive motor 41 for that supply roll. This stops temporarily the supply of that web from its supply roll. Gradually, as the slack in that web is taken up by the continuing rotation of the tension rollers 14, 15, the bottom of the slack loop in that web rises until the corresponding dancer roller D actuates an upper limit switch 42. This happens when a substantially zero slack condition of that web is reached. This upper limit switch turns on the drive motor 41 for the supply roll for that web, and this condition prevails until the corresponding dancer roller again actuates the lower limit switch.

As shown in FIG. 4, the drive motor 41 for each supply roll 12 or 13 is controlled by a latching relay 43 of known design. The lower limit switch 40 is normally closed and it controls the unlatching of relay 43. The upper limit switch 42 is normally open and it controls the latching of relay 43. When the dancer roller D moves up and actuates the upper limit switch 42 to its closed condition, this latches the relay 43 in a condition for energizing the motor 41 from a power supply. Relay 43 remains latched and motor 41 remains on until the dancer moves down far enough to actuate the lower limit switch 40 to its open condition. When this happens, relay 43 is unlatched, turning off motor 41. This condition prevails until the upper limit switch 42 is closed the next time by the dancer roller.

Toward the right end of the apparatus in FIGS. 1 and 2, a pair of upper and lower drive rollers 16, 17 engage the overlapped webs 10, 11 between them. The lower drive roller 17 is rotated by a variable speed motor drive 18 at a speed effective to advance the webs faster than they would move if advanced solely by the tension rollers 14, 15. Therefore, the length of the webs between the drive rollers 16, 17 at one end and the tension rollers 14, 15 at the other is under a predetermined uniform tension, and the rollers 14, 15 exert a backward drag on this length of the webs. This drag may be varied by means of a variable rectified voltage that is applied to an electromagnetic clutch C acting between the drive motor M and the upper roller 14, as shown schematically in FIG. 2.

Just to the right of the tension rollers 14, 15 in FIGS. 1 and 2 is located a vacuum-operated lint remover 19. Following this, a printer module 20 prints lettering or any other desired indicia or patterns on the top fabric web 10. Preferably, this printer module has one or more rotatable printing rollers 21 that print on the upper web 10 at uniformly spaced intervals as the two webs are advanced uninterruptedly through the printer module at constant speed. These printing rollers are driven by the webs 10, 11 as the latter advance.

In addition to printing the desired lettering or other patterns, the printer module also prints a reference mark once during each rotation of the printing rollers, and this reference mark is used to initiate the subsequent sewing and cutting operations on this same segment of the overlapped webs. A first photoelectric detector 22 senses this reference mark as the upper web moves past into the sewing station 23.

The sewing station in the apparatus has four single-needle lockstitch sewing machines 24, 25, 26 and 27, all mounted on an X-Y table T that is movable horizontally along perpendicular coordinate axes which respectively extend longitudinally and transversely of the webs. The sewing machines 24, 25 are mounted on the X-Y table at one side of the webs, and the sewing machines 26, 27 are mounted on the opposite side. The sewing machines are offset from one another in sequence lengthwise of the webs so that, without interfering with each other, they stitch four longitudinally offset, identical stitch patterns in the same segment of the webs. These stitch patterns are determined by the horizontal movement of the X-Y table with respect to the longitudinal and transverse coordinate axes and by the continuous constant speed movement of the webs along the longitudinal axis.

The table movement is controlled by a programmed numerical control apparatus 29 of known design which

has a memory in which are stored the X and Y coordinate movement commands for the table. The program can be changed whenever desired by means of a punched tape input into the numerical control console.

FIG. 3 illustrates in dashed lines identical generally keyhole shaped stitch patterns 24a, 25a, 26a, 27a produced simultaneously by the four sewing machines 24-27 so as to be offset from each other on the webs. The stitching pattern shown is for ammunition bags that are later cut from the sewn-together webs by circular cuts along the lines 24b, 25b, 26b and 27b, respectively.

At each machine, as the webs move from left to right in FIG. 3, the stitch pattern begins outside and to the lower right of the circular outline of the respective cut (24b, 25b, 26b or 27b) that is to be made later, and then it proceeds from right to left into this circular outline, following the generally keyholeshaped pattern that is determined by the X and Y incremental movement commands it receives from the numerical control console 29 and by the continuing constant speed movement of the webs 10, 11 from left to right.

The X commands to the sewing machines include a component that compensates for the constant speed longitudinal (X) movement of the webs. This permits the use of an open loop program that terminates when the X-Y table T is back at the original "zero" starting point while the actual needle position of the sewing machine has advanced down the web, from right to left along the web, by a distance corresponding to the web length required for the stitch patterns sewed by the four machines 24-27 on the table. In actual practice a tolerance time interval or overlap is provided so that the X-Y table is back at its original zero position a few milliseconds before the next "zero" point on the webs has coincided with the zero point of the command program from the numerical control console 29.

The "zero" point on the webs that begins the next programmed stitching operation of the four sewing machines 24-27 simultaneously is determined by a timing signal from the photodetector 22 when the latter senses the reference mark printed on the upper web 10. In this manner the keyhole pattern stitching is always properly correlated with the actual position of the printing on the upper web 10, even if for any reason the printing happens to be irregularly positioned lengthwise of the webs. Therefore, a positional error in the printing operation will result in no worse than a waste of web material, but it will not cause the stitching pattern to be mispositioned with respect to the individual imprints on the upper web.

An edge guide control 30 of known design is provided between the X-Y table 28 and the drive rollers 16, 17 for sensing the lateral position of a longitudinal edge of the stitched-together webs 10, 11 and adjusting the transverse position of the webs accordingly, when necessary, to maintain them in proper registration laterally of the direction of web movement.

After the imprinted and stitched together upper and lower webs 10, 11 have passed between the drive rollers 16, 17, they move past a second photoelectric detector 31 and then into a cutting station 32 where the circular cuts 24b, 25b, 26b and 27b (FIG. 3) are made. The timing of the cutters is determined by the photo detector 31, which senses the registration mark on each segment of the printed pattern and initiates the operation of the cutters so that the cut lines are properly po-

sitioned with respect to the imprint and the stitch lines on each portion of this segment of the webs that is to become an individual bag.

Preferably, the cutting operation is performed by a hydraulic press in which the cut bags are driven down through the lower die and stacked below the press for removal.

After the circular cuts have been made in the sewed-together webs, the remainder of the two webs is taken up by a motor-driven takeup roll 33, which is provided with a dancer roller 34 at a slack loop 35 in the webs at its inlet side. This slack loop is produced when the motor 41' for the takeup roll 33 is turned off while the drive rollers 16, 17 continue to advance the remnant web material. When the motor for the takeup roll 33 is on, it drives this roller at a speed effective to take up the remnant web material faster than it is being advanced by the drive rollers 16, 17, and consequently the slack loop 35 is shortened. The dancer roller 34 cooperates with upper and lower limit switches 42' and 40', respectively in essentially reverse manner as the dancer rollers D at the outlet side of the supply rolls 12 and 13. The motor 41' and the limit switches 40' and 42' are connected in a circuit as shown in FIG. 4, which has already been described in detail.

With this arrangement, the drive motor for the takeup roll 33 is turned off when the upper limit switch is actuated by the dancer roller 34, which happens when a substantially zero slack condition is reached at the inlet side of the takeup roll 33. This motor stays off until the lower limit switch is actuated by the dancer roller 34, which happens when the maximum slack condition is reached. The actuation of the lower limit switch turns on the drive motor for the takeup roll 33 and this condition prevails until the upper limit switch is actuated again by the dancer roller 34.

In the operation of this apparatus, the tensioned length of web material between the drive rollers 16, 17 at one end and the tension rollers 14, 15 at the other is effectively isolated or segregated mechanically from the length of web material between the supply rolls 12, 13 and rollers 14, 15, where the slack loops 10a and 11a are provided, and from the length of web material between rollers 16, 17 and the takeup roll 33, where the slack loop 35 is provided. Therefore, the printing and sewing operations which take place on this tensioned length of the web material are not affected by minor irregularities or discrepancies in the operation of the supply and takeup rolls.

It will be apparent from the foregoing description that the present apparatus can operate at a speed determined by the operating capabilities of the printer, the sewing station apparatus, and the cutting apparatus. The movement of the web material between these operating stations is continuous, and it adds nothing to the operating time allowed for these operations. Therefore, the overall productivity of the apparatus is greater than if time would have to be allowed for indexing the web material from one operating station to the next. Also, as already pointed out, the sewing and cutting operations are correlated with the printing operation so that any possible errors occurring in the distinct operations are not cumulative on the finished pieces.

We claim:

1. In an apparatus for sewing together webs of material, said apparatus including sewing machine means,

and means for supplying webs to be sewed together, the improvement which comprises the combination of:

means for moving said sewing machine means along a predetermined two-dimensional stitching pattern; and means for advancing the webs in overlapped relationship continuously at substantially constant speed and under substantially uniform tension past said sewing machine means while the latter are moved through said two-dimensional pattern to sew corresponding stitch patterns in the overlapped webs.

2. Apparatus according to claim 1 and further comprising means for timing the beginning of the two-dimensional pattern movement of said sewing machine means from an imprint on one of said webs.

3. Apparatus according to claim 1, and further comprising means operative in timed relationship with the movement of said sewing machine means through said predetermined two-dimensional pattern for cutting individual pieces from the sewed-together webs after the latter pass said sewing machine means.

4. Apparatus according to claim 3, and further comprising means for timing the beginning of the two-dimensional pattern movement of said sewing machine means, and means for timing the operation of said cutting means from a reference mark printed on one of the webs.

5. Apparatus according to claim 1, and further comprising:

printing roller means driven by the overlapped webs for printing on one of the webs before they reach said sewing machine means;

means ahead of said sewing machine means for sensing a registration mark printed on said one web by said printing roller means and for controlling accordingly the beginning of said two-dimensional pattern movement of said sewing machine means.

6. Apparatus according to claim 5, and further comprising:

means for cutting individual pieces from the sewed-together webs after they pass said sewing machine means;

and means after said sewing machine means and ahead of said cutting means for sensing said registration mark and for timing accordingly the operation of said cutting means.

7. In a sewing apparatus having a sewing machine moving in a two-dimensional stitching pattern, the combination of:

means for advancing web material continuously at substantially constant speed past said sewing machine, said advancing means engaging the web material separately at the inlet and outlet sides of said sewing machine and maintaining the web material under substantially uniform tension as it moves past said sewing machine while said sewing machine is moved through said two-dimensional stitching pattern;

means for providing a slack loop in said web material before it is engaged under tension at the inlet side of said sewing machine;

and means for providing a slack loop in said web material after its tensioned engagement at the outlet side of said sewing machine.

8. Apparatus according to claim 7, and further comprising:

means for printing on the tensioned web material before it reaches said sewing machine;

and means for timing the beginning of said two-dimensional stitching pattern by said sewing machines in accordance with the position of a reference mark printed on said web material by said printing means.

9. Apparatus according to claim 8, wherein said printing means comprises printing roller means driven by the web material as the latter advances continuously.

10. Apparatus according to claim 7, and further comprising cutting means for cutting individual sewed pieces from the web material after its tensioned engagement at the outlet side of said sewing machine and before said last-mentioned slack loop.

11. Apparatus according to claim 9, and further comprising:

cutting means for cutting individual sewed pieces from the web material after its tensioned engagement at the outlet side of said sewing machine and before said last-mentioned slack loop;

and means for timing the operation of said cutting means in accordance with the position of said reference mark on the web material.

12. A sewing apparatus comprising:

at one end, a pair of supply rolls for supplying webs that are to be sewed together;

at the opposite end, a takeup roll for winding up the web remnants;

juxtaposed tension rollers for withdrawing the webs from the supply rolls and for overlapping one web over the other;

juxtaposed drive rollers operative to pulling the overlapped webs forward from the tension rollers uninterruptedly under substantially constant tension and at substantially uniform speed;

and means for moving sewing machine means along a predetermined two-dimension stitching pattern over said overlapped webs between said tension rollers and said drive rollers to sew the webs together as they are advanced continuously at substantially constant speed.

13. Apparatus according to claim 12, and further comprising:

means for driving the supply rolls at a speed effective to unwind the webs faster than they are advanced by said tension rollers, so as to produce slack loops in the webs between the supply rolls and the tension rollers;

and means for starting said supply roll driving means at a minimum slack loop condition of the corresponding web and for stopping said driving means at a maximum slack loop condition of said web.

14. Apparatus according to claim 12, and further comprising:

means for driving the takeup roll at a speed effective to wind up the web remnants faster than the webs are advanced by said drive rollers;

means for stopping said last-mentioned driving means to create a slack loop in the web remnants between said drive rollers and said takeup roll;

and means for starting said last-mentioned driving means at a maximum slack loop condition between said drive rollers and said takeup roll.

15. Apparatus according to claim 13, and further comprising:

means for driving the takeup roll at a speed effective to wind up the web remnants faster than the webs are advanced by said drive rollers;

means for stopping said last-mentioned driving means to create a slack loop in the web remnants between said drive rollers and said takeup roll;

and means for starting said last-mentioned driving means at a maximum slack loop condition between said drive rollers and said takeup roll.

16. Apparatus according to claim 12, and further comprising:

web-driven printing roller means between said tension rollers and said sewing machine means for printing on the top web;

and means for timing the beginning of the pattern movement of said sewing machine means in response to the passage of a reference mark printed on the top web by said printing roller means.

17. Apparatus according to claim 16, and further comprising:

means for cutting individual pieces from the continuously moving webs after they have been sewed together;

and means for timing the operation of said cutting means in response to the passage of said reference mark on the top web.

18. Apparatus according to claim 17, wherein said cutting means is located between said drive rollers and said takeup roll.

19. Apparatus according to claim 18, and further comprising:

means for driving the takeup roll at a speed effective to wind up the web remnants faster than the webs are advanced by said drive rollers;

means for stopping said last-mentioned driving means to create a slack loop in the web remnants between said cutting means and said takeup roll;

and means for starting said last-mentioned driving means at a maximum slack loop condition between said drive rollers and said takeup roll.

* * * * *