# United States Patent [19]

**Neill et al.**

[11] **3,820,484**

[45] **June 28, 1974**


[54] **CAP MAKING APPARATUS AND METHOD**


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[73] Assignee: **International Paper Company**, New York, N.Y.



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[21] Appl. No.: **275,353**

[52] **U.S. Cl.**... **112/121.26**, 112/121.11, 112/121.24, 112/262, 2/192

[51] **Int. Cl.**..... **D05b 21/00**

[58] **Field of Search**..... 112/121.26, 121.24, 121.18, 112/121.15, 121.12, 121.11, 2, 262, 269, 104, 122, 128; 2/224, 192; 156/251, 160; 223/15



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 1,243,089 | 10/1917 | Merrow | 112/121.24 X |
| 1,788,417 | 1/1931 | Weis | 112/121.24 |
| 2,188,488 | 1/1940 | Talmadge | 112/262 |
| 2,266,538 | 12/1941 | Evans | 112/121.26 |
| 2,317,698 | 4/1943 | Stotz | 112/121.24 X |
| 2,976,199 | 3/1961 | Rand | 156/251 X |
| 3,477,398 | 11/1969 | Weigert | 112/104 |
| 3,505,149 | 4/1970 | Sanchez | 156/160 X |
| 3,604,015 | 9/1971 | Dove | 2/224 |
| 3,669,046 | 6/1972 | Fowler | 112/121.15 |



*Primary Examiner*—James R. Boler

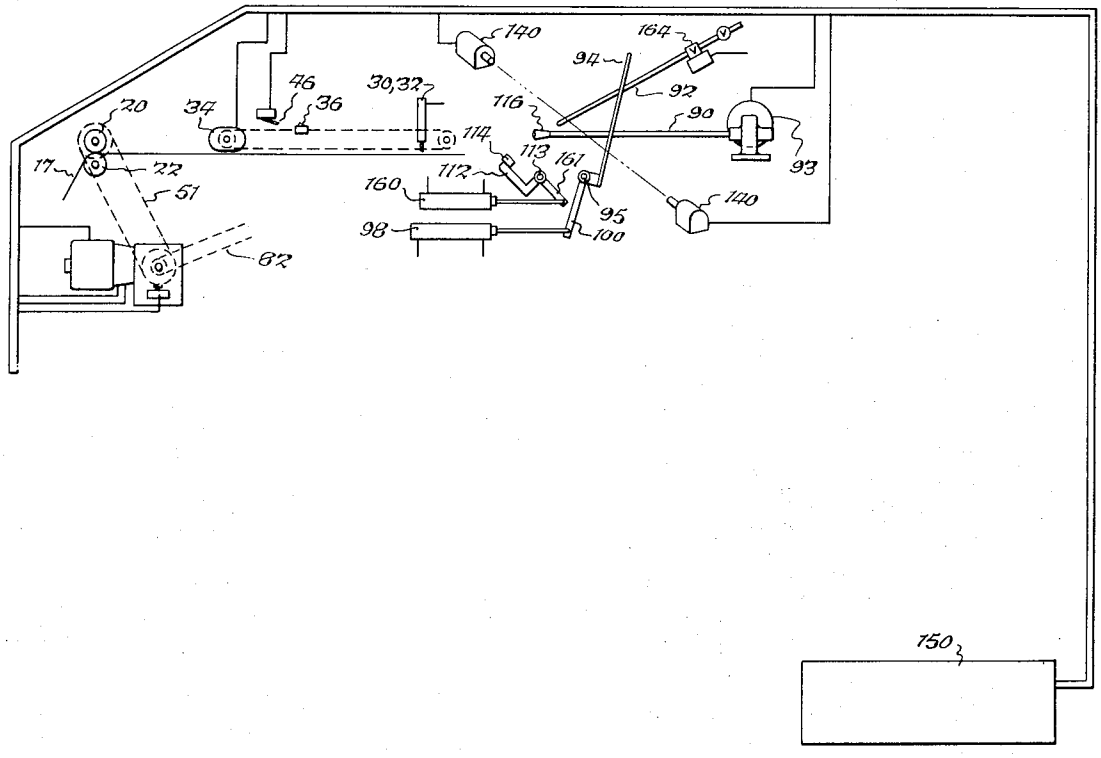
*Attorney, Agent, or Firm*—Gary A. Walpert

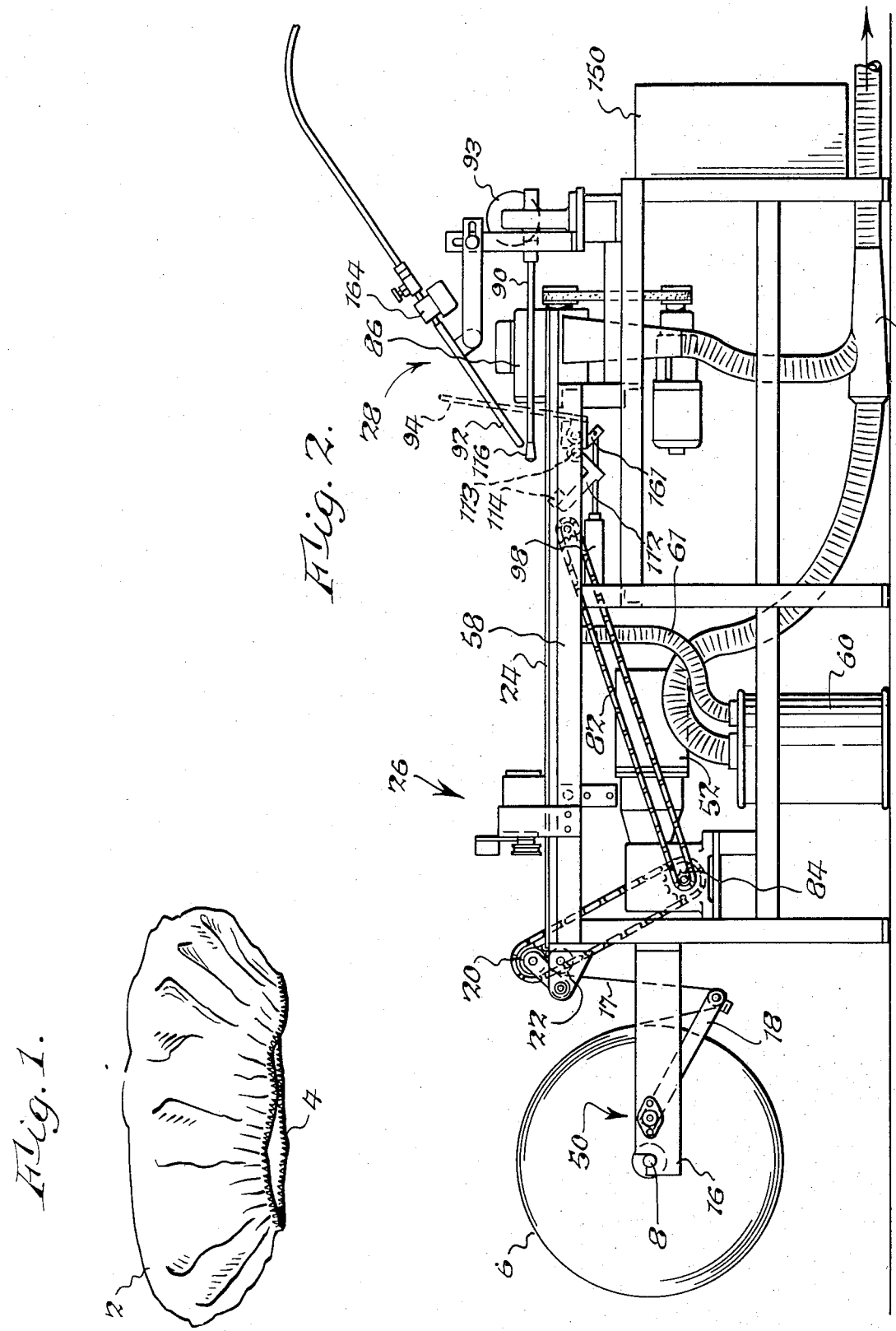


[57] **ABSTRACT**

A cap making apparatus and method where a body of a fabric piece is rotated along an axis through its central portion and in timed relation to the movement of an edge of the fabric through a sewing machine. A stretched elastic material is attached by the sewing machine to the fabric piece along a closed curve. In one embodiment, excess fabric is trimmed during rotation of the piece, and the axis is fixed, the curve thereby becoming a closed circle. Rotational movement may be transmitted to the central portion by gripping and rotating that portion.


**6 Claims, 15 Drawing Figures**




Fig. 2.
Fig. 1.
2
4
6
8
16
17
18
20
22
24
26
28
50
52
58
60
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86
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93
94
98
150
164
761
772
773
774
776
778

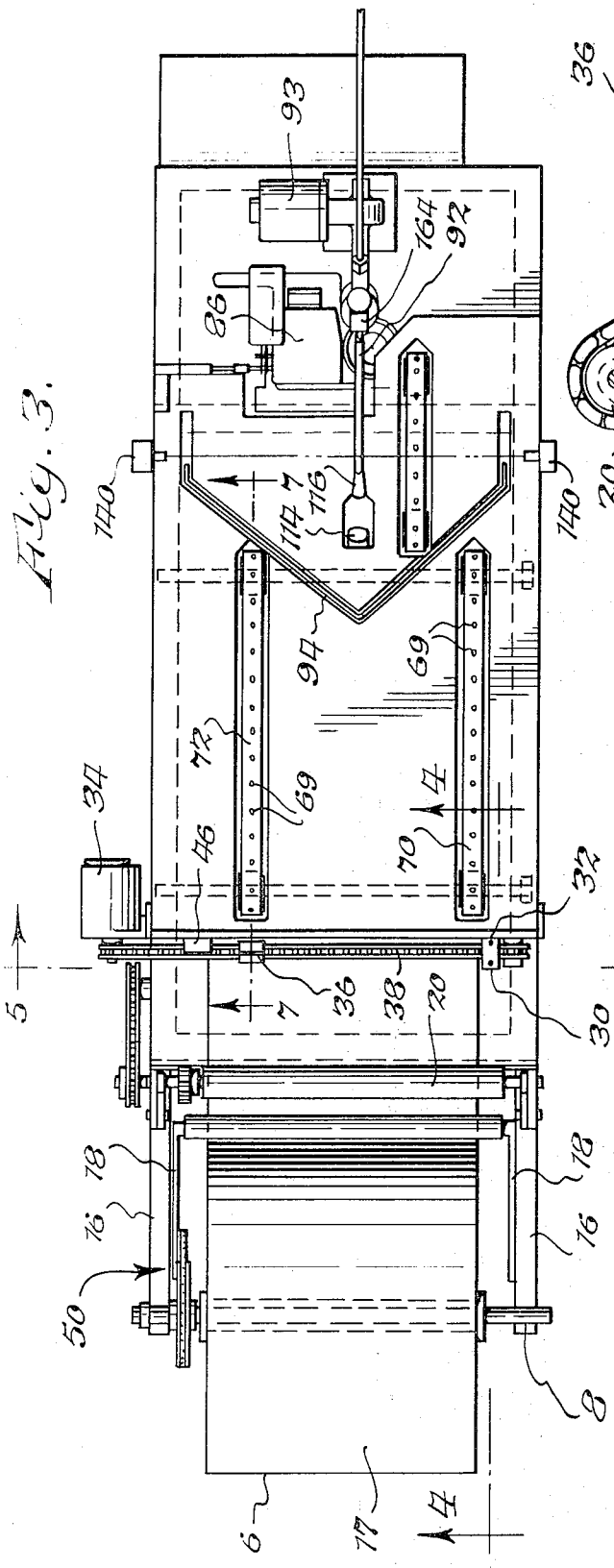


Fig. 3.

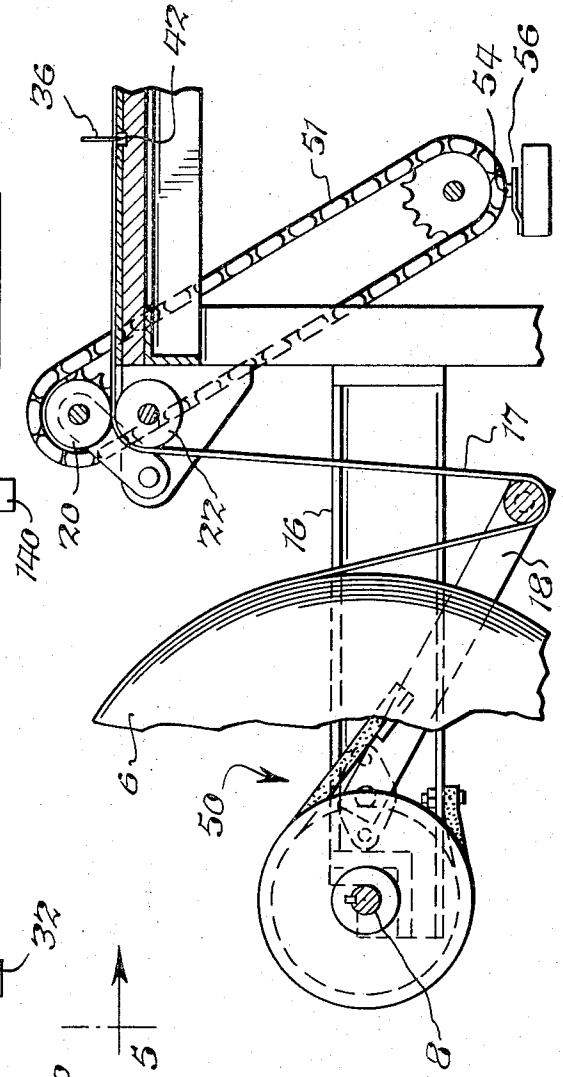


Fig. 4.

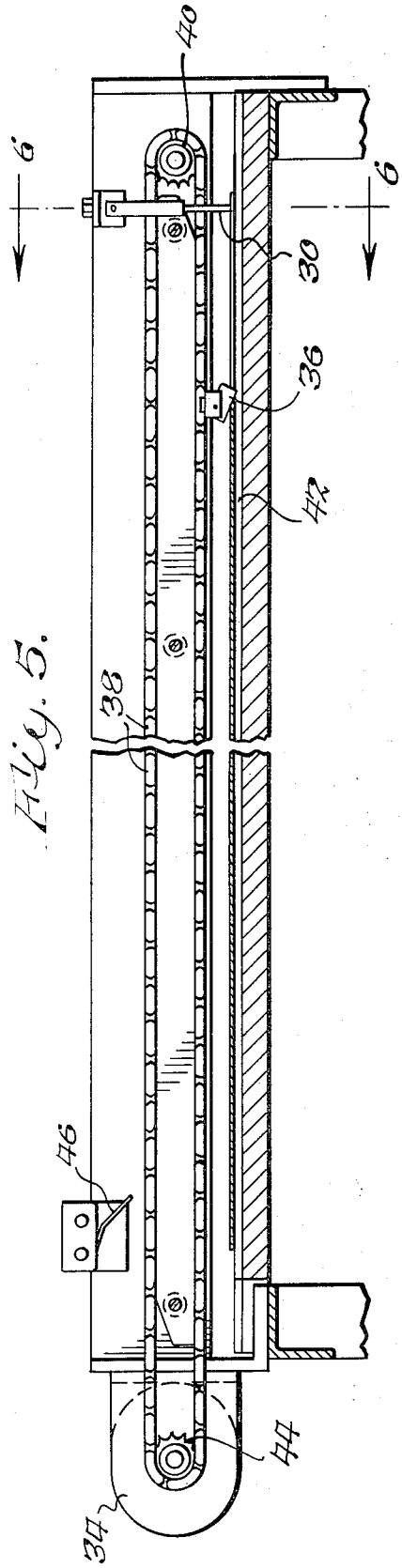



Fig. 5.

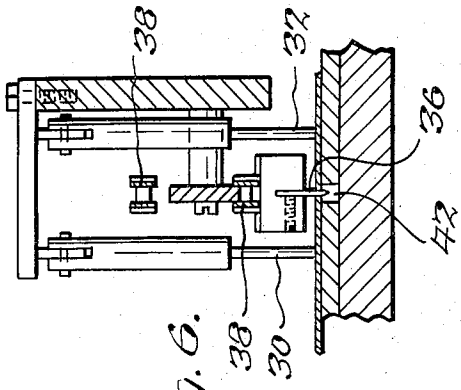



Fig. 6.

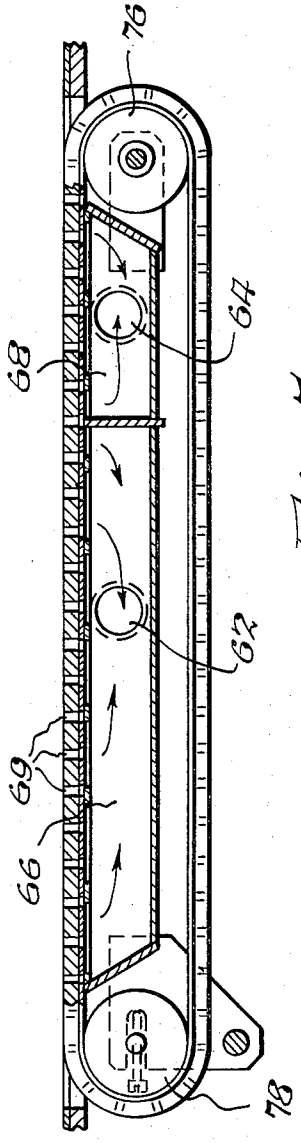
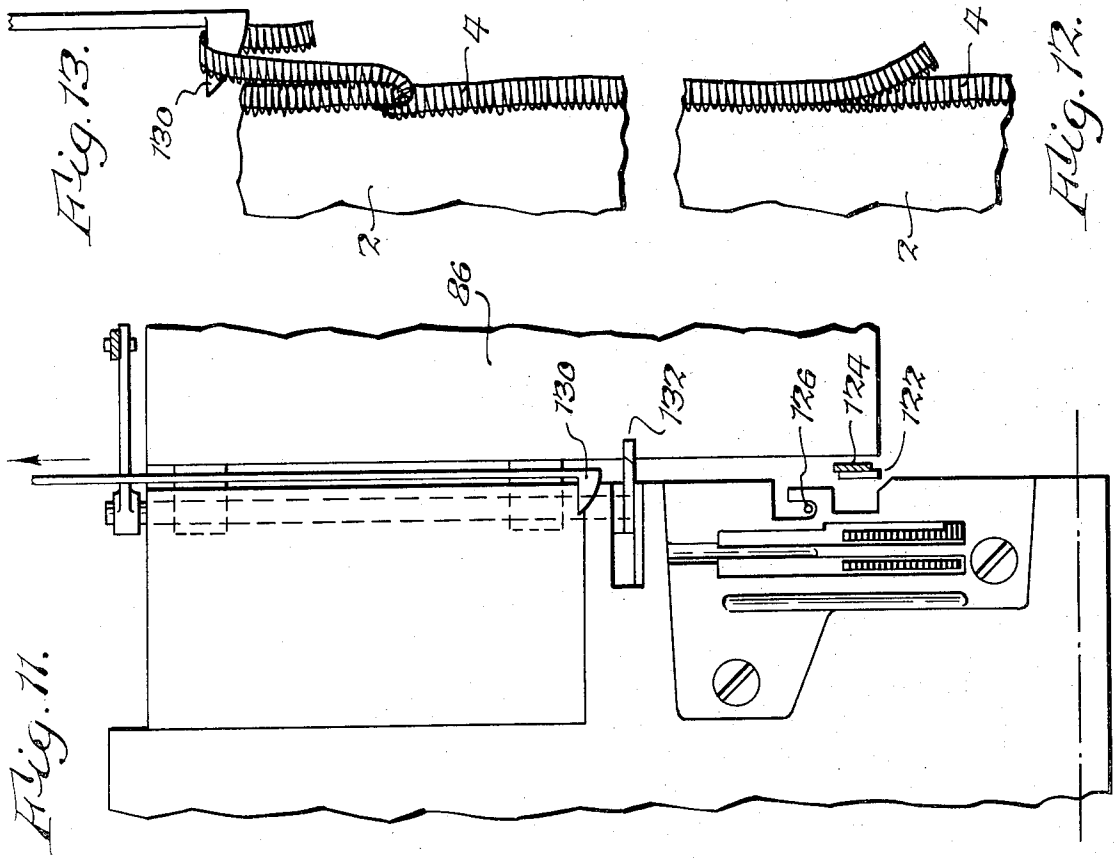
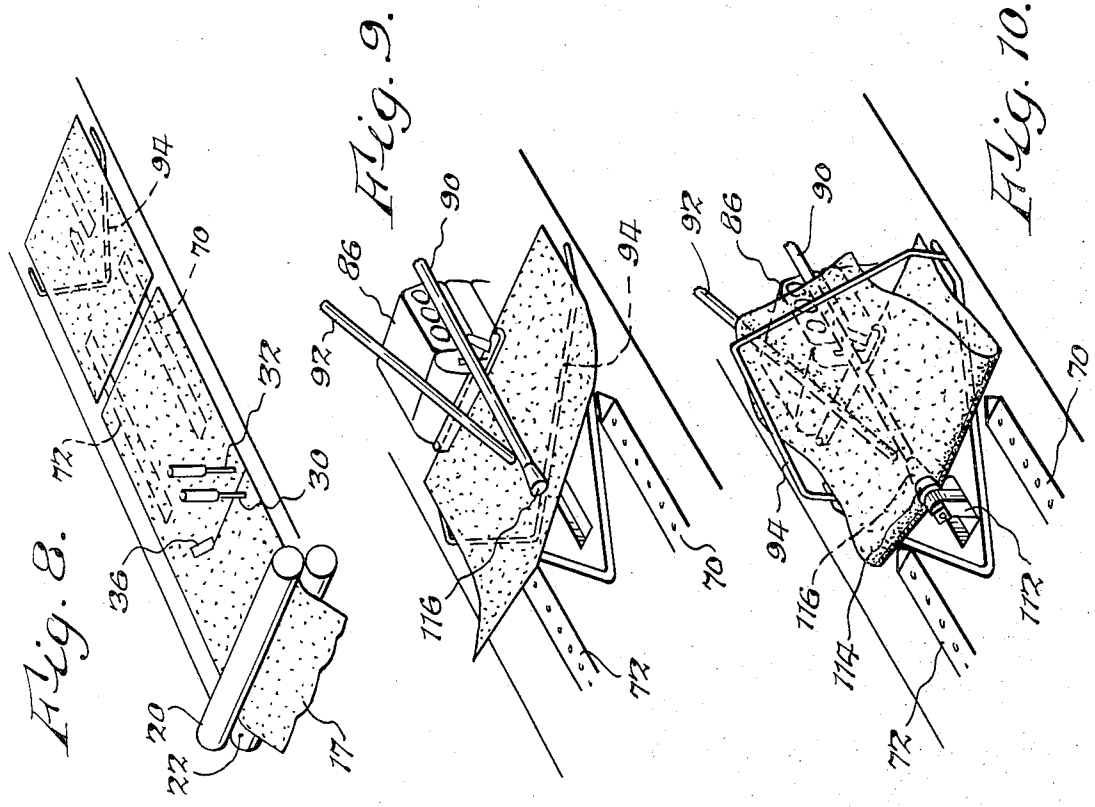



Fig. 7.


Fig. 13.
130
4
2
Fig. 12.
4
2
Fig. 11.
86
130
132
126
124
122


Fig. 8.
94
70
72
32
30
36
20
22
17
Fig. 9.
90
86
92
94
100
116
74
70
Fig. 10.
92
86
90
94
116
114
74
112
70

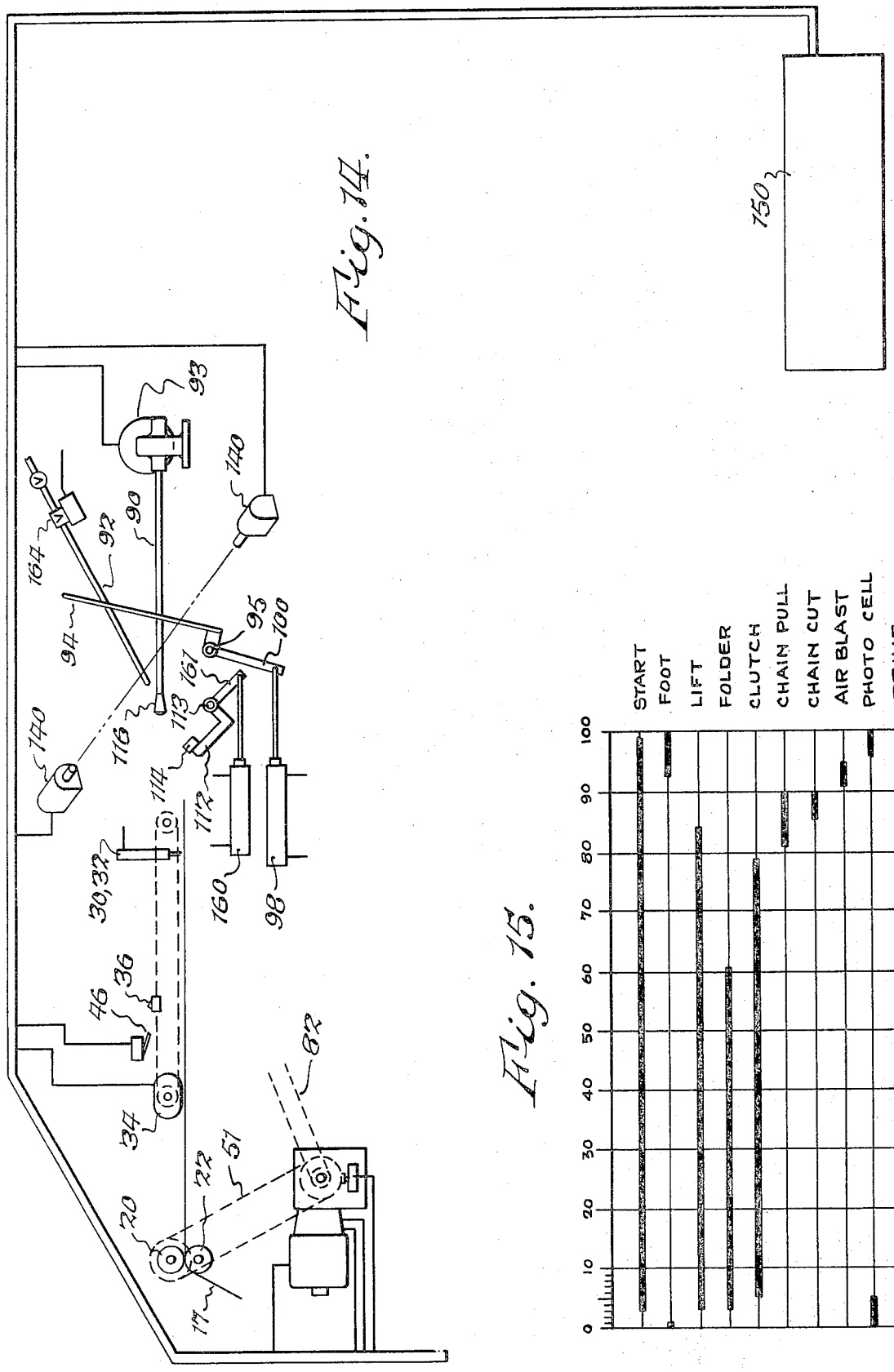

150
93
140
164
92
90
94
95
100
161
113
116
114
112
140
30,32
160
98
36
46
34
62
72
51
20
17

Fig. 14.


START
FOOT
LIFT
FOLDER
CLUTCH
CHAIN PULL
CHAIN CUT
AIR BLAST
PHOTO CELL
DRIVE
0
10
20
30
40
50
60
70
80
90
100

Fig. 15.

# CAP MAKING APPARATUS AND METHOD

## BACKGROUND OF THE INVENTION

The invention relates to an apparatus and method for making caps. More particularly, it relates to an apparatus and method for automatically sewing a stretched elastic material to a nonwoven fabric piece to produce the cap.

A primary use of caps made according to the invention is in hospitals where many procedures require maintaining sanitary conditions. In these situations such caps provide both men and women, expecially nurses, with the necessary means to prevent their hair for contaminating the surroundings, for example, the operating room, while at the same time providing both comfortable and inexpensive wearing apparel. It is a preferred procedure in the hospital environment to dispose of the cap after each wearing. Thus, at least in that circumstance, it is desirable to produce an inexpensive finished product, for example, by using an automatic apparatus capable of handling inexpensive nonwoven materials.

It is therefore one object of this invention to provide an improved method of and apparatus for making caps.

It is another object of this invention to provide an automatic apparatus and method for making such caps efficiently, easily and inexpensively from a roll of nonwoven fabric web while maintaining a high output rate.

## SUMMARY OF THE INVENTION

The method aspect of the invention comprises rotating a fabric piece about an axis through a central portion of the piece; and in timed relation thereto, simultaneously attaching a stretched elastic material to the fabric peice in a predetermined closed curve around its axis of rotation.

More particularly, the method also includes forming the fabric pieces by severing them from a continuous web of fabric and thereafter folding each piece approximately in half before gripping and rotating the fabric piece, and sewing the elastic material to it. Another aspect of the method includes trimming the fabric piece during dewing to form a circular disc and removing the waste rim material. Termination of the sewing and trimming operations completes the cap after which the thread and elastic material are severed and the finished cap is ejected by a short blast of air.

The apparatus aspect of the invention comprises means for rotating a fabric piece about an axis through a central portion of the piece and means; operative simultaneously and in timed relation to the rotating means is means for attaching a stretched elastic material to the fabric piece in a predetermined closed curve around the axis of rotation.

More particularly, the apparatus aspect of the invention comprises a sewing machine for sewing the elastic material in a closed circle. The means for rotating includes means for gripping the central portion of each fabric piece and rotating it about its central axis in timed relation with the operation of the sewing machine. A trimming means is included for example ahead of the sewing needle and radially outward from the attaching means to trim waste material off the fabric piece and to cut the fabric piece into a disc as the fabric rotates.



In a particular embodiment, the apparatus includes means for feeding fabric from a continuous roll, a cutting means to sever the web at predetermined lengths, and means to advance the predetermined lengths of fabric to the attaching means.

Other objects, features and advantages will appear from the following description of a preferred embodiment and method of the invention, taken together with the attached drawings thereof, in which:

FIG. **1** is a front elevation view of a cap made by the process and apparatus of this invention;

FIG. **2** shows a front elevation view of a preferred embodiment of the apparatus according to the invention;

FIG. **3** shows a top plan view of the apparatus of FIG. **3**;

FIG. **4** is a vertical sectional view along line **4—4** of FIG. **3**;

FIG. **5** is a vertical sectional view along line **5—5** of FIG. **4**;

FIG. **6** is a vertical section along line **6—6** of FIG. **5**;

FIG. **7** is a vertical section along line **7—7** of FIG. **3**;

FIG. **8** is a schematic perspective drawing of the fabric being fed onto the table of the machine;

FIG. **9** is a schematic perspective drawing showing the fabric being lifted upwardly;

FIG. **10** is a schematic perspective drawing showing the fabric folded over and gripped around its central portion by the rotating means;

FIG. **11** is a plan view of the sewing machine portion of the apparatus according to the invention;

FIG. **12** is a view of the finished chain elastic junction after the elastic is cut;

FIG. **13** is a view of the elastic being hooked;

FIG. **14** is a schematic layout showing the power and control components of a preferred apparatus; and

FIG. **15** is a timing chart of a complete cycle of a preferred embodiment of the invention.

## DETAILED DESCRIPTION

Referring now to FIG. **1**, the cap made by the inventive method and apparatus includes a body **2** and an elastic portion **4.** The elastic portion gathers the material of the body along its edge in a shirring effect and serves to retain the cap on the wearer's head. Referring now to FIG. **2**, a preferred embodiment of the invention includes a roll **6** of fabric, for example, a nonwoven, continuous web fabric, journaled for rotation about a shaft **8** which is supported by a horizontally extending support member **16.** Support member **16** is rigidly attached to a main table frame **19.** A web fabric **17** from roll **6,** is fed around a tension arm **18** and through feed rollers **20** and **22** onto a table feed surface **24.** A predetermined measured length of fabric is fed by feed rollers **20, 22** along the table feed surface to a cutting means **26** where the web is severed into a substantially square-shaped piece. The cut fabric piece is advanced further along the table upper surface and is positioned at the attaching means **28.** A stretched elastic material is attached to the fabric piece along a predetermined closed curve, and it is preferred that a trimming means be positioned adjacent the attaching means to cut excess material from the square-shaped fabric piece. Ex-

cess fabric is disposed of through a fabric removal system. Upon completion of a finished fabric cap, the cap is removed from the apparatus, for example ejected by a short blast of air.

More particularly, feed rollers **20, 22** are pinch rollers which unwind the roll of fabric in a predetermined manner. The rotational motion of the roll is controlled by a brake mechanism **50.** In this particular embodiment, the continuous web **17** of fabric is advanced by the frictional force applied by upper feed roller **20** which is a driven roller. As the web is advanced, nearly constant tension is maintained in the continuous fabric web by a downward gravitational force from a tension bar **18** which operates in conjunction with brake mechanism **50,** the latter positioned in horizontally extending support **16.** (See FIG. 4). In operation, as the tension bar begins to pivot downward, an indication that the web is unrolling at a too rapid rate, its journaled end causes the braking mechanism to apply pressure to shaft **8,** thereby slowing, and in an extreme position stopping, rotation of the roll of web. There results a give and take relationship whereby proper feed of web from the roll in maintained.

The length of fabric web which is advanced is determined by a chain link connection **51.** The chain link connection **51** drives upper feed roller **20** from a driving motor **52** and effects feeding of a predetermined amount of fabric web to and past the cutting means. In this embodiment, operation of the chain drive power is initiated by a main cam line control timer **150.** The measurement is completed when a cam block **54** comes around to trigger a limiting switch **56** which, in turn, causes the power from the driving motor to be turned off. The length of the chain link connection **51** thereby determines the length of fabric which is advanced.

The continuous fabric web is now in position to be cut (FIG. 8). The cutting means includes, in this embodiment, a pair of hold-down bars **30** and **32** (FIGS. **6, 8**) which when operative, descend, pinning the fabric against the table upper surface, thereby holding the fabric stationary and in place. At the same time, a motor **34** is started, which advances a cutting blade **36,** mounted on a chain link **38,** into position for cutting the fabric web. As blade **36** rotates around a geared roller **40,** the fabric web is intersected and severed as shown in FIG. **8.** The blade, which extends below the surface of the web into a transverse groove **42,** traverses the width of the fabric web. After the blade travels the entire width of the fabric web and rounds a driven gear roller **44,** it triggers a limit switch **46** which terminates power to motor **34.** Hold-down bars **30** and **32** are raised to an inoperative position, releasing the cut, substantially square-shaped, fabric piece.

At the completion of the cutting operation, a conveyer system, here a vacuum conveyer system **58,** advances the cut fabric piece from the cutting means into position at the attaching means **28.** The vacuum conveyer system **58,** shown in greater detail in FIG. **7,** comprises a vacuum source **60** (FIG. 2) connected flexibly via duct **61** to openings **62** and **64** in chambers **66** and **68,** respectively. Air is exhausted from the chambers thereby creating a partial vacuum. In this manner, a small quantity of air is suctioned through openings **69** in conveyer belts **70, 71,** and **72** (FIG. 3). Conveyer belts **70, 71,** and **72** are made, for example, of a relatively dense material having very dense, small cell construction, such as, for example, sponge. Thus very little air passes through any part of the belt except through the holes **69** as intended. The belts are driven in a feed direction (see FIG. 7) by a driven roller **76,** roller **76** being driven by a chain link drive **82** which derives its power from a driven shaft **84** (FIG. 2). Rotating roller **78** is free wheeling. The fabric is thus pulled flat against upper surface **79** of the belts, the upper surface being flat with respect to the upper surface **24** of the main table frame. In this manner, the movemment of the cut fabric piece is precisely controlled by controlling the movement of the belts.

The cut fabric piece is advanced by the vacuum conveyer to the attaching means where the piece is positioned so that it lies ready to receive the stretched elastic. In this embodiment, the attaching means includes a sewing machine **86** and the fabric piece lies beneath sewing needle **126.** The body of the fabric piece also lies beneath a driver rotating member, here a shaft **90** and a hollow shaft **92.** Rotating shaft **90** is, in this embodiment, continuously driven by motor **93.** With the fabric piece in place at the sewing machine, a folder member, comprising, in this embodiment, a wire frame **94,** pivots around point **95** from an inoperative position beneath the surface of the table, to an operative position out of the plane of the table surface, thereby lifting the fabric and folding it upon itself, and around hollow shaft **92** and rotating shaft **90** (FIGS. **9** and **10**). The means to pivot wire frame **94** comprises an air operated solenoid **98** which is operatively connected to an extension member **100** from the folding member, (See FIG. **14**). Thus as the solenoid pulls in, the folding member pivots to the operative position.

A means for rotating the fabric imparts a rotational force along an axis through a central portion of the fabric piece. The rotation of the central portion is conditioned to be in timed relation to the movement of the fabric through the sewing machine when the elastic material is attached to the fabric. In this particular embodiment, the axis of rotation is fixed and coincides with the axis of shaft **90.** The means for rotating the fabric includes a driven rotating surface **116,** an end surface of shaft **90,** and a mating, freely rotatable member **112,** having a freely rotatable surface **116.** In operation, mating rotatable member **112** pivots around pivot point **113** from an inoperative position beneath the upper surface of the table to an operative position opposite surface **116** of rotating shaft **90.** Pivoting of mating rotatable member **112** is effected by actuation by the control timer **150** of air operated solenoid **160** in conjunction with an extended arm member **161** of mating member **112.** When the folding wire frame and mating member attain their operative positions (FIG. **15**), the fabric piece assumes roughly a conical form and a central portion is gripped between surfaces **114** and **116.** Mating surfaces **114** and **116** are somewhat spherically shaped to present a smooth surface to the fabric body. Thus, in this particular embodiment, surface **114** rotates in response to the rotational force from rotating shaft **90** transmitted through the rotating central portion of the fabric piece.

The fabric is now prepared to receive the stretched elastic material. Thus, with the fabric folded over upon itself and gripped between surfaces **114** and **116,** the attaching means, here comprising the sewing machine, begins operation. In this particular embodiment, simultaneous with the operation of the sewing machine, that is, as the fabric advances through the machine, a trim-

ming means operates to trim the relatively square-shaped fabric piece to a predetermined closed curve.

It is important to observe that the rotational speed of the rotating shaft **90** must correspond to the speed of movement of the fabric piece edge through the sewing machine. Thus by correctly controlling the rotational speed of rotating shaft **90,** so that the body of the fabric piece rotates about an axis through its central portion in a timed relation to the movement of the fabric piece edge through the sewing machine, the body of the fabric "keeps up" with the movement of the fabric edge, thereby preventing twisting, stretching or other undesired distortion or damage to the fabric. Thus rotation of the fabric body is controlled by the sewing machine and the rotating shaft. It is equally important to observe that as the mating surfaces **114** and **116** grip the fabric, the body will begin to rotate. It is therefore essential that the timing control **150** be arranged to begin attaching the stretched elastic material to the fabric at the precise moment that the body of the fabric begins to rotate under the influence of the mating surfaces.

As mentioned above, the attaching means includes sewing machine **86** which is a standard sewing machine adapted for sewing the stretched elastic material to the fabric piece using, in this preferred embodiment, a cross-chain stitch. The fabric piece is brought into position about the sewing needle **126** held in position by the presser foot (not shown). As the fabric piece is fed through the sewing machine the attached material describes a curve of attachment defined by the axis of rotation of the fabric and the sewing machine. The trimming means, which in this embodiment includes upper and lower trim knives **122** and **124** (see FIG. **11**), trims away excess fabric. Thus, the trim knives are positioned just radially beyond the attaching means and slightly in advance of the sewing needle **126.** When, as in this embodiment, the axis of rotation and the sewing machine are fixed in position, the fabric piece is trimmed to a circular disc. The excess trimmed fabric is removed from the vicinity of the sewing machine needle **126** by the fabric disposal system, here including eductor unit **128,** a vacuum device. As the sewn fabric piece exits from the sewing mechanism, the attached elastic relaxes and the fabric gathers.

When the sewing operation is completed, that is, when the elastic has begun to overlap itself, fabric edge movement ceases as stitching terminates and simultaneously body movement ceases as mating member **112** is pivoted to its inoperative position. This sequence of events is accomplished by predetermined timing built into control timer **150.** Thereafter, hook **130** originally in an inoperative position (FIG. **11**), operates to further tension the elastic (FIG. **13**), and knife **132** cuts the elastic material (FIG. **12**). The presser foot releases and the cap is now free of the apparatus.

After the elastic cutting operation, the cap is removed from the apparatus. A short blast of air through hollow shaft **92,** which is now interior of the central portion of the cap, ejects the cap from the machine so that a new fabric piece can be advanced into position.

A sensing means is used to ensure that the finished cap has been removed from the apparatus. In this embodiment, the sensing means comprises a photocell system **140** (FIG. **14**). The beam of the photocells traverses the area from which the finished cap is removed. If the cap is still there, thus in a position to interfere with later manufacture, the beam is blocked and a signal indicating that there is an obstruction is transmitted to the timing control **150.** Receipt of such a signal when the area is supposed to be clear is effective to cause the timing control to shut down the apparatus.

Having described the various operations of a particular embodiment of the invention, a preferred interrelationship of these operations will be described to achieve operational efficiency of the automatic apparatus. In some embodiments it may be preferable to perform the operations serially and with no overlap. However, in the preferred embodiment the operations overlap to enable the apparatus to attain a greater output capacity. It is thus necessary to have accurate timing and control means. Preferably, the standard cam line control timer **150,** as is well known in the art, is used to achieve the required timing and control. One such Control Timer is Model Series 47 of the Replaceable Switch Cycle Timer Division of Vocaline Company of America, Inc.

In the particular embodiment of the invention (referring to FIG. **15**), a complete cycle, required to produce one cap, takes 6.67 seconds (nine turns of the cam line per minute). The cycle is divided into one hundred time intervals. The interrelation of method operations is as follows: Towards the end of the cycle, after ejecting the just finished cap with the air blast through hollow shaft **92,** the sensing means, photocells **140,** are turned on to ensure that the operational area is clear, that is, that the cap has been removed. While the photocells are on (at the beginning of the next cycle) the presser foot of the sewing machine, which was in a released position, clamps down upon a new fabric piece which has reached and is in position at the attaching means. A few moments later both the mating member **112** and the pivoting wire frame **94** begin to pivot into position, folding the fabric upon itself and gripping the fabric body against rotating surface **116** of rotating shaft **90.** The pivoting action is accomplsihed through the operation of solenoids **160, 98,** activated on command of the control timer **150.** In this particular embodiment, the rotating shaft is always turning and, as the fabric body is gripped, it begins to turn in response to the torque applied from surface **116.** Simultaneously, the sewing machine clutch is released and the sewing operations begins on the newly positioned fabric piece. Approximately two-thirds through the cycle, the wire frame pivots back to its initial inoperative position beneath the table. At approximately time interval seventy-nine, the sewing operation stops as the mating surface member pivots to its inoperative position beneath the surface of the table. The stretched elastic material is then pulled and cut. During the time interval in which the elastic is being pulled, the vacuum conveyer drive begins to advance a newly cut fabric piece forward into position at the attaching means. After the elastic is cut, an air blast, as a result of operation of solenoid valve **164,** ejects the finished cap from the automatic apparatus as the presser foot releases freeing the finished fabric cap. After the air blast, the newly cut fabric piece reaches its final position at the sewing machine and the sensing means again turns on to ensure that the last finished cap has been ejected. The cycle repeats itself, automatically producing caps at the rate of nine per minute.

Other embodiments will occur to those skilled in the art and are within the following claims.

What we claim is:

1. A method of forming a cap comprising the steps of

rotating a fabric piece about a stationary axis through a central portion of the piece,

simultaneously: *a*) trimming material from the fabric piece as it rotates to form it into a circular disc, and *b*) attaching a stretched elastic material from a source supply to the edge of the disc,

further stretching the elastic material after a predetermined length has been attached to the rotating disc, and

severing the elastic material from its source of supply.

2. The method of claim 1 further including the steps of

cutting the fabric piece from a source of web material, and

advancing and positioning the fabric piece for rotation.

3. Apparatus for forming a cap including

a source of nonwoven continuous web fabric,

cutting means for severing the web into fabric pieces,

means to advance the fabric pieces, one after the other, to an attaching means,

means for rotating a fabric piece about an axis through a central portion of the piece, said rotating means including means for gripping the central portion of the fabric piece,

means, operative simultaneously and in timed relation to the rotating means, for attaching a stretched elastic material to the fabric piece in a predetermined closed curve around the axis of rotation, and

trimming means positioned radially outward of the attaching means and operative in timed relation thereto for removing excess material from the fabric piece.

4. Apparatus for forming a cap including

means for rotating a fabric piece about an axis through a central portion of the piece,

said rotating means including a driven rotating member and a mating, freely rotatable member, said members having an operative relationship in which the fabric is gripped between the two members and rotated,

means, operative simultaneously and in timed relation to the rotating means, for attaching a stretched elastic material to the fabric piece in a predetermined closed curve around the axis of rotation,

a main table frame having a feed surface, wherein the driven rotating member has a rotating surface which lies at an angle to the feed surface,

means for folding the fabric piece substantially in half, and

means for supporting the folded fabric, the folded fabric enclosing the driven rotatable member and being in contact with the rotating surface of the driven member.

5. The apparatus of claim 4 wherein the folding means includes a wire frame, the frame being pivotable from beneath the fabric piece to effect folding of the fabric piece.

6. Apparatus for forming a cap including

means for rotating a fabric piece about an axis through a central portion of the piece,

said rotating means including a driven rotating member and a mating, freely rotatable member, said members having an operative relationship in which the fabric is gripped between the two members and rotated,

means, operative simultaneously and in timed relation to the rotating means, for attaching a stretched elastic material to the fabric piece in a predetermined closed curve around the axis of rotation,

a tensioning hook,

means for moving said hook to further stretch the elastic material,

a knife member, and

means for actuating said knife member for cutting the further stretched elastic material.

* * * * *

# UNITED STATES PATENT OFFICE
# CERTIFICATE OF CORRECTION

Patent No. 3,820,484 Dated June 28, 1974

Inventor(s) William M. Neill; George A. Burt, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 48, the word "rim" should be "trim".

Column 4, line 16 insert "a" after "beneath".

Column 5, line 27, the word "about" should be "above".

Column 6, line 39, the word "accomplsihed" should be "accomplished".

Column 6, line 46, the word "operations" should be "operation".

Column 8, line 1, the word "sad" should be "said".

**Signed and sealed this 5th day of November 1974.**

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents