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54 **Manufacture of an expanded web of sheet material.**

57 A sheet of material is passed through meshing rotary shearing and forming dies to form rows of convolutions 16 which in each row are separated by an undeformed neutral zone N between each pair of adjacent convolutions. The rows are staggered so that the peak of a convolution in one row coincides with the troughs in adjacent rows and vice versa but the neutral zones coincide to maintain the integrity of the expanded web. The expanded web 12 can then be laminated to a plane sheet 11. The resulting structure is useful as a cigarette wrapper which is wrapped around a tobacco rod through which the longitudinal air flow is as shown by the arrow. The dimensions and periodicity of the convolutions can be adjusted to control air flow through the wrapper.

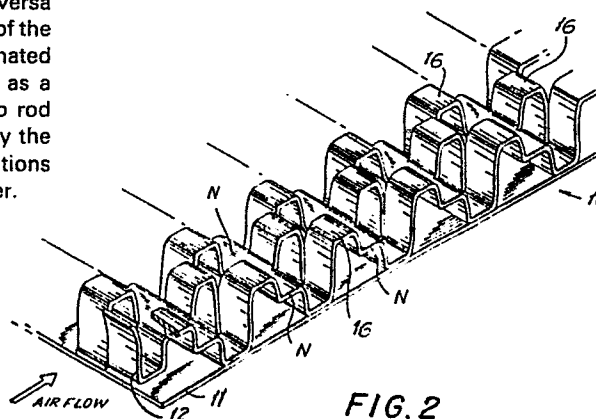


FIG. 2

MANUFACTURE OF AN EXPANDED WEB OF SHEET MATERIAL

The present invention relates to the manufacture of an expanded web, the product being suitable amongst other things for making a cigarette wrapper.

In the mass production of cigarettes, maintenance of standard characteristics from cigarette to cigarette is important. One standard characteristic closely controlled by manufacturers is cigarette firmness, which generally is a function of tobacco rod density. Firmness affects smoking characteristics and contributes to the subjective feel of the cigarette in the smoker's hand.

The conventional cigarette wrapper is relatively flimsy paper which imparts little or no strength or rigidity to the cigarette rod, but rather serves primarily to contain the tobacco. Thus, the cigarette rod derives its strength and firmness almost entirely from the density of tobacco in the rod. Reduction of rod density usually results in a less firm cigarette.

Therefore, there exists a need for a cigarette wrapper which will provide desired firmness and strength in a cigarette rod relatively independently of tobacco rod density.

In accordance with the present invention there is provided a method of making an expanded web comprising shearing and forming a web of formable sheet material to create rows of generally sinusoidal convolutions, the rows extending longitudinally along the web and each convolution in a row extending above and below the original plane of the web and being joined to the next longitudinally succeeding convolution by a flat portion of the web lying substantially in the original plane of the web.

Preferably the convolutions in each row are formed to be 180° out of phase with the convolutions in adjacent rows, the flat portions in each row being in alignment with those of adjacent rows.

The formed web may be laminated to the surface of a second web of sheet material to form a composite web.

The present specification describes a specific embodiment of the method which is suitable for making an expanded or composite web for use as a cigarette wrapper. Also described is apparatus for carrying out the method at high speed and directly on line with a

cigarette making machine. In this apparatus a planar web of formable sheet material is sheared and formed to create an expanded web having rows of generally sinusoidal convolutions extending across its width and down its longitudinal axis. The expanded web is laminated to a second web, preferably consisting of conventional cigarette paper, which forms the outer layer of a cigarette wrapper when the composite web is curled about its longitudinal axis to form a tube encircling a tobacco rod.

The invention will be described in more detail with the aid of example illustrated in the accompanying drawings, in which:-

Figure 1 is a partially cut-away perspective view of cigarette having a wrapper formed from a composite web,

Figure 2 is a perspective view of the composite web used in the cigarette of Figure 1,

Figure 3 is a partial schematic view of an apparatus for forming the composite web,

Figure 4 is a partial plan view of one pair of rotary shearing and forming dies suitable for use in the apparatus of Figure 3,

Figure 5 is a partial plan view of two pairs of rotary shearing and forming dies,

Figures 6, 7 and 8 are sectional views taken along lines 6-6, 7-7, and 8-8, respectively, of Figure 5,

Figure 9 is a plan view of the sheared and formed web,

Figure 10 is a sectional view of the sheared and formed web taken along lines 10-10 of Figure 9,

Figures 11 to 13 are schematic views showing the forming and curling of the composite web about its longitudinal axis to form a tube,

Figure 14 is a partial sectional view of a cigarette having a wrapper formed from the composite web,

Figure 15 is a side sectional view of an alternative form of the sheared and formed web,

Figures 16 to 18 are schematic views showing a normal, a condensed, and an extended expanded web, respectively, and

Figure 19 is a diagrammatic view of machinery incorporating a modified form of the apparatus of Figure 3.

As seen in Figure 2, a composite web 10 generally comprises a

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layer of paper 11 attached to an expanded web 12. In its use as a cigarette wrapper 13, the composite web is curled about its longitudinal axis to encircle a tobacco rod 14, which may then be attached to a filter 15 by known means. As can be seen, the convolutions 16 in the expanded web 12 run in rows extending longitudinally down the web and the rows lie side-by-side across the web width.

In forming the composite web 10, a web of formable material 17 is fed off of a bobbin 18 (Figure 3). Web 17 passes between meshing rotary shearing and forming dies 19 and 20. Dies 19 and 20 comprise a plurality of meshing pairs of die elements A-B and C-D extending across the web width, the meshing face of each die element having a width corresponding to the desired width of convolutions 16. As the web 17 passes through dies 19 and 20, each convolution 16 is sheared along its lateral boundaries by teeth on the dies, which also serve to form the web 17 into the convoluted configuration.

After shearing and formation, expanded web 12 (formed from original web 17) passes between guides 21 to accumulator wheel 22. Accumulator wheel 22 is in nip relation to glue wheel 23 which applies a line of glue 24 along the centre line of formed web 17. Alternatively, glue wheel 23 may be situated to apply glue line 24 along the centre line of web 25 feeding from bobbin 26. As yet another alternative web 12 and web 25 may be simply drawn into a laminated confronting relationship and guided together downstream without the placement of a glue line therebetween.

If glue wheel 23 is located to apply glue line 24 to web 25, a nip roller must be placed in nip relation to accumulator wheel 22 to assist in controlling the feed of web 17 past the accumulator. If desired, the additional roller may be another accumulator wheel.

Web 25 is the paper web which will form the outer layer 11 of the composite wrapper. Web 25 is fed through press rollers 27 to confront the underside of expanded web 12 and so be secured to expanded web 12 along glue line 24. The nip between press rollers 27 should be sufficiently small to urge the confronting webs together for a secure bond, but not so small as to permanently deform the convolutions 16 in expanded web 12. The web bonding is preferably assisted by a heat source to aid in setting the glue line

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24. After bonding of the webs together, the composite web 10 may be fed directly into a cigarette making machine for forming into expanded cigarette wrappers.

Web 17 preferably comprises a ductile cellulosic material with sufficient resiliency so that it will not tear at the extremity of each convolution 16 during forming by dies 19 and 20. It also should be sufficiently shearable that it will cut along the lateral boundaries of each convolution during shearing by dies 19 and 20. The material should be strong enough to retain the form imparted to it by the dies. Suitable material may be paper, reconstituted tobacco, flax paper, or mixtures thereof. The material should have a thickness corresponding to the clearance between dies 19 and 20, and that clearance is preferably on the order of 3 mils.

Accumulator wheel 22, in addition to cooperating with glue wheel 23 to form a nip at the point of glue application, also serves to meter the expanded web 12 onto web 25. Accumulator wheel 22, which may be a rotating brush wheel, runs at substantially the same linear speed as the linear speed of web 25, while dies 19 and 20 may run at variable speeds. If the dies run at a linear speed faster than that of web 25 and wheel 22, the periodicity of the generally sinusoidal convolutions 16 imparted to web 17 by dies 19 and 20 will be reduced, resulting in a condensed expanded web 170 (Fig.17). Conversely, operation of dies 19 and 20 at a linear speed slower than that of wheel 22 and web 25 will increase the periodicity of convolutions 16 and give an extended expanded web 180 (Figure 18). And operation of the dies at the same linear speed as wheel 22 and web 25 will produce a normal expanded web 160 (Figure 16).

Figure 4 illustrates the preferred configuration of the meshing teeth of dies 19 and 20. A representative portion of each die includes flat sections 28 and 29, generally sinusoidal tooth 30 and corresponding generally sinusoidal recess 31, and generally sinusoidal tooth 33 and recess 32. When flat sections 28 and 29 are at bottom dead centre and top dead centre of their respective rotations, they are separated by a clearance substantially equal to the thickness of web 17, and the midway point of that clearance lies in the centre of the web thickness. Thus, there is realized a

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neutral zone N in which there is no deformation of the web by the flat sections of dies 19 and 20.

As dies 19 and 20 further rotate, tooth 30 meshes with recess 31 while maintaining a clearance equal to web thickness. The web 17 is thus formed into the lower half of a generally sinuoidal pattern. Further rotation of dies 19 and 20 meshes tooth 33 with recess 32 to generate the upper half of the sinusoidal convolution and then both dies return to the neutral zone defined by flat sections 34 and 35, where no forming of the web occurs. The length of each die tooth, as defined by the distance, for example, from the bottom of recess 31 to the tip of tooth 33, is on the order of 1 millimeter, although this dimension may be varied as desired to create an expanded web having any required thickness.

Each individual die is preferably about 1 mm. wide and each die set 19 and 20 preferably comprises 20 such 1 mm. dies. Additionally, a die about 3 mm. wide is located at each lateral end of each die set. With this die arrangement, an expanded web 12 approximately 22 mm. wide can be formed without any feathering of the web edges which might result from commonly encountered lateral web drift as the web feeds through dies 19 and 20. Despite slight web drift, the outer 3 mm. dies are sufficiently wide so that the web edges will be uniformly sheared and formed.

In practicing the invention, meshing pairs of die elements A-B and C-D are preferably extended across the width of web 17, each A die element lying 180° out of phase from the next contiguous B die element and each C die element lying 180° out of phase from the next contiguous D die element (Figures 5-8). The result of this arrangement is that alternate rows of convolutions extend across the web width, each row lying 180° out of phase from its abutting rows. Moreover, each row of convolutions is joined to the next row by a flat segment which lies in the original plane of web 17 and results from lack of formation in the neutral zone N defined by flat die sections 34 and 35 and 28 and 29.

Rotary dies 19 and 20 may be driven in any known manner. Preferably, they are driven by a variable speed D.C. motor connected to their axles in known manner. Likewise, accumulator wheel 22 and glue wheel 23 are driven in conventional manner, as are rollers 27,

which draw web 25 off of bobbin 26. Bobbins 18 and 26 are preferably mounted on free-wheeling axles.

Figures 6-8 illustrate the cooperation of dies 19 and 20 during successive points in their rotation. When the flat sections 28 and 29 of the dies mesh, they abut web 17 without deformation of the web (Figure 6). As rotation occurs, tooth 30 forms web 17 while tooth 33 forms the web in the opposite direction to generate the next adjacent convolution 180° away. Further rotation of the dies reverses their respective effects on the web. Additionally, as dies 19 and 20 rotate, the scissor formed by the lateral edges of successive pairs of teeth 30 and 33 shears the web longitudinally from the end of one neutral zone to the beginning of the next, thus allowing the dies to more readily form the convolutions in web 17.

Web formation also may be assisted by adjusting the moisture content of web 17 prior to formation followed by drying of the formed web 12 to set the sheared and formed configuration. Setting agents also may be applied to the web to help in retaining the formed configuration, and those setting agents may further contain flavorants or additives as desired.

After web 17 is converted by dies 19 and 20 into expanded web 12 and laminated to web 25, it is available for use as a cigarette wrapper. Web 25 provides outer wrapper 11, which is preferably slightly wider than expanded web 12 (Figure 11). When the composite wrapper 10 is curled about its longitudinal axis to form a tube for encircling a tobacco rod, the additional width of wrapper 11 provides sufficient material for forming a suitable overlapping glue seam by known means. The outer edges of expanded web 12 meet to form butt joint 50 which is covered and held in place by the overlapping glue seam.

Curling of the composite wrapper into a tube causes successive rows of convolutions to overlap slightly at their radially inward ends and to spread slightly at their radially outward ends. Surprisingly, it has been found that, by controlling the periodicity of the convolutions during formation of expanded web 12, the cumulative cross-sectional size of longitudinally-extending gaps 40 can be regulated. By varying the linear speed of dies 19 and 20, the expanded web can be extended or condensed, thus resulting in

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variation of the size of gaps 40 when the composite web is curled about its longitudinal axis to form a wrapper for a smoking article, such as a cigarette. Proper selection of the size of gaps 40 can result in a total gap area equal to the total perforation area conventionally used in cigarette filter wrap and tipping design and construction. This additional means for controlling gas flow gives the cigarette designer another method of regulating smoke dilution and delivery. Additionally the web may be perforated or may be made of a material with any desired porosity to further enhance its dilution characteristics. Should it be desired to close off gaps 40, an annular plug or other blocking means may be placed at the junction of tobacco rod 14 and filter 15 to preclude gas flow from gaps 40 into the filter.

Figure 15 illustrates an alternate form 12' of the expanded web achieved by modifying the shape of the teeth on dies 19 and 20. Any die configuration which creates a generally sinusoidal cross section convolution in web 12' may be used within the scope of the invention.

Turning to Figure 19 the machinery shown is suitable for use in a conventional cigarette-making machine, such as a Molins Mark 9-5 machine. The apparatus generally comprises a bobbin 100 of formable sheet material 17 to be formed into expanded web 12. Web 17 passes through conventional splicer 101 where material from alternate bobbin hub 102 may be spliced to web 17 in known fashion. Pinch rollers 103 pull web 17 off of bobbin 100 and feed the web into accumulator 104, from where web 17 is drawn around idler wheels 105 and 106 and through rotary shearing and forming dies 19 and 20. Shearing and forming dies 19 and 20 act on web 17 to form expanded web 12 in the manner discussed above.

After shearing and forming, expanded web 12 is metered through accumulator wheels 107 and 108 and fed onto web 25, which will become outer wrapper 11 in expanded wrapper 13. Web 25 is drawn from a known cigarette wrapper feed assembly (not shown) preferably located parallel to and slightly off-line from the apparatus. The web 25 is brought on line with expanded web 12 by passage around two 45° rollers in known manner. The second 45° roller is illustrated at 110. From roller 110, web 25 passes through printing station 112

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where it is printed in known fashion with desired decorations or brand marks.

After printing web 25 passes around idler wheel 144 to glue wheel 116 where glue line 24 is applied longitudinally down the centre line of the surface of web 25 which will confront expanded web 12. Web 25 is then passed around idler 118 to nip rollers 120 and 121 where it confronts and is urged against the surface of expanded web 12. From nip rollers 120 and 121, the now composite web 10 passes through dryer 122 where glue line 24 is set for a secure bonding of the laminated structure. After drying of glue line 24, composite web 10 is transferred in known fashion to the garnisher of a cigarette making machine where the web is curled about its longitudinal axis for receipt of tobacco or other cigarette filler by conventional cigarette making means. Alternatively, the webs may be laminated in confronting relationship without gluing and thereafter may be guided together to the garnisher.

CLAIMS:

1. A method of making an expanded web comprising shearing and forming a web of formable sheet material to create rows of generally sinusoidal convolutions, the rows extending longitudinally along the web and each convolution in a row extending above and below the original plane of the web and being joined to the next longitudinally succeeding convolution by a flat portion of the web lying substantially in the original plane of the web.
2. A method as claimed in claim 1 in which the upper and lower extremities of the generally sinusoidal convolutions are generally flat and lie substantially parallel to the original plane of the web of formable sheet material.
3. A method as claimed in claim 1 or 2 in which the web of formable sheet material comprises a sheet material about 3 mils thick.
4. A method as claimed in claim 1, 2 or 3 in which the web of formable sheet material comprises a cellulosic material.
5. A method as claimed in any of the preceding claims in which the convolutions in each row are formed to be 180° out of phase with the convolutions in adjacent rows, the flat portions in each row being in alignment with those of adjacent rows.
6. A method as claimed in any of the preceding claims wherein the formed web is laminated to the surface of a second web of sheet material to form a composite web.
7. A method as claimed in claim 6 in which the convolutions are formed by a continuous process, the lamination of the two webs is carried out continuously and the relative speeds of advance of the webs are adjustable to vary the periodicity of the convolutions.

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8. A method as claimed in claim 6 or 7 in which the second web is cigarette paper.
9. A method as claimed in claim 6, 7 or 8 in which the width of the second web is sufficiently greater than that of the first web to provide an overlap seam upon curling the composite web about its longitudinal axis to form a tube.
10. An expanded web of sheet material comprising a plurality of rows of generally sinusoidal convolutions formed from the sheet, the rows lying side by side across the width of the web, each convolution in a row extending above and below the plane of the web and being connected to the longitudinally succeeding convolution by a portion of the web lying substantially in the plane of the web.
11. A composite web comprising a lamination of an expanded web as claimed in claim 10 with a second flat web.
12. The composite web of claim 11 in which the extremities of the convolutions are generally flat and lie substantially parallel to the original plane of the first web.
13. The composite web of claim 11 in which the first web comprises a sheet material about 3 mils thick.
14. The composite web of claim 13 in which the sheet material comprises a cellulosic material.
15. The composite web of claim 11 in which the second web comprises cigarette paper.
16. The composite web of claim 11 in which the width of the second web is sufficiently greater than the width of the first web to provide an overlap seam upon curling the composite web about its longitudinal axis to form a tube.

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17. A composite web as claimed in any of claims 11 to 16 in which the convolutions in each row are formed to be 180° out of phase with the convolutions in adjacent rows, the flat portion in each row being in alignment with those of adjacent rows.

18. A smoking article comprising a rod of smoking material surrounded by a wrapper, the wrapper being a composite web as claimed in any of claims 11 to 17.

19. Apparatus for manufacturing an expanded web by the method claimed in any of claims 1 to 5 comprising a set of meshing rotary forming and shearing dies for creating the convolutions.

20. Apparatus as claimed in claim 19 in which the die set comprises a plurality of horizontally-disposed pairs of dies, the teeth on each die lying 180° out of phase from the teeth on each horizontally adjacent die and each tooth of a die being joined to the next recess on the die by a flat segment, the flat segments of the die sets defining a neutral zone in which substantially no shearing or forming of the web occurs.

21. Apparatus as claimed in claim 19 or 20 for manufacturing a composite web in accordance with the method claimed in any of claims 6 to 9 comprising first feed means for delivery of a web of formable sheet material to the die set, second feed means for supplying a second web of paper-like material for lamination to a surface of the first web after passage of the first web through the die set and drive means for rotating the die set.

22. Apparatus as claimed in claim 21 comprising first accumulator means for metering the first web onto the second web after passage of the first web through the rotary dies.

23. Apparatus as claimed in claim 21 or 22 in which the drive means for the die set is operable to drive the rotary dies at different

speeds relative to the speed of the second feed means, **0162704**
varying the shape of the convolutions.

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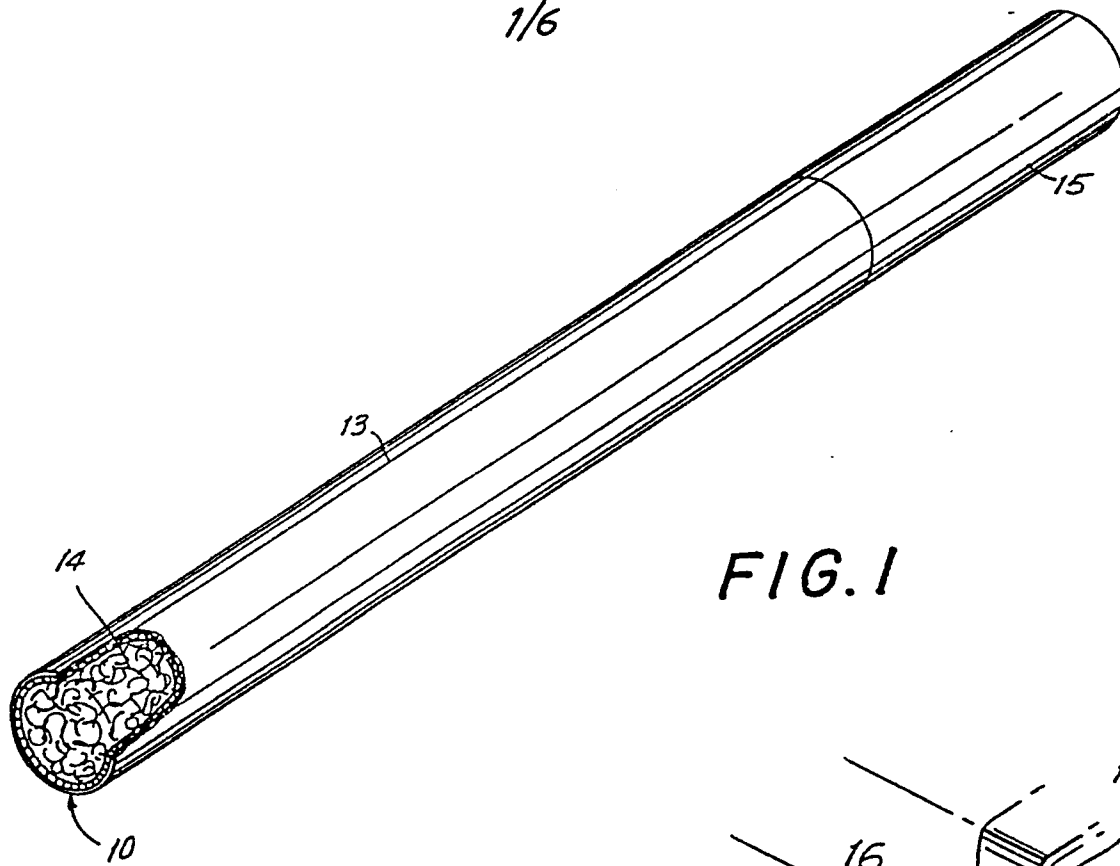


FIG. 1

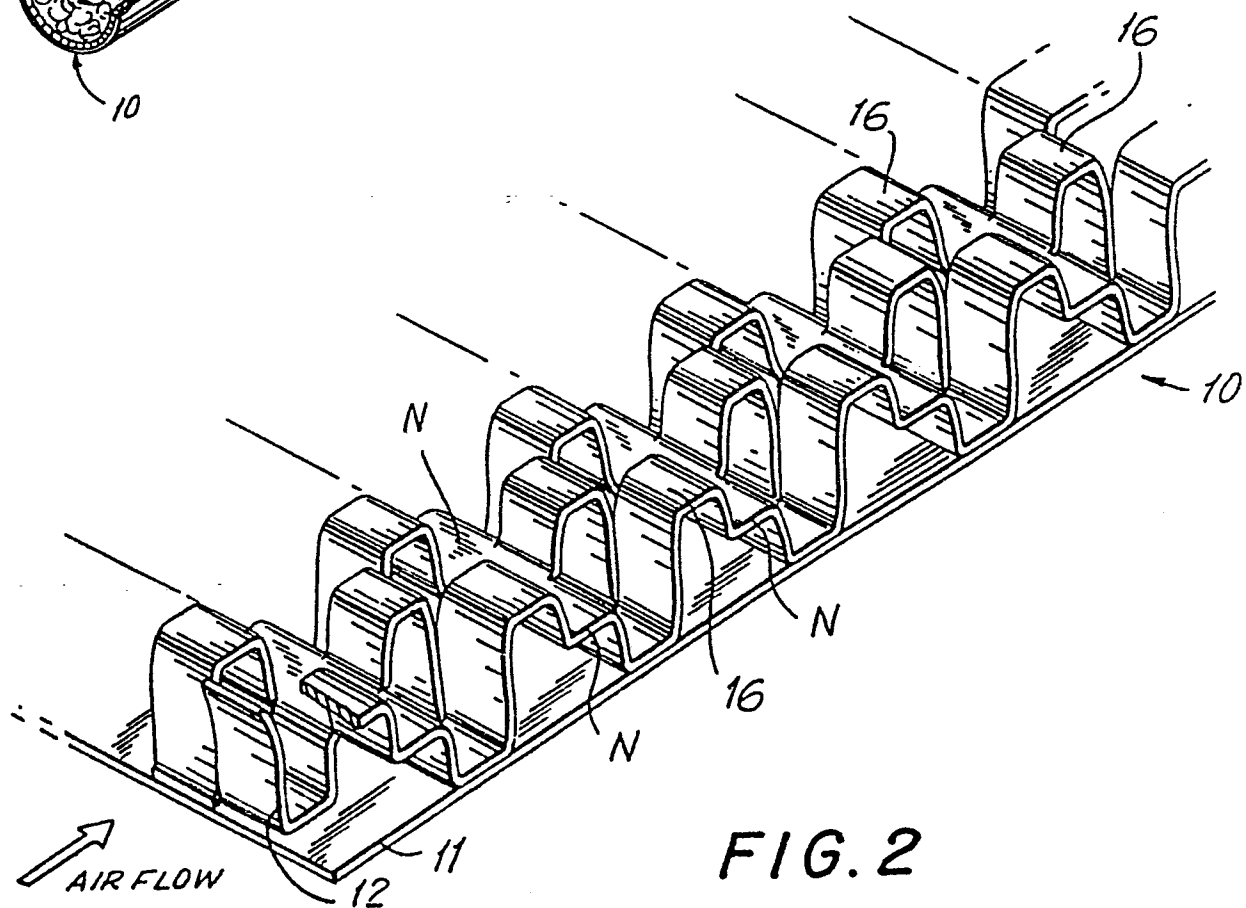


FIG. 2

FIG. 3

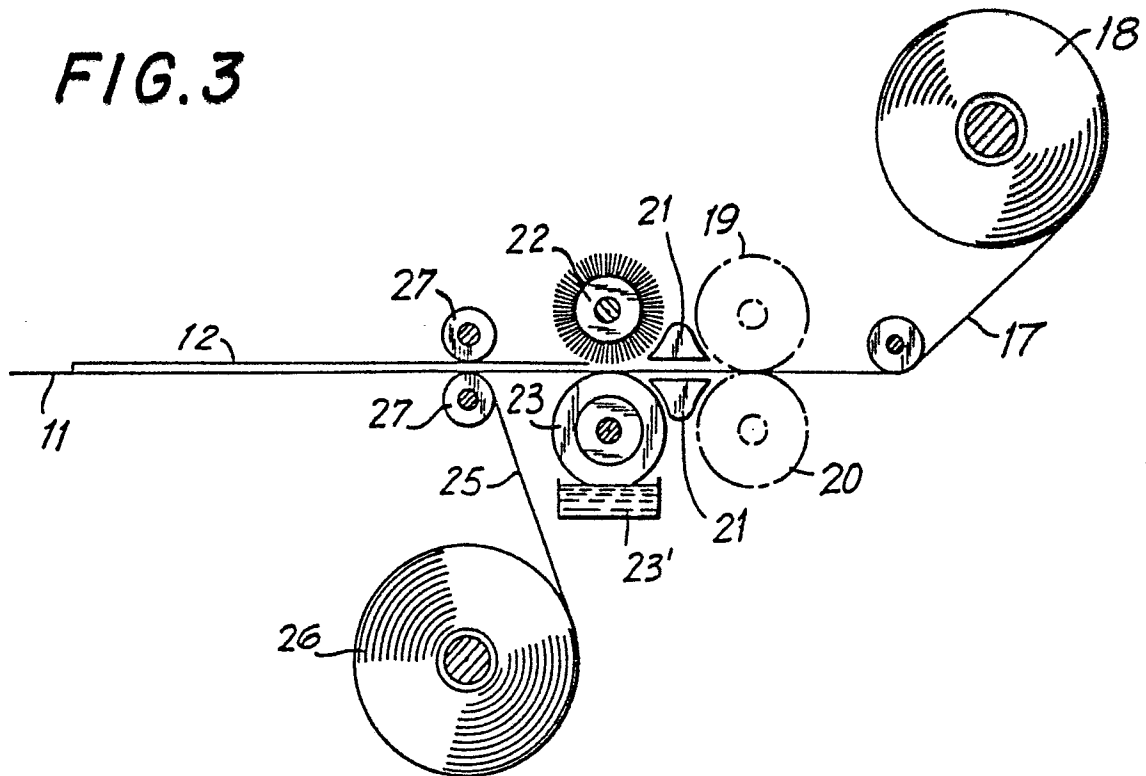


FIG. 4

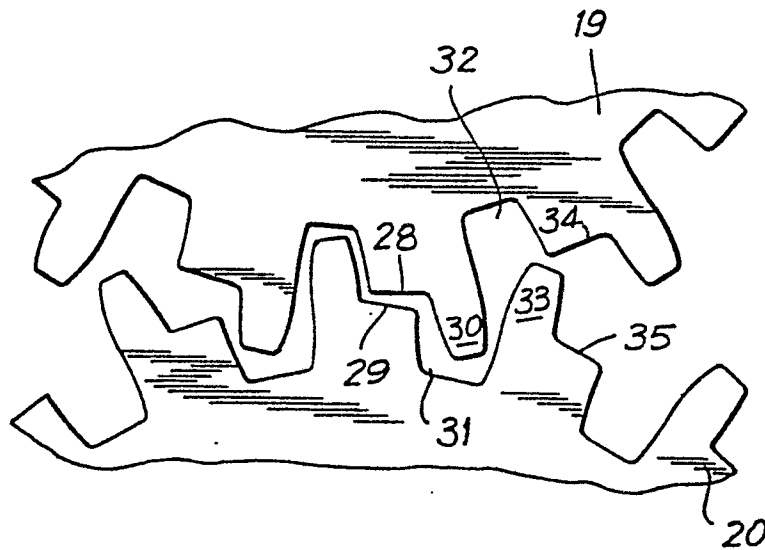
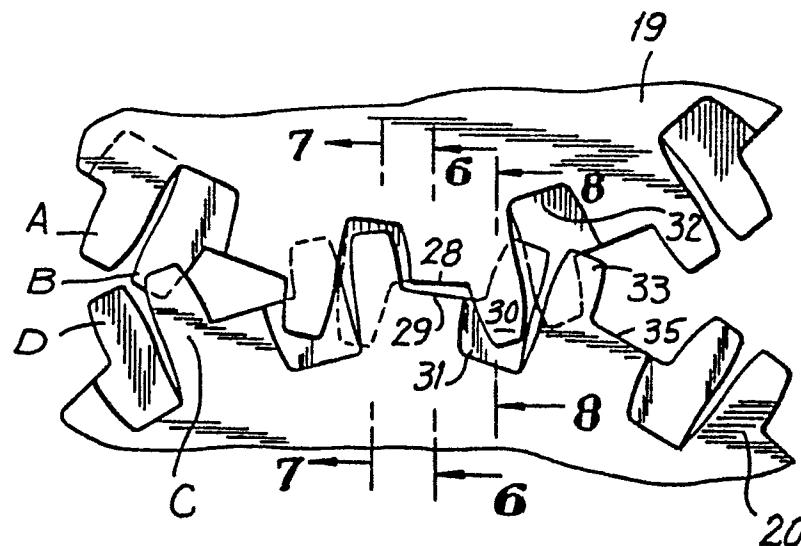


FIG. 5



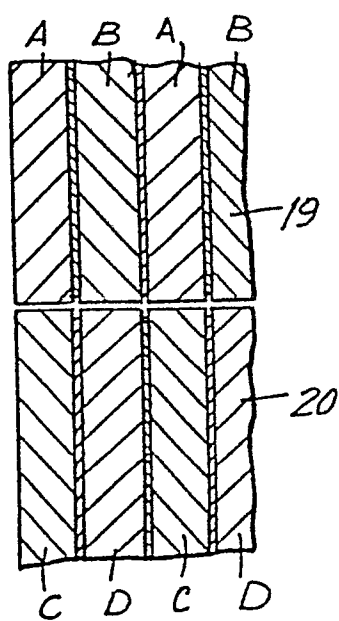


FIG. 6

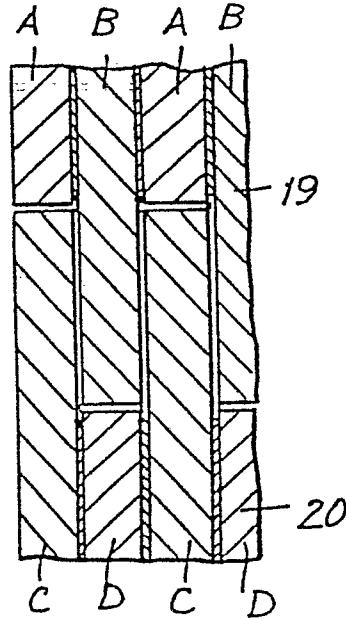


FIG. 7

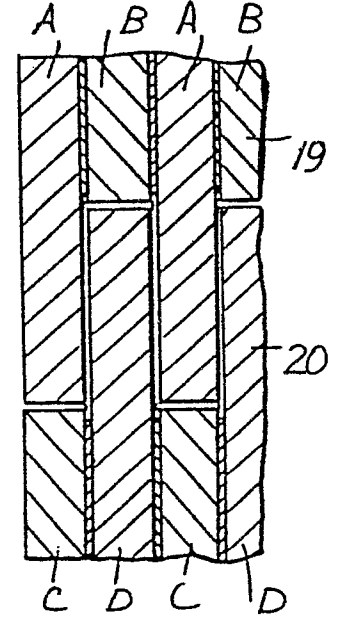


FIG. 8

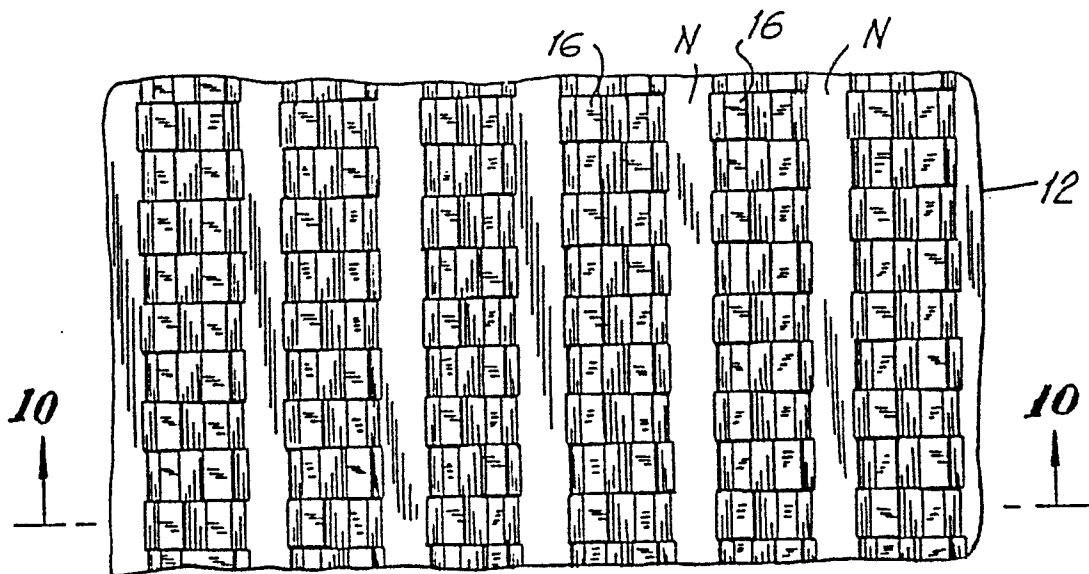


FIG. 9

FIG. 10

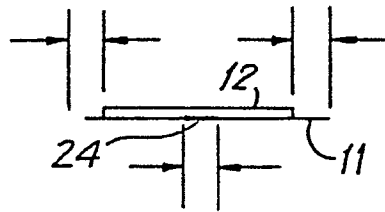
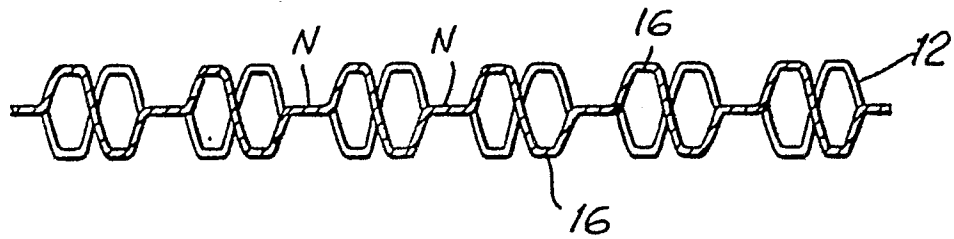
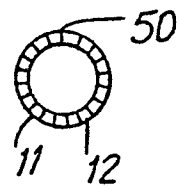


FIG. 11

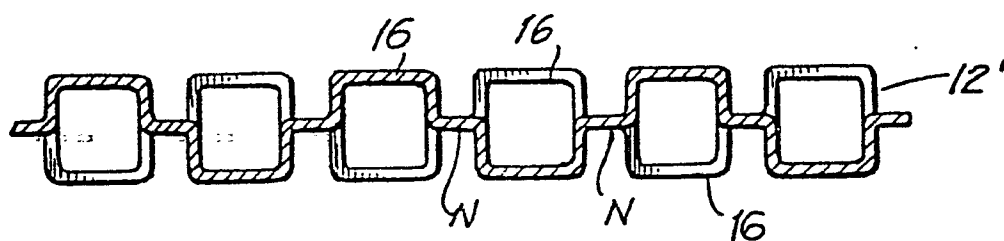
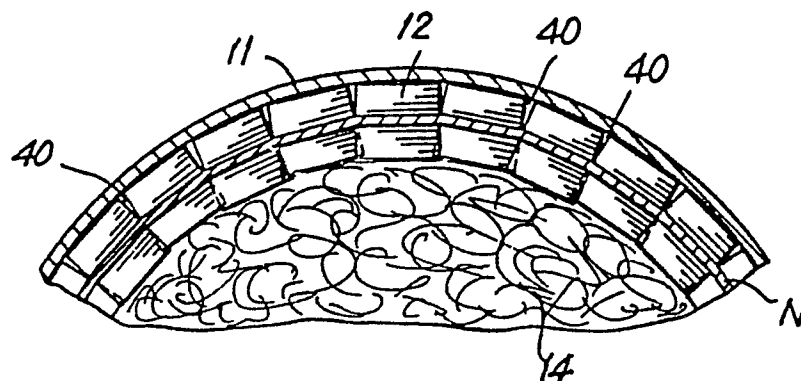
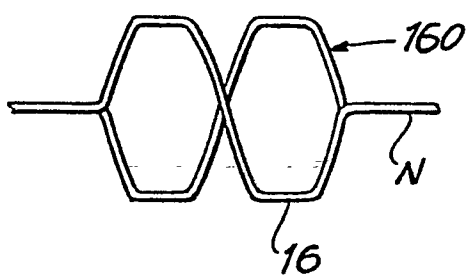
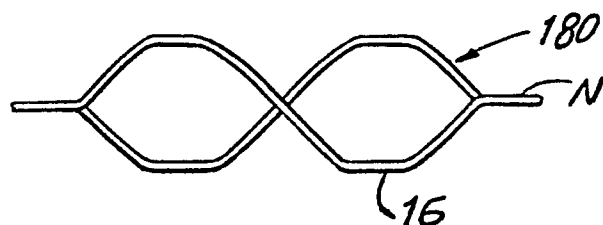
FIG. 12



FIG. 13



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FIG. 14**FIG. 15****FIG. 16****FIG. 18****FIG. 17**