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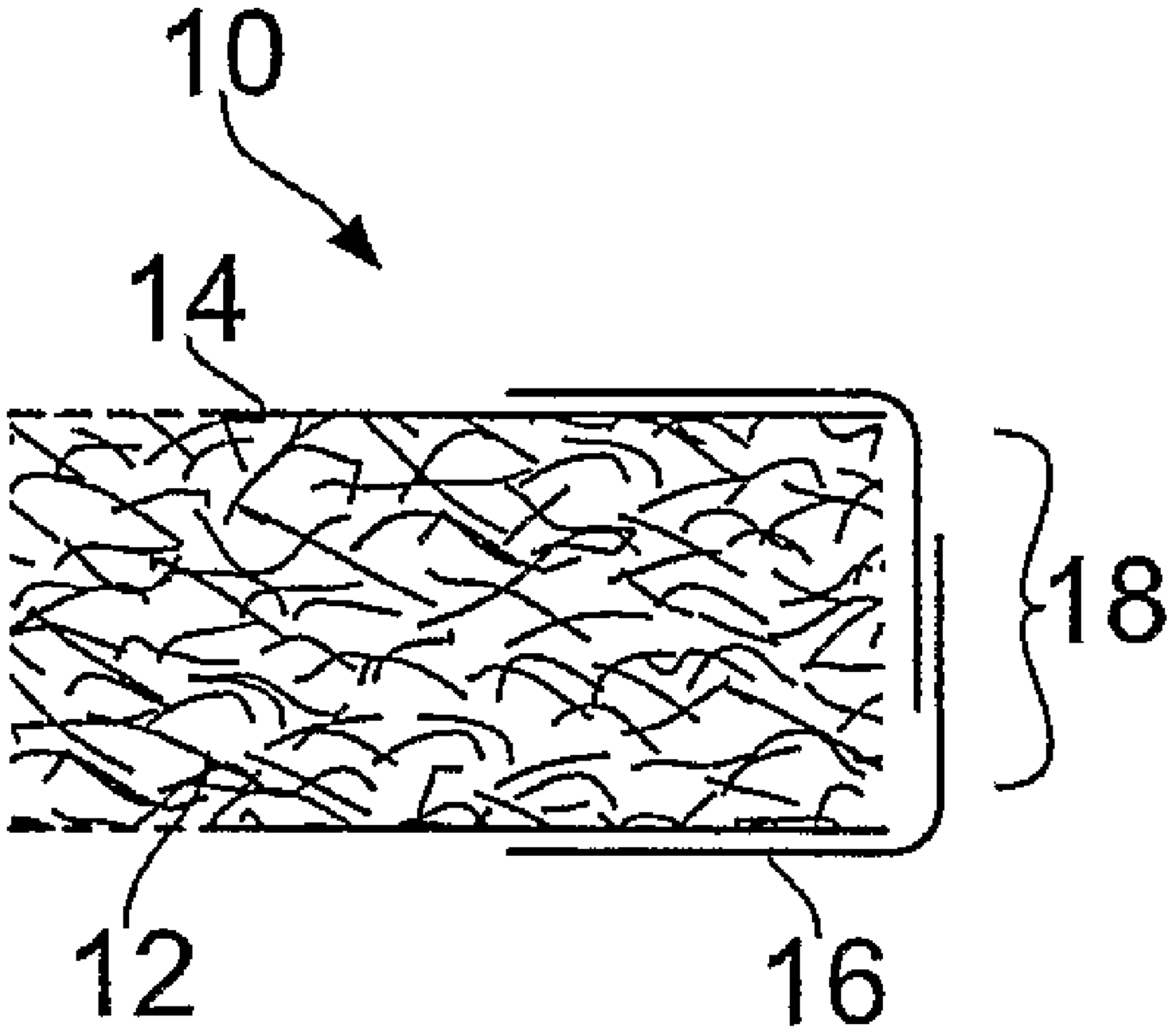
(54) Titre : ARTICLE A FUMER AVEC UNE EXTREMITE FERMEE ET PROCEDES ET APPAREIL POUR SA FABRICATION

(54) Title: SMOKING ARTICLE WITH CLOSED END AND METHODS AND APPARATUS FOR MANUFACTURE THEREOF



(57) Abrégé/Abstract:
A method of making a smoking article comprises providing a folly or partially fabricated smoking article comprising at least a tobacco rod of tobacco wrapped in cigarette paper; adhering a foldable paper to the cigarette paper such that the foldable paper

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(57) Abrégé(suite)/Abstract(continued):
encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and folding the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod. Various techniques can be employed to apply different lengths of foldable paper to the tobacco rod and to achieve different folding patterns. The folded paper may be inverted by pressing inwardly with a pin or rod after folding to produce a more permanent fold.

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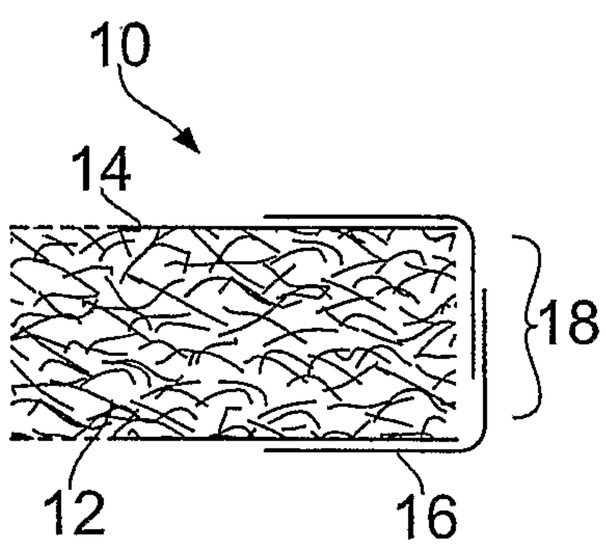
(54) Title: SMOKING ARTICLE WITH CLOSED END AND METHODS AND APPARATUS FOR MANUFACTURE THEREOF



(57) Abstract: A method of making a smoking article comprises providing a folly or partially fabricated smoking article comprising at least a tobacco rod of tobacco wrapped in cigarette paper; adhering a foldable paper to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and folding the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod. Various techniques can be employed to apply different lengths of foldable paper to the tobacco rod and to achieve different folding patterns. The folded paper may be inverted by pressing inwardly with a pin or rod after folding to produce a more permanent fold.

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TITLE OF THE INVENTION

SMOKING ARTICLE WITH CLOSED END AND METHODS AND APPARATUS FOR MANUFACTURE THEREOF

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles having closed ends, and methods and apparatus for making smoking article having closed ends.

Manufactured smoking articles such as cigarettes conventionally comprise a tobacco rod having a wrapping of cigarette paper, and a filter attached to the tobacco rod by a tipping paper, although plain cigarettes, lacking a filter, are also available. In either case, the end of the cigarette which is intended to be lit is often open, so that the tobacco inside the cigarette paper is exposed. This allows leakage or spillage of tobacco from the cigarette, and also allows contaminants and foreign bodies to enter the tobacco.

It has been previously proposed to close one or both ends of a cigarette by folding or otherwise manipulating a portion of the cigarette paper that extends beyond the tobacco rod. For example, US 1,164,118 describes a cigarette-making machine that forms a tube of cigarette paper, closes one end of the tube, fills the tube with tobacco, and then closes the other end. Both closures are achieved by components that grip the tube ends and rotate to twist the paper while the tube is held stationary. US 501,498 describes a machine that wraps cigarette paper around tobacco, compresses the tobacco from both ends to make paper overhangs for folding, and then closes each end of the paper using two tuckers that push the paper over and a conical head that is inserted into the end of the closed cigarette and rotated to force the paper inwards and smooth it. The cigarette is held still while the closure components move. US 903,101 describes a machine that forms a tube of cigarette paper and closes one end before

filling the tube with tobacco. The closure is effected by a notched plate that slides over the end of the tube and back again, while both tube and plate are moving along the longitudinal direction of the tube. US 3,208,458 describes a machine that wraps cigarette papers around tobacco, the papers having scalloped edges. The cigarette is then held still while a series of three blades spaced 120° apart move in and out against the ends of the cigarette to fold over the separate flaps of the scalloped edges of the paper. GB 278,534 describes a cigarette with the cigarette paper turned inwardly over the end of the wrapped tobacco to form a tubular extension into the tobacco that partially covers the tobacco.

However, these various approaches to closing the end of a cigarette are not at all recent, and are hence not well-suited to modern cigarette manufacturing techniques. The present invention aims to provide closed end cigarettes using methods and apparatus that are more compatible with current cigarette manufacturing machinery.

SUMMARY OF THE INVENTION

Accordingly, a first aspect of the present invention is directed to a method of making a smoking article, comprising: providing a fully or partially fabricated smoking article comprising at least a tobacco rod of tobacco wrapped in cigarette paper; adhering a foldable paper to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and folding the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod. The foldable paper may be adhered to the outside of the cigarette paper.

It has been found that closing the end of a smoking article by folding over a separately applied outer layer of paper has advantages over methods that rely on folding over an extension of the cigarette paper itself. It is possible, for example, to obtain an extending portion of the cigarette paper by tapping the smoking article or standing it on its filter end on a vibrating table to cause the tobacco to settle further down inside the cigarette paper. However, the tobacco (smoking material) is of a non-uniform nature and hence different components will settle to different levels, and give an inconsistency to the smoking quality. Alternatively, the tobacco can be pressed down inside the cigarette paper, but this gives a non-uniform density that again results in an inconsistent smoking quality. Wrapping a separate foldable paper around the cigarette paper removes any need to redistribute or otherwise manipulate the tobacco once the smoking article has been assembled, so that quality can be maintained. Also, keeping the tobacco rod in the structure in which it is initially fabricated maintains the clean flat cut end of the tobacco, which offers a much better surface against which the fold the foldable paper than can be obtained through tapping, vibrating or compressing, which tend to modify the tobacco surface and make it less flat and robust. Hence the folding can be more easily and efficiently performed, and the resulting folded end can have a neater appearance.

Any paper that can be folded over to close the end of the tobacco rod can be used, for example, standard cigarette paper as used to wrap the tobacco and form the tobacco rod. However, a porous paper is beneficial, as it makes it easier for the smoker to draw on the cigarette when lighting it, since more air can flow through the paper. Also, porous paper is typically thinner and lighter than standard cigarette paper, so that it can be folded more easily and neatly, giving a more compact folded end. Therefore, in some embodiments, the foldable paper is a lighter weight paper than the cigarette paper. For example, the foldable paper may have a porosity greater than 3,000 CU, or greater than 6,000 CU, or greater than 12,000 CU, or greater than 24,000 CU. In some embodiments, the foldable paper may be porous plug wrap paper. This is particularly thin and light with ample porosity so as not to impede drawing, and is further already readily available in the tobacco industry.

The foldable paper may be embossed with one or more crease lines along which the overhanging foldable paper is folded. Providing such crease lines facilitates the paper folding, in that folding becomes easier as less force is needed to bend the paper, and the folds more readily form in the intended positions. This gives a more consistent appearance to the folded end. The foldable paper may be provided pre-embossed. Alternatively, the method may further comprise, before adhering the foldable paper to the cigarette paper, embossing the foldable paper with one or more crease lines along which the overhanging foldable paper is to be folded.

The foldable paper encircling the tobacco rod may extend over only part of the length of the tobacco rod, or alternatively the foldable paper encircling the tobacco rod may extend over substantially the whole length of the tobacco rod. The former arrangement allows a minimum amount of paper to be used, thus saving materials and reducing costs. The latter arrangement, if applied to a partially completed smoking article lacking a filter, allows the edge of the foldable paper remote from the overhanging part to be covered with tipping paper when the filter is attached to the tobacco rod. This gives a neat appearance to the smoking article and also removes an

exposed edge that could otherwise become caught or torn during later handling of the smoking article.

In some embodiments, adhering the foldable paper to the cigarette paper comprises: applying adhesive to the foldable paper; bringing the smoking article into contact with the foldable paper such that an edge of the foldable paper adheres to the cigarette paper; and carrying the smoking article in a vacuum flute on the outer surface of a rotating drum, the smoking article arranged with its longitudinal axis parallel to the rotation axis of the drum, so as to bring the smoking article into contact with a curved static plate spaced apart from the drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, the rolling causing the foldable paper to wrap around the smoking article. Since this technique relies on individual pieces of foldable paper applied to individual smoking articles, it is suitable for a foldable paper that extends over any length of the tobacco rod. It is merely necessary to use an appropriately sized foldable paper at the start of the process. Rotating drums with vacuum flutes are widely used in smoking article manufacture, so an existing production line may be readily adapted to include apparatus for performing this method of applying the foldable paper.

Further, for embodiments in which the foldable paper is applied as a individual piece, the foldable paper may be shaped along an edge such that the overhanging foldable paper has an edge profile that gives a reduced amount of overlapped paper after folding compared to a straight edge. This can be used to give a neater appearance to the folded end, and may also give a fold arrangement that maintains its folded position better with less tendency for the folds to spring apart after folding.

In other embodiments, adhering the foldable paper to the cigarette paper comprises: arranging the smoking article in a sequence of smoking articles arranged end to end but spaced apart by a distance equal to the desired length of the overhanging foldable paper; feeding the sequence of smoking articles onto a

continuous length of foldable paper, the foldable paper having a width at least equal to the circumference of the tobacco rods; wrapping the foldable paper around the smoking articles to encircle the tobacco rods, and adhering it in place; and cutting through the foldable paper flush to an end of each smoking article, to separate the smoking articles and form the overhanging foldable paper. Alternatively, adhering the foldable paper to the cigarette paper may comprise: arranging the smoking article in a sequence of smoking articles arranged end to end in pairs where the articles in each pair abut at their adjacent ends and the pairs are spaced apart by a distance equal to twice the desired length of the overhanging foldable paper; feeding the sequence of smoking articles onto a continuous length of foldable paper, the foldable paper having a width at least equal to the circumference of the smoking articles; wrapping the foldable paper around the smoking articles to encircle the tobacco rods, and adhering it in place, and cutting through the foldable paper where the smoking articles in each pair abut and also at the midpoint of the spaces between the pairs, to separate the smoking articles and form the overhanging foldable paper. These techniques give a foldable paper that extends over the full length of the tobacco rod. The techniques can be implemented by adapting apparatus currently used for applying a second paper layer to double-wrapped tobacco rods.

In various embodiments, folding the overhanging foldable paper may comprise carrying the smoking article in a vacuum flute on the outer surface of one or more rotating drums so as to bring the overhanging foldable paper into contact with one or more folding devices that bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod. As mentioned above, rotating drums with vacuum flutes are already commonly used in smoking article production, so their application to the methods of the present invention allows the invention to be conveniently implemented without extensive investment in new and complex apparatus.

A variety of folding devices may be employed to achieve different folding effects and number of folds. For example, the one or more folding devices may comprise a reciprocating tucker with a width less than the diameter of the smoking article that extends partially over the end of the tobacco rod flush with the tobacco therein to create a first fold and then retracts, a fixed tucker with a width less than the diameter of the tobacco rod and a surface that is flush with the tobacco against which the end of the tobacco rod passes to create a second fold opposite the first fold, and a pair of static plough folders providing surfaces flush with the tobacco and having oppositely disposed converging edges, against which the end of tobacco rod passes to form third and fourth folds opposite one another and orthogonal to the first and second folds. This gives a four-way envelope-style fold.

Alternatively, the one or more folding devices may comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a plough folder fixed to the plate and comprising a surface flush with the end of the tobacco rod that has an edge that converges towards the drum in the direction of rotation of the drum such that as the smoking article rolls over the plate the end of the tobacco rod passes against the surface and the overhanging foldable paper is engaged by the converging edge and is gradually folded inwards over the tobacco in a continuous fold.

In a further alternative, the one or more folding devices may comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a sequence of teeth extending from the plate towards the drum and having surfaces flush with the end of the tobacco rod, each tooth engaging a part of the overhanging foldable paper and creating a fold as the smoking article rolls over the plate, each fold

overlapping the previous fold. This produces an iris-style fold, where the number of individual overlapping folds is determined by the number of teeth. Hence, the number of teeth can be selected to achieve a particular appearance of the iris fold.

In another alternative, the one or more folding devices may comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotatable cam associated with each vacuum flute on the rotating drum, each cam having a surface flush with the end of the tobacco rod and configured to sweep across the end of the tobacco rod as the smoking article rolls over the plate, the edge of the cam pushing against the overhanging foldable paper to fold it inwards over the tobacco. In this context, the cam may have a smooth edge that creates a continuous fold, or alternatively the cam may have a toothed edge that creates a series of overlapping folds. This latter option gives an iris fold in which the number of folds corresponds to the number of teeth.

In a yet further alternative, the one or more folding devices may comprise a pair of adjacent rotatable surfaces flush with the end of the tobacco rod that sweep outwardly over the end of the tobacco rod from the rear of the smoking article as it is carried by the rotating drum to create first and second adjacent folds, and a static tucker having a surface flush with the end of the tobacco rod against which the end of the tobacco rod passes to create a third fold. This gives a three-way fold.

In another embodiment, the one or more folding devices may comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotating threaded screw positioned with its axis of rotation orthogonal to the axis of rotation of the rotating drum and substantially tangential to the perimeter of the drum, and the threaded surface flush with the end of the tobacco rod such that the

screw thread engages with the overhanging foldable paper as the smoking article rolls across the plate and the rotation of the screw folds the paper inwards over the tobacco. A number of individual overlapping folds are produced, giving an iris-style fold. The pitch of the screw thread determines the number of folds.

In a further embodiment, the one or more folding devices may comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, and a pair of static plough folders providing oppositely disposed surfaces flush with the end of the tobacco rod and having converging edges, against which the end of tobacco rod passes to create third and fourth folds opposite one another and orthogonal to the first and second folds. This produces a four-way envelope fold.

In an alternative embodiment, the one or more folding devices may comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, and a pair of reciprocating folders that sweep inwardly over the end of the tobacco rod and then retract to create third and fourth folds opposite one another and orthogonal to the first and second folds. Again, a four-way envelope fold is produced.

Alternatively, the one or more folding devices may comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, a fixed folder disposed at the side of a vacuum flute of a third, adjacent, rotating drum to which the smoking article is transferred from the second drum which engages with the overhanging foldable paper as the smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a third fold orthogonal to the first and second folds, and a further fixed folder disposed at the side of a vacuum flute of a fourth, adjacent, rotating drum to which the smoking article is transferred from the third drum which engages with the overhanging foldable paper as the smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a fourth fold opposite to the third fold. This is further alternative way to produce a four-way envelope fold.

In any of the above methods including protrusions in vacuum flutes, one or both of the said protrusion and the further protrusion may be configured to move between an extended position for effecting the first or second fold as the smoking article enters the vacuum flute, and a retracted position after the fold is effected in which the protrusion does not protrude into the flute. Retracting the protrusion after folding allows further motion of the smoking article to proceed with less impediment, giving a smoother production process. Also, the gradual folding motion of a moving protrusion can produce a better quality fold than the more abrupt impact between a smoking article and a fixed protrusion.

In another embodiment, the one or more folding devices may comprise a first pair of pincers longitudinally aligned with a vacuum flute of a first rotating drum, and

biased in an open position to receive the overhanging foldable paper of a smoking article in the vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and a second pair of pincers longitudinally aligned with a vacuum flute of a second rotating drum, and biased in a open position to receive the overhanging foldable paper of the smoking article when transferred to the vacuum flute after folding in the vacuum flute of the first rotating drum, the pincers operable to close on the remaining overhanging foldable paper and push the opposite parts of the paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

Alternatively, the one or more folding devices may comprise a first pair of pincers longitudinally aligned with a vacuum flute of a first rotating drum, and biased in an open position to receive the overhanging foldable paper of a smoking article in the vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and one or more supplementary folding devices associated with a second rotating drum arranged to receive the smoking article after folding with the first drum, and operable to fold the remaining opposite parts of the paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

According to further embodiments, adhering the foldable paper to the cigarette paper may comprise: applying adhesive to the foldable paper; bringing the smoking article into contact with the foldable paper such that an edge of the foldable paper adheres to the cigarette paper; and introducing the smoking article onto a lower surface that is spaced apart from an upper surface by a distance less than the diameter of the smoking article, the upper surface moving relative to the lower surface along a direction parallel to the surfaces and orthogonal to the longitudinal axis of the smoking articles such that contact with the surfaces causes the smoking article to rotate about

its longitudinal axis so that it rolls over the lower surface as the upper surface moves, the rolling causing the foldable paper to wrap around the smoking article. The upper surface may comprise an endless belt rotating around a pair of rollers.

Further, folding the overhanging paper may then comprise using the rolling of the smoking article over the lower surface to bring the overhanging foldable paper into contact with one or more folding devices that bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod. The one or more folding devices may comprise a series of teeth extending from the lower surface towards the upper surface and having surfaces flush with the end of the tobacco rod, each tooth engaging a part of the overhanging foldable paper and creating a fold as the smoking article rolls over the lower surface, each fold overlapping the previous fold. Other folding devices may alternatively be used, however.

Folding the overhanging foldable paper may comprise pushing part of the paper inwards to create a first fold, pushing a further part of the paper inwards to create a second fold opposite the first fold, and trimming off some or all of the remaining, unfolded paper. This reduces the amount of overlapping paper in the folded end, making the smoking article easier to light.

The method may further comprise, after folding the overhanging foldable paper, pushing against the end of the tobacco rod with a pin having a width less than the diameter of the smoking article to depress the folded paper and cause it to better maintain its folded position. This is a simple way to overcome any tendency of the folded paper to spring outwards slightly from its folded position, and is preferable to the use of adhesive to hold the folded end in place.

In some embodiments, the foldable paper is provided with adhesive on all or part of the inner surface of the overhanging portion, and the method further comprises, after folding the overhanging paper, pressing against the end of the tobacco rod to cause the folded paper to become adhered in its folded position. The adhesive may be

heat-activated, and pressing against the end of the tobacco rod may include applying heat to the end of the tobacco rod.

Also, the method may further comprise, in the event that the smoking article is a partially fabricated smoking article, attaching a filter unit to the end of the tobacco rod opposite to the end intended to be lit. To speed production, the filter unit may be attached to the end of the tobacco rod simultaneously with the adhering and/or folding of the foldable paper.

In a further embodiment, the method may further comprise, after folding the overhanging paper, inspecting the folded overhanging paper for defects, and rejecting a smoking article found to have a defective folded overhanging paper. The inspecting may comprise capturing one or more images of the folded overhanging paper and comparing the one or more images with one or more stored images of non-defective folded overhanging paper. The captured images comprise, for example, an end view of the folded overhanging paper and/or a side view of the folded overhanging paper.

A second aspect of the present invention is directed to apparatus configured to perform a method of making a smoking article according to any embodiment of the first aspect.

A third aspect of the present invention is directed to a smoking article comprising: a tobacco rod of tobacco wrapped in cigarette paper; and a foldable paper adhered to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit, the overhanging foldable paper folded to substantially cover the tobacco at the end of the tobacco rod. The foldable paper may be adhered to the outside of the cigarette paper.

The foldable paper may be a porous paper, such as porous plug wrap paper. The foldable paper may have a porosity greater than 3,000 CU, or greater than 6,000 CU, or greater than 12,000 CU, or greater than 24,000 CU. Further, the foldable paper may be embossed with one or more crease lines along which the overhanging foldable

paper is folded. The foldable paper encircling the tobacco rod may extend over only part of the length of the tobacco rod, or over substantially the whole length of the tobacco rod.

The foldable paper may be shaped along an edge such that the overhanging foldable paper has an edge profile that gives a reduced amount of overlapped paper after folding compared to a straight edge.

The overhanging foldable paper may be folded with a first fold, a second fold opposite the first fold, a third fold orthogonal to the first and second folds, and a fourth fold opposite the third fold. In an alternative, the overhanging foldable paper may be folded with a plurality of folds, each fold overlapping the adjacent fold.

The smoking article may further comprise a filter unit attached to the end of the tobacco rod opposite to the end intended to be lit.

A fourth aspect of the present invention is directed to apparatus for making a smoking article comprising: a first sub-apparatus operable to receive a fully or partially fabricated smoking article comprising at least a rod of tobacco wrapped in cigarette paper and to adhere a foldable paper to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and a second sub-apparatus operable to receive a smoking article with an overhanging foldable paper produced by the first sub-apparatus and to fold the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod.

The first sub-apparatus and the second sub-apparatus may be configured according to a range of different embodiments. Additionally, the apparatus may further comprise a third sub-apparatus operable to receive a smoking article with a folded overhanging foldable paper from the second sub-apparatus and to push a pin having a width less than the diameter of the smoking article against the folded overhanging foldable paper to depress the folded paper and cause it to better maintain its folded position, and/or to apply pressure and/or heat to the folded overhanging foldable paper to active adhesive

on the overhanging foldable paper and cause it to become adhered in its folded position. Further, the apparatus may also comprise a fourth sub-apparatus operable to attach a filter unit to the end of a tobacco rod of a partially fabricated smoking article, opposite to the end intended to be lit. Also, an inspection system may be included, operable to inspect the folded overhanging paper for defects and reject a smoking article found to have a defective folded overhanging paper.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention and to show how the same may be carried into effect reference is now made by way of example to the accompanying drawings in which:

Figures 1A and 1B show cross-sectional side views of the end of a smoking article provided with a foldable paper for closing the lighting end of the smoking article, with the foldable paper respectively in unfolded and folded positions, in accordance with an embodiment of the invention;

Figure 2 shows a schematic representation of a first embodiment of a process for applying a foldable paper to a smoking article;

Figures 3A and 3B show schematic representations of examples of a second embodiment of a process for applying a foldable paper to a smoking article;

Figure 4 shows a schematic representation of a first embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figures 5A-5D show a sequence of end views of a smoking article having an applied overhanging foldable paper which is successively folded using four folds;

Figure 6 shows a schematic side representation of a second embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 7 shows a schematic side representation of a third embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 8 shows an end view of a smoking article having an applied foldable paper folded into an iris-style fold such as by the apparatus of Figure 7;

Figure 9 shows a schematic side representation of a fourth embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 10 shows a schematic side representation of a fifth embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 11 shows a schematic side representation of a sixth embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 11A shows an end view of a smoking article having an applied foldable paper folded into a three-way fold, such as by use of the apparatus of Figure 11;

Figure 12 shows a perspective schematic representation of a first embodiment of apparatus for applying a foldable paper to a smoking article and folding the paper;

Figures 13A and 13B shows cross-sectional side views of a smoking article having first and second folds made to its overhanging foldable paper using the apparatus of Figure 12;

Figure 14 shows a perspective schematic representation of a second embodiment of apparatus for applying a foldable paper to a smoking article and folding the paper;

Figure 15 shows a perspective schematic representation of a third embodiment of apparatus for applying a foldable paper to a smoking article and folding the paper;

Figures 16A, 16B, 16C and 16D show assorted side and perspective views of a further embodiment of apparatus for folding overhanging foldable paper applied to a smoking article;

Figure 17 shows a schematic side representation of an alternative embodiment of apparatus for applying a foldable paper to a smoking article and folding the paper;

Figures 18A, 18B and 18C show end views of smoking articles having applied foldable papers folded according to three further embodiments;

Figures 19A and 19B show schematic side representations of two embodiments of apparatus for pressing a pin into previously folded paper of a smoking article to improve the closure;

Figure 20 shows a schematic side representation of a smoking article having a pressing pin applied to its folded paper, such as with the apparatus of Figures 19A or 19B;

Figure 21 shows three examples of shaped-edge foldable paper that may be utilised in embodiments of the present invention;

Figure 22 shows a plan view of a foldable paper with adhesive applied according to an embodiment of the invention; and

Figure 23 shows a view from above of an example inspection system for detecting smoking articles with defective folded ends, according to another embodiment.

DETAILED DESCRIPTION

The present invention proposes closing the end of a smoking article by providing an extra portion of paper at the end of the tobacco rod of the smoking article that is intended to be lit, so that the paper overhangs the end of the rod, and then folding the overhanging paper inwards to cover over the exposed tobacco. A tobacco rod comprises a cylinder of tobacco wrapped in cigarette paper, with the end of the tobacco substantially flush with the end of the paper. According to the invention, an additional piece of foldable paper is stuck with adhesive around the outside of the cigarette paper after the tobacco rod is formed, so that the foldable paper encircles the tobacco rod, and extends beyond the end of the tobacco rod by an amount that is sufficient to substantially enclose the tobacco when the overhanging paper is folded inwards.

Figure 1A shows a longitudinal cross-sectional view through the end of a tobacco rod having an overhang of foldable paper according to an embodiment of the invention. The tobacco rod 10 comprises tobacco 12 wrapped in a cigarette paper 14 in the conventional manner, with the addition of a portion of foldable paper 16 that is adhered around the circumference of the end portion of the cigarette paper 14. A length 18 of the foldable paper 16 extends beyond the end of the tobacco 12 and the cigarette paper 14 to form an overhang.

Figure 1B shows the same view of the tobacco rod 10 after folding of the foldable paper 14. The overhanging part 18 of the foldable paper 14 is folded inwards against the end surface of the tobacco 12 so as to close the end of the tobacco rod and cover the tobacco that would otherwise be exposed at the end of the tobacco rod that is intended to be lit.

The term "tobacco" as used herein is intended to be understood as including tobacco material (such as stem, lamina, tobacco dust, cut tobacco and expanded tobacco), reconstituted tobacco and substitute tobacco materials.

The foldable paper may be any paper that can conveniently be folded in the required manner. A piece of regular cigarette paper, the same as the cigarette paper of the tobacco rod, may be used. However, it has been found that a more satisfactory result can be achieved if a paper of a lighter weight than cigarette paper is used. A lighter paper is thinner and hence more easily folded. Also, a lighter paper has greater porosity, which makes it easier for the smoker to draw on the smoking article when lighting it, so that ease of lighting is less impaired by the presence of the folded paper. For example, porous plug wrap paper, of the type generally used to wrap around the acetate tow core of a cigarette filter unit, may be used. This is a thin paper with a high porosity, and is also conveniently readily available in the industry due it being already used in cigarette manufacture. More generally, paper with a porosity greater than 3,000 CORESTA units (CU), or greater than 6,000 CU, or greater than 12,000 CU, or greater than 24,000 CU is recommended, although papers with other porosity values are not excluded.

Figures 1A and 1B show an embodiment in which the foldable paper is relatively short compared to the overall length of the tobacco rod, so that the foldable paper extends only a short distance along the length of the cigarette paper. For example, the length of foldable paper that overlaps the cigarette paper may be substantially equal to the length that overhangs the end of the tobacco rod. The length may be selected according to how much paper it is desired to use (a short length obviously using less paper and hence being less costly), and how large an area of overlap is needed to provide a secure adherence of the foldable paper to the cigarette paper. While a short length is economic, long lengths may be used instead, up to and including a length of foldable paper that extends over substantially the entire length of the tobacco rod. This latter example has the advantage that the end of the foldable paper opposite to the folded end can be hidden under a tipping paper used to join a filter unit to the tobacco rod, giving a smooth outer surface to the tobacco rod of the completed smoking article. This gives an improved aesthetic appearance to the

smoking article, and also protects the edge of the foldable paper and prevents it becoming caught and possible torn during subsequent processing and handling of the smoking article.

For foldable paper applied over the length of the tobacco rod, it is convenient to apply the foldable paper to the tobacco rod before the tobacco rod is assembled with a filter unit to form a completed smoking article, so that the edge of the foldable paper can be wrapped under the tipping paper as mentioned above. However, for embodiments using a shorter length of foldable paper, the foldable paper can be applied to the tobacco rod at any stage in the fabrication of the smoking article, including before or after a filter unit is joined to the tobacco rod. Hence, methods of the invention are applicable to both fully and partially fabricated smoking articles, where it is merely required that a tobacco rod be provided for adherence of the foldable paper to the cigarette paper thereof. If the smoking article is only partly fabricated, and comprises a tobacco rod without a filter at the time of applying the foldable paper, a filter unit can be added subsequently to form a filter smoking article. Alternatively, the smoking article may be intended as a plain cigarette, so that no filter is added to the tobacco rod. Consequently, in the following description and appended claims, the term "smoking article" is intended to cover both substantially completed smoking articles, and partially completed smoking articles (which may comprise a tobacco rod only). Furthermore, if the smoking article is only partly fabricated, a filter unit can be added simultaneously with the application and folding of the foldable paper. This combines two handling stages into one and hence reduces production time for the smoking articles. Simultaneous processing in this way is facilitated by the fact that the application and folding of the foldable paper can be carried out using conventional smoking article manufacturing apparatus such as is employed for filter attachment with only small modifications, so that the additional processes can be readily integrated into existing production lines.

According to one embodiment, it is proposed that the foldable paper be supplied as individual glued pieces that are applied to individual smoking articles, and then wrapped around the tobacco rods so that the glue adheres to the cigarette paper and holds the foldable paper in place.

A convenient way to handle the smoking articles during this process is to carry them on the surface of one or more rotating drums, as is commonly done in existing smoking article manufacturing processes. A rotatable drum, mounted on a spindle and driven by a motor at an appropriate speed of rotation to synchronise with related machinery, has a plurality of longitudinal grooves or flutes in its outer surface around its circumference, each flute arranged parallel to the rotational axis of the drum and dimensioned to accommodate a smoking article. Each flute has one or more holes in its surface that are connected to a vacuum pump so that a smoking article can be held in the flute by suction. The smoking articles can thereby be received onto a drum or discharged from a drum, including being passed from one drum to an adjacent drum, by turning the vacuum on and off at the appropriate times. One or more drums can be used to carry smoking articles past a variety of processing devices that perform different manufacturing steps on the smoking articles.

Figure 2 shows a schematic representation of the use of rotating drums for applying a foldable paper to a smoking article, shown as a view along the axes of rotation of the drums. In this example, the foldable paper is provided as a pre-wound roll 20 of appropriate paper 22, such as porous plug wrap, the paper on the roll 20 having a width that is the required length of the foldable paper when it is wrapped around a tobacco rod (i.e. the length of the overhang plus the length of the portion that extends over the cigarette paper along all or part of the tobacco rod). The paper 22 is unwound from the roll 20 and passed through a pair of embossing rollers 23, which emboss the paper with one or more crease lines corresponding to the lines along which the paper is to be folded to close the end of the smoking article. The crease lines facilitate the later folding of the foldable paper, but need not be included, so the

embossing rollers 23 may be absent from the apparatus. Alternatively, the foldable paper 22 may be provided pre-embossed on the roll 20. The foldable paper then travels past a glue applying device 26 which applies adhesive 24 to one side of the paper 22. Any suitable glue applying device may be used, such as a roller system or a glue spray unit. After gluing, the paper 22 from the roll 20 is then cut to the correct length using a cutting device 28. The correct length is a length sufficient to completely encircle the smoking article, with optionally an overlapping edge. In this example, the cutting device 28 is a vacuum cutting drum 28. This is a drum with a plurality of cutting blades 29 spaced around its circumference. Rotation of the drum 28 brings the blades in turn into contact with the paper 22, and each blade cuts off a correct length 30 of the paper 22. The surface of the drum 28 is also provided with suction holes through which a vacuum is applied to hold the individual foldable papers 30 against the drum 28 as it rotates.

The foldable paper 30, now glued and of the necessary size, is carried by the rotation of the vacuum cutting drum 28 into a position in which its leading edge extends into the path of a smoking article 32 being carried on the surface of a first rotating drum 34. The smoking article 32 is delivered to the drum 34 from a hopper or an adjacent drum, and taken up by a flute on the surface of the drum 34. As the drum 34 rotates, the smoking article 32 comes into contact with the leading edge of the foldable paper 30, and the foldable paper 30 sticks to the cigarette paper of the smoking article 32 because of the previously applied adhesive. This sticking action pulls the foldable paper 30 off the vacuum cutting drum 28, so that the foldable paper is now carried by the smoking article 32. The vacuum cutting drum 28 and the rotating drum 34 are positioned relative to one another along the longitudinal direction of the smoking article 32 so as to give the required length of overhang when the paper 30 is stuck to the smoking article 32.

The first rotating drum 34 rotates further, carrying the smoking article 32 and attached foldable paper 30 with it. A second rotating drum 36 is positioned adjacent to

the first drum 34 and rotating in an opposite direction about a parallel axis. The rotation of the drums 34, 36 brings the smoking article 32 into a flute on the second drum 36, and appropriate switching of the vacuum suction in the two flutes transfers to the smoking article to the second drum 36.

A rolling plate 38 is positioned adjacent to the second drum 36. The rolling plate 38 is a static plate having a curved surface 40 with a profile that matches the outer circumference of the drum 36. The plate 38 is located such that the curved surface 40 is spaced from the surface of the drum 36 by slightly less than the amount by which the smoking article 32 protrudes from the surface of the drum 36. As the drum 36 rotates it brings the smoking article 32 into the space between the drum 36 and the surface 40 of the rolling plate 38, but in an interference fit owing to the spacing. This interference fit causes the smoking article 32 to rotate about its own longitudinal axis within the flute (in an opposite direction to that of the rotation of the drum) as the smoking article is carried through the space by the drum 36, so that the smoking article 32 in effect rolls over the curved surface 40 of the rolling plate 38. This rolling also causes the smoking article 32 to roll over its attached foldable paper 30, so that the foldable paper 30 adheres right around the circumference of the tobacco rod and forms a tube that extends beyond the end of the tobacco rod. When the smoking article 32 is carried past the rolling plate 38, it is ready for folding of the overhanging foldable paper.

Application of the foldable paper according to the embodiment of Figure 2 can be used for any length of foldable paper, and for partially and fully assembled smoking articles.

A potential problem that may arise from use of a rolling plate to apply the foldable paper is that of ends fall-out, in which tobacco pieces at the open end of a tobacco rod can become loosened and may subsequently be lost. In the present case, this can be caused by the pressure exerted on the end of the smoking article by the rolling plate. This can be addressed by appropriate configuration of the rolling plate

and rotating drum combination to reduce the pressure applied to the smoking article, and/or to shift the position(s) along the length of the smoking article at which pressure is applied.

An alternative approach is pre-gluing of the cigarette paper before fabrication of the smoking article. One or more lines or dots of adhesive can be applied to the inside surface of the cigarette paper before it is wrapped around the tobacco, the lines or dots positioned to coincide with the end of each smoking article. The end part of the tobacco is thereby secured within the cigarette paper, and is less likely to be loosened during application of the foldable paper.

Figure 3A shows a schematic representation of a technique for applying a foldable paper that extends over the full length of the tobacco rod of the smoking article. In this case, a continuous length of foldable paper 42 is fed from a roll (not shown), and arranged in the horizontal direction. The paper has a width which is at least the circumference of the smoking article so that it can completely encircle the tobacco rod when wrapped around the smoking article. Possibly the width of the foldable paper is greater than the circumference of the smoking article, so that there is an overlap when the foldable paper is wrapped around the tobacco rod, which may assist with gluing, for example. Adhesive is applied to the upper surface of the foldable paper, at least along one edge. The amount and position of the adhesive can be selected as desired, depending on how much of the surface of the foldable paper it is desired to stick to the cigarette paper, and whether an overlap is used.

A continuous stream of smoking articles 44 is delivered onto the upper surface of the foldable paper 42, as indicated in section A of the Figure. The smoking articles do not have filters, and may comprise only a tobacco rod in the form of tobacco 46 wrapped in cigarette paper 48. The smoking articles 44 are arranged end to end in a line, and positioned along the length of the foldable paper 42. However, the smoking articles are spaced apart along the line by a distance d that is equal to the desired length of the overhang of the foldable paper.

The smoking articles 44 and the foldable paper 42 are moved along together, as shown by the arrow in the Figure, and fed into a tube (not shown) having an inner diameter substantially the same as the diameter of the smoking articles 44. As shown in section B of the Figure, the wall of the tube guides the foldable paper 42 around the smoking articles 44, and the adhesive causes the foldable paper 42 to stick in place so as to encircle the cigarette papers 48 of the smoking article 44. This results in a continuous tube of foldable paper 42 with smoking articles 44 spaced apart in a line inside the tube.

Finally, the continuous tube is cut into sections, as shown in section C of the Figure. A cutting device 50, such as a blade, is arranged to cut through the tube of foldable paper 42 at intervals corresponding to the length of the smoking articles 44 plus the foldable paper overhang. The cuts are positioned to be flush with one end of each tobacco rod. This divides the continuous tube into individual smoking articles 44 each comprising a tobacco rod with a foldable paper wrapped around it that extends over the whole length of the tobacco rod and further extends beyond one end of the tobacco rod to give the desired overhang 18 for folding.

Alternatively, the stream of smoking articles 44 may be delivered onto the foldable paper 42 in pairs, with the two article in each pair being substantially touching or abutting at their adjacent ends, and the pairs being spaced apart by a distance 2d, which is equal to twice the desired length of the overhang of foldable paper. Once wrapped in the continuous tube of foldable paper 42, the smoking articles 44 are then separated by the tube being cut at the midpoint of each space between pairs of smoking articles, and also at the point where the articles 44 in each pair abut.

Figure 3B shows a schematic representation of this arrangement, using the same reference numerals as Figure 3A. A second cutting blade 50' is shown in phantom to indicate, in conjunction with the first cutting blade 50, the two cutting points relative to each pair of smoking articles 44. In reality, the cuts can all be effected by a single cutting device if preferred.

An advantage of these methods of applying the foldable paper to the smoking articles is that they can be readily adapted from known apparatus for making cigarettes with a double-wrapped tobacco rod. Such cigarettes have an outer layer of paper overlying the cigarette paper, and the tobacco rods for these cigarettes can be made by delivering a continuous stream of single-wrapped tobacco rods, arranged end to end with no spaces, onto a glued length of outer wrap which is then wrapped around the tobacco rods. The resulting continuous tube is then cut at each break between the single-wrapped rods. By adjusting the supply of tobacco rods so as to give the necessary spacing between the rods, and using a cutting device that can cut through the foldable paper tube without crushing or deforming the overhang, the embodiments of the present invention as shown in Figures 3A and 3B may be implemented.

The present invention further proposes a number of techniques for folding the overhanging foldable paper so as to cover the exposed end of the tobacco rod. It is proposed that these techniques be implemented by carrying the smoking articles, already provided with overhangs of foldable paper, on one or more rotating drums like those described above with regard to Figure 2 that bring the foldable paper overhangs into contact with one or more folding devices that engage the paper to push it inwards over the tobacco. Different devices can be employed to achieve different folding effects, with various numbers and arrangements of folds.

Figure 4 shows a schematic view of a first example of a folding arrangement, comprising four folding devices arranged next to a rotating drum. The drum 52 carries smoking articles 54 in vacuum flutes on its outer surface, as described before, the smoking articles having been delivered thereto from a hopper or another rotating drum. As the drum rotates, it carries the smoking articles past the four folding devices in turn. Each folding device comprises a substantially flat surface arranged orthogonal to the axis of rotation of the drum 52 and hence also to the longitudinal axes of the smoking articles 54. Further, the surfaces of the folding devices are located in a plane

that is substantially flush with the end surfaces of the tobacco in the tobacco rods of the smoking articles 54 as they are carried by the drum 52.

The first folding device 56 comprises a reciprocating tucker in the form of surface having a width that is less than the diameter of the smoking articles. It has a fixed location with respect to the drum 52, but which can move back and forth along a direction perpendicular to its width which is also substantially parallel to a tangent of the drum 52, as shown by the arrow in the Figure. In a starting position, the reciprocating tucker occupies a position retracted from the drum which allows a smoking article to pass by untouched. When a smoking article 54 reaches the position 54a, past the reciprocating tucker 56, the tucker moves forward so that its surface slides partially over the end of the tobacco rod on the trailing side, pushing part of the overhanging foldable paper before it to that the paper is pushed inwards and over the tobacco. The tucker 56 is then retracted before it reaches the foldable paper overhanging the opposite side of the smoking article 54. A first fold is thereby formed.

The second folding device 58 comprises a static tucker, again in the form of a surface having a width less than the diameter of the smoking article. It occupies a fixed position with respect to the drum 52, arranged with its width substantially perpendicular to a further tangent of the drum 52. It is located such that the smoking article, carried by the rotating drum and already having a first fold, passes behind the tucker 58 (with respect to the viewing direction of Figure 4) with the surface of the tobacco flush with the surface of the tucker 58. The front edge of the tucker pushes against the overhanging foldable paper as the smoking article moves into the tucker, and folds it over against the tobacco, to create a second fold opposite the first fold. The presence of the first fold on the trailing side of the smoking article means that the smoking article is free to pass under the static tucker once the leading side of the paper has been folded as the second fold. The positions of the first folding device 56 and the second folding device 58, and the movement of the first folding device relative to the speed of the drum 52, are arranged so that the first tucker 56 makes its fold just prior

to the smoking article starting to be folded by the second tucker 58. Upon completion of the second fold, the first tucker 56 retracts to allow the next smoking article to pass by prior to the first tucker moving forward again to create a first fold on the trailing side.

The third folding device 60 comprises a static plough folder. This has a surface with a tapering profile, arranged to offer an edge to the incoming leading side of the smoking article that begins at one side of the smoking article end (with respect to the direction of travel of the smoking article) and converges towards the midline of the smoking article end as the travel path of the smoking article proceeds. Thus, as the smoking article is carried past the folder, the edge engages the overhanging paper at the side of the smoking article, and gradually pushes it inwards and over against the end of the tobacco rod as this end passes against the surface of the folder. This creates a third fold that is substantially at right angles to the first and second folds.

Finally, the fourth folding device 62 comprise a further static plough folder. This has the same structure as but the opposite configuration to the third folding device 60, so that the converging edge is positioned on the other side of the smoking article. Therefore, travel of the smoking article past this plough folder engages the opposite overhanging paper, and folds it inwards against the end of the tobacco rod to create a fourth fold opposite to the third fold. For reasons of space, the fourth folding device 62 will probably need to be positioned downstream from the third folding device 60, so that each of the surfaces can extend sufficiently far across the end of the tobacco rod to completely fold over the overhanging foldable paper.

The folding devices of Figure 4 create an envelope fold comprising two opposite folds overlaid by two further opposite folds that are orthogonal to the first opposite folds.

Figures 5A-5D show schematic representations of the end view of a smoking article being provided with an envelope fold, such as by use of the apparatus of Figure 4. A first fold 64 is followed by a second fold 66 on the opposite side of the smoking

article, a third fold 68 at right angles to the first and second folds, and a fourth fold 70 opposite to the third fold. The exposed tobacco 72 at the end of the tobacco rod is gradually covered over.

Figure 6 shows a schematic representation of a further example of folding apparatus. A rotating drum 74 that carries smoking articles 54 in vacuum flutes on its surface, as before, is used in conjunction with a static rolling plate 76, like the rolling plate 38 described with reference to Figure 2. As before, the interference fit of the smoking article 54 between the surface of the rotating drum 74 and the curved surface of the rolling plate 76 causes the smoking article 54 to rotate about its own longitudinal axis so that it rolls over the surface of the plate 76. In this example, the rolling plate 76 is provided with a plough folder 78. The plough folder 78 is fixed to the rolling plate 76 and comprises a surface extending from the curved surface of the rolling plate 76 that is in the plane of the ends of the tobacco rods of the smoking articles 54 so that the ends of the rods pass against the surface as the smoking articles 54 roll over the rolling plate 76. The surface of the plough folder 78 has an edge that begins at the surface of the rolling plate, and converges towards the surface of the drum, so that the far end of the plough folder extends at least halfway across the space between the rolling plate 76 and the drum 74. When a smoking article is carried onto the rolling plate 76 by rotation of the drum 74, the front end of the plough folder 78 engages with the overhanging foldable paper at the end of the tobacco rod, and gradually pushes it over and inwards against the end surface of the tobacco. As the smoking article 54 rolls over the rolling plate 79, the edge of the plough folder 78 continually engages with a new part of the overhanging foldable paper and folds it over against the tobacco. As the smoking article 54 progresses across the plough folder 78, the converging edge gradually extends across more of the end of the smoking article 54, thus folding the overhanging paper over along its whole length. In this manner, a continuous fold is formed all around the circumference of the tobacco rod and the overhanging paper is brought flat against the end of the tobacco in the

tobacco rod. When the smoking article 54 emerges from the end of the plough folder 78, its end is completely covered by folded paper, provided that the original overhang was of sufficient length.

Figure 7 shows a schematic representation of a further example of a folding apparatus. This is similar to that of Figure 6, in that it utilises a rotating drum 74 to roll smoking articles 54 over the surface of a static rolling plate 76. In this example, however, the plough folder is replaced with a series of teeth 80. Like the plough folder, the teeth 80 extend inwardly from the surface of the rolling plate 76 and have surfaces in a plane level with the end of the tobacco in the tobacco rods of the smoking articles 54. Each tooth 80 has an edge that begins on the surface of the rolling plate 76 and converges towards the surface of the drum, so that the far end of each tooth 80 extends at least half way across the space between the rolling plate 76 and the drum 74. Thus, each tooth 80 may be thought of as an individual plough folder. However, the length of each tooth in the direction of travel of the smoking articles is less than the circumference of the smoking articles, so each tooth 80 can only fold over a part of the overhanging foldable paper. The next tooth 80 engages the overhang where the previous tooth has stopped folding, and makes a new and separate fold that overlaps the previous fold. Each tooth 80 makes a separate fold which overlaps the preceding fold. Thus, there must be enough teeth to fold over all of the overhanging paper, so the total length of the teeth must be at least the circumference of the smoking article 54. This gives an iris-style fold, comprising the same number of folds as there are teeth 80 on the rolling plate 76.

Figure 8 shows a schematic end view of a smoking article having its end closed with an iris fold. The five overlapping folds have been formed in the order a to e, for example using the five teeth 80 on the rolling plate 76 shown in Figure 7.

Figure 9 shows a schematic representation of a yet further example of a folding apparatus that uses a rotating drum 74 and a static rolling plate 76. In this example, each vacuum flute for carrying a smoking article 54 has an associated cam folder 82.

For each flute, the cam folder 82 comprises a cam which is rotatably mounted on the end face of the drum 74 in line with the flute such that the cam provides a surface that extends beyond the edge of the end face of the drum, over the smoking article 54 in the flute, the surface being flush with the end of the tobacco rod of the smoking article 54. The axis of rotation of the cam is parallel to that of the drum 74, and, being a cam, the surface has an edge which is eccentric with respect to the axis of rotation. Thus, as the cam rotates, the edge of the surface gradually extends further and further over the end of the tobacco rod. The maximum extent should be at least half-way across the width of the smoking article.

When a smoking article 54 enters a flute on the drum 74, the associated cam is in a position in which the cam surface does not protrude beyond the edge of drum 74. When the smoking article reaches the rolling plate 76, the cam folder is switched on, and the cam surface begins to rotate. As the edge begins to protrude past the edge of the drum 74, the edge engages with the overhanging foldable paper and pushes it over against the end of the tobacco in the tobacco rod. At the same time, the smoking article 54 is rolling over the rolling plate 76, so that as the cam edge extends further over the end of the tobacco rod, a new part of the overhang is brought into engagement with the cam edge, to be pushed inwards over the tobacco. The cam rotation is timed such that as the smoking article 54 rotates once across the rolling plate 76, the cam also rotates once so that the edge swings out over the end of the tobacco rod, and then gradually recedes as the eccentricity of the cam moves closer to the rotation axis again. These movements combine to produce a continuous fold in the overhanging foldable paper, all around the circumference of the smoking article. The rotating cam works in a similar way to the smooth-edged plough folder of Figure 6, by providing a tapering edge that gradually extends further and further across the end surface of the tobacco rod as the smoking article rolls around, to produce a single continuous fold.

The folding effect of the tooth-style folder of Figure 7 may also be replicated using cam folders. This can be achieved by providing cams with stepped edges instead

of the smooth profile shown in Figure 9. Each step in the edge produces a separate fold of just part of the overhanging foldable paper, with successive folds overlapping to produce a final iris fold.

Figure 10 shows a schematic representation of a still further folding apparatus that uses a rotating drum 74 in combination with a rolling plate 76. In this example, the rolling plate 76 operates in conjunction with a rotating threaded screw 84 to engage and fold the overhanging paper. The threaded screw 84 is driven by motor 86 and arranged with its longitudinal axis, and hence also its axis of rotation, substantially orthogonal to the axis of rotation of the drum 74 and the longitudinal axes of the smoking articles 54 carried by the drum. The threaded screw 84 is further positioned so that it extends largely along the extent of the rolling surface of the rolling plate, and with the threaded surface in the same plane as the ends of the tobacco rods of the carried smoking articles. In this way, the threaded surface forms a surface flush with the ends of the tobacco rods over which the tobacco surface can be moved to fold over the overhanging paper, as with the flush surfaces in the previous embodiments. To achieve folding, the threaded screw 84 is rotated at the same time as the smoking article 54 rolls over the surface of the rolling plate 76. The threads of the screw hence come into contact with successive parts of the overhanging foldable paper, engage therewith, and fold each part inwards against the end of the tobacco rod. By matching the speed of rotation of the threaded screw to the rolling speed of the smoking article, or setting the speeds to be a ratio, the folds can be made neatly adjacent and overlapping to form a tidy iris fold. The pitch of the screw thread determines the number of folds.

Figure 11 shows another example of a folding apparatus in accordance with the invention that uses a rotating drum 74 to carry smoking articles 54 past three folding devices to create three folds. Two of the folding devices are a pair of rotating folders 88 which have a fixed location with respect to the drum 74, and are arranged side by side substantially along a radius of the drum but beyond the edge of the drum 74, to

provide two surfaces flush with the ends of the tobacco rods of the smoking articles 54. The surfaces rotate about axes parallel to the rotation axis of the drum, and have edges shaped such that the rotation brings the surfaces into and out of the path of the smoking articles 54 as the drum rotates. For example, the surfaces may be cams, so that the eccentricity of the cam rotation gives a surface that in some positions extends over part of the end of a smoking article, and in some positions does not, because the edge is closer to the axis of rotation of the cam. Alternatively, the surfaces may be centrally mounted circular surfaces with a missing sector, such as a quarter, as shown in the Figure. Thus, in some rotational positions, the surface extends partially over the end of the tobacco rod, and in other positions, the missing sector coincides with the tobacco rod so that the surface does not extend over the end of the tobacco rod. The two rotating surfaces of the rotating folders are arranged to rotate in opposite directions, and in either of the above examples of surface shape, the effect is to provide two surfaces with leading edges that engage with adjacent parts of the overhanging foldable paper as the surfaces rotate, further rotation of the surfaces causing the surfaces to sweep over the end of the tobacco rod and fold over the foldable paper to form first and second folds. The folds are substantially along the two sides of the smoking article with respect its direction of travel, but also adjacent in a substantially V-shaped formation.

The rotational positions, directions of rotation and speeds of rotation of the two rotating folders 88 are chosen such that a smoking article can initially pass between them with no folding (the surfaces are in positions in which they do not extend over the ends of the tobacco rods). At a particular point, when the smoking article 54 is in range of the folding surfaces when they are rotated into position (approximately 54a in Figure 11), the folders 88 rotate, the leading edges of the surfaces engage with the rear of the overhanging foldable paper, and the surfaces sweep forwards across the end of the tobacco rod to fold the two sides of the overhanging paper flat against the tobacco. The surfaces need to be rotating faster than the drum to achieve this so that the

smoking article 54 does not move out of range of the rotating folders 88 before folding is complete. Alternatively, the rotating drum 74 may be halted while the rotating folders 88 rotate.

The two rotating folders 88 can be arranged as a pair, as in Figure 11, so that the first and second folds are formed simultaneously. This is advantageous if the rotating drum is halted for folding, as less time is needed to make these two folds. However, the same folding effect can be achieved by positioning the rotating folders 88 at different points around the drum 74.

The apparatus of Figure 11 further comprises a third folder 90, which is a static tucker like the second folding device 58 in Figure 4. The third folder provides a surface fixed relative to the drum, and as with previously described surfaces, arranged in the same plane as the end of the tobacco in the tobacco rods. As the smoking article having first and second folds approaches the third folder 90, the edge of the surface engages the leading edge of the overhanging foldable paper, and folds it flat against the tobacco as the smoking article passes under the surface of the folder 90 to create a third fold. Alternatively, a further rotating folder may be used to make the third fold, having a surface with a suitably shaped edge to sweep over the appropriate part of the overhanging foldable paper as the smoking article is carried past.

Figure 11A shows an end view of a smoking article with its end closed with a three-way fold, such as may be formed with the apparatus of Figure 11, for example.

Figure 12 shows a simplified schematic perspective view of apparatus according to an embodiment of the invention that uses a series of five rotating drums to apply a foldable paper to the end of the smoking article, and then fold the overhanging foldable paper over in a four-way envelope fold.

The rotating drums 100, 102, 104, 106, 108 are represented with dotted lines only, for the sake of clarity. The drums are arranged in sequence from right to left and positioned adjacent to one another so that the smoking articles 54 carried thereon can be transferred from a flute on one drum to a flute on the next drum by appropriately

timed switching of the vacuum suction. The first and second drums 100 and 102 are used to apply a foldable paper 110 to the end of each smoking article 54 in the same way as described with reference to Figure 2. The first drum 100 carries the smoking articles 54 past a supply of glued foldable papers 110 so that each smoking article 54 picks up a foldable paper 110. The second drum 102 carries the smoking articles 54 over a rolling plate (not shown) so that the resulting rolling motion causes the foldable paper 110 to be wrapped around the tobacco rod and stuck to the cigarette paper (smoking article 54b).

After application of the foldable paper 110, the smoking article is transferred from its flute on the second drum 102 to a flute on the third drum 104 (smoking article 54c). Each flute on the third drum is provided with a flute former, which is a protrusion extending outwardly from the surface of the flute that pushes against the overhanging foldable paper 110 as the smoking article enters the flute, and hence folds the foldable paper 110 flush against the end of the tobacco rod as the smoking article moves fully into its seat within the flute, if the smoking article is appropriately positioned relative to the protrusion.

Figure 13A illustrates a side view of the smoking article 54c as it is beginning to enter a flute 112 on the third drum 104 (the smoking article 54c moving into the flute 112 in the direction of the arrow). The protrusion 114 pushes the overhanging foldable paper 110 over into a folded position as the end of the tobacco rod 116 slides under the protrusion 114. This creates a first fold in the foldable paper 110.

The smoking article 54 having a first fold in its foldable paper 110 is then transferred to a flute in the fourth drum 106. The flutes on the fourth drum 106 are provided with flute formers or protrusions which act to create a second fold in the foldable paper 110 as the smoking article 54d enters the flute, in the same manner as for the third drum 104. Given that the first fold is made at the side of the smoking article 54 closest to the centre of the third drum 104 as the smoking article 54 enters the flute on the third drum 104, the second fold is made opposite to the first fold

because the side of the smoking article 54 furthest from the centre of the third drum 104 is the side of the smoking article 54 that enters the flute on the fourth drum 106.

Figure 13B shows a side view of the smoking article 54d as it is beginning to enter a flute 112 on the fourth drum 106. The protrusion 114 pushes the overhanging foldable paper 110 over into a folded position as the end of the tobacco rod 116 slides under the protrusion 114, to create a second fold opposite the first fold.

The fourth drum 106 is also provided with a static rolling plate (not shown) that operates to rotate the smoking articles by approximately 90° within the flutes (smoking article 54e). This action brings the smoking articles in a position in which the as yet unfolded parts of the overhanging foldable paper 110 are arranged along the radius of the fourth drum 106. To facilitate the rotation with the rolling plate, it may be necessary to arrange the protrusions 114 on the fourth drum 106 to be retractable into a position where they do not extend into the flutes and hence do not become caught on the unfolded foldable paper as the smoking articles 54 turn within the flutes.

More generally, the protrusions on both the third drum and the fourth drum may be movable between an extended position in which they act to fold the overlapping paper as the smoking article enters the flute, and a retracted position in which they do not protrude into the flute and hence do not impede future motion of the smoking article, including rotation within the flute and transfer from the flute. Movement between the two positions may be timed to synchronise with the rotation of the various drums, to achieve a smooth and continuous passage of the smoking articles through the drum sequence. Alternatively, the protrusions on one or both of the third and fourth drums may be static.

Finally, the smoking articles 54 are transferred to a fifth drum 108, which carries the smoking articles 54f past a pair of plough folders 118 which operate as the plough folders described with regard to Figure 4 to fold over the two remaining overhanging parts of the foldable paper 110 to create third and fourth folds opposite one another and orthogonal to the first and second folds.

Figure 14 shows a simplified schematic perspective view of apparatus according to a further embodiment of the invention that also uses a series of five rotating drums to apply a foldable paper to the end of the smoking article, and then fold the overhanging foldable paper over in a four-way envelope fold. In this example, the first, second, third and fourth drums 100, 102, 104, 106 operate in the same way as for the embodiment of Figure 12 to apply a foldable paper 110 to each smoking article 54 and to create first and second folds in the overhanging foldable paper 110 using protrusions in the flutes of the third and fourth drums 104, 106. Again, the fourth drum 106 has a fixed rolling plate that rotates the smoking articles by 90° before they are transferred to the fifth drum 108.

The embodiment of Figure 14 differs from that of Figure 12 in that the plough folders 118 of Figure 12 are replaced by a pair of reciprocating folders 120. These folders are two folding surfaces in the plane of the end of the tobacco rods carried by the smoking article 54 on the fifth drum 108 that can pivot between a first position where they are both out of the path of the smoking articles 54 so that a smoking article can pass between them with no contact to the overhanging foldable paper, and a second position in which they lie in the path of the smoking articles 54 so that the ends of the tobacco rods pass flush with the folding surfaces. As the folders 120 move from the first position to the second position, the edges of the folding surfaces sweep across the end of the tobacco rod, pushing the two remaining parts of the overhanging foldable paper inwards to create the third and fourth folds.

Figure 15 shows a simplified schematic perspective view of apparatus according to a yet further embodiment of the invention that uses a series of six rotating drums to apply a foldable paper to the end of the smoking article and then fold the overhanging foldable paper over into a four-way envelope fold. Once again, the first, second, third and fourth drums 100, 102, 104, 106 operate in the same way as for the embodiment of Figure 12 to apply a foldable paper 110 to each smoking article 54 and to create first and second folds in the overhanging foldable paper 100 using

protrusions in the flutes of the third and fourth drums 104, 106. However, in this example, there is no rolling plate associated with the fourth drum 106, so the smoking articles are not rotated in their flutes before entering the flutes of the fifth drum 122.

Each flute of the fifth drum 122 is provided with a shaped static folder 126 that is attached to the end surface of the drum 122 (only one shown). As with previously described folders, each static folder offers a surface in the plane of the end of the tobacco rods of the smoking articles held on the associated drum against which the end of the tobacco rod slides with the result that part of the overhanging foldable paper is pushed over and folded flat against the end of the tobacco rod. In the present example, after the first and second folds are formed, the two remaining overhanging parts of the foldable paper 110 are located at the side of the smoking articles with respect to the direction in which the smoking articles enter the flutes of the fifth drum 122 (because of the lack of a rolling plate to turn smoking articles on the fourth drum 106). Hence, the static folders 126 are located to overhang a side of each flute, to fold in the corresponding side of the overhanging foldable paper 110. The static folders 126 are shaped so that they present an edge to the incoming smoking articles that begins towards the outside of the smoking article and converges towards the centre of the end of the smoking article as the smoking article enters the flute. Hence the static folders operate in a similar manner to plough folders, and fold in a part of the overhanging foldable paper 110 that is at the edge of the smoking article with respect to the forward direction of movement of the smoking article as the smoking article enters and moves into the flute. A third fold is thereby created that is orthogonal to the first and second folds.

Similarly, the sixth drum 124 also has static folders 128 associated with each flute. The static folders 128 are located with respect to the flutes so as to fold over the remaining part of the overhanging foldable paper, thus creating a fourth fold opposite the third fold.

In the embodiments of Figures 14 and 15, the protrusions on the third and fourth drums may be static or movable, as described with reference to Figure 13.

Figure 16A shows a cross-sectional side view of a further embodiment of apparatus for folding the foldable paper, using pincers. The apparatus 150 comprises a shaft 152 by which the apparatus can be mounted on a rotatable drum, and a pincer mechanism 154 mounted on one end of the shaft 150. The pincer mechanism 154 is mounted so that it can move along the direction defined by the length of the shaft 150. The pincer mechanism 154 comprises a cylindrical housing 156 sized to receive the end of a smoking article, and a pair of pincers 158 mounted on opposite sides of the housing 156. Each pincer 158 is formed from an L-shaped member that is pivotably mounted on the housing 156 at the angle between the two arms of the L-shaped member. Each pincer 158 is mounted such that one arm 160 of the L-shaped member forms a pincer arm that extends generally longitudinally and terminates in an inwardly facing jaw 162. The other arm 164 of the L-shaped member forms a connecting arm that extends generally outwardly and terminates in a connection point 166 by which the arm 164 is connected to one end of a spring 168 which extends longitudinally. The other end of the spring 168 is connected to a slidable collar 170 that encircles the housing 156 and can slide longitudinally over part of the housing 156. The slidable collar 170 generally occupies a retracted position (as shown in Figure 16A) in which it is drawn back away from the pincer jaws 162. In this position, the tension of the springs 168 pulls on the connecting arms 164 of the pincers 158, turning the pincers about the pivotal mounting so that the jaws 162 are open.

Figure 16B shows a plurality of pincer apparatus 150 mounted on a rotatable drum 172. Each apparatus 150 is longitudinally aligned with a vacuum flute 174 in the drum 172 and positioned at the end of the vacuum flute 174 so that the apparatus 150 can operate on a smoking article held in the vacuum flute 174. In use, therefore, multiple smoking articles are transferred to the vacuum flutes 174 of the drum 172 so

that folding of the foldable paper can be carried out on all the smoking articles together.

Figure 16C shows a side view of the apparatus 150 in use in a first step of folding. After a smoking article 54 is transferred to a vacuum flute on the rotating drum, the pincer mechanism 154 moves forward towards the smoking article 54, as shown by the arrow, until the overhanging foldable paper 110 is received within the jaws 162 of the pincers 158. The edge of the jaws 162 is aligned with the end of the tobacco in the smoking article 54.

Figure 16D shows a side view of the apparatus 150 in use in a second step of folding. After alignment of the smoking article 54 and the pincers 158 as shown in Figure 16C, the slidable collar 170 moves forward over the outside of the housing 156, towards the pincers 158. This releases the tension in the springs 168 so that the pincers 158 are free to pivot about the pivotal mountings. At the same time, the edge of the slidable collar 170 comes into contact with the connecting arms 164 of the pincers 158, and pushes against them, which has the effect of pivoting the pincers 158 so that the jaws 162 close towards each other, as indicated in Figure 16D. The jaws 162 push opposite sides of the overhanging foldable paper 110 inwards over the tobacco in the smoking article 54, thereby creating opposite first and second folds of an envelope fold. After folding, the slidable collar 170 retracts, allowing the springs 168 to pull the jaws 158 open. Then the pincer mechanism 154 also retracts away from the smoking article to release it for further processing.

After this folding stage, the smoking articles can be transferred from the rotatable drum to apparatus for forming the third and fourth folds. For example, a second rotating drum having further pincer apparatus 150 can be provided, with an intermediate stage, such as a rolling plate, for rotating the smoking articles so that they are transferred onto the second drum with the overhanging foldable paper in the correct orientation for folding with the pincer apparatus. Alternatively, the further pincer apparatus could be mounted with the pincers in an orthogonal position to those

of the first rotatable drum, so that there is no need to rotate the smoking articles. Otherwise, any other folding apparatus can be used to create opposite third and fourth folds orthogonal to the first and second folds, to give an envelope fold.

Figure 17 shows a schematic side representation of a further embodiment of apparatus for applying the foldable paper to the smoking article, and also for folding the overhanging foldable paper. The apparatus does not include any of the rotating drums described thus far. Instead, the apparatus comprises a lower horizontal surface 140 and an upper horizontal surface 143 spaced above the lower surface 140 by an amount slightly less than the width of a smoking article 54, so that a smoking article 54 introduced into the space experiences an interference fit. The upper surface comprises an endless belt 143 rotating about two horizontally arranged rollers 144. A smoking article 54 carrying a glued foldable paper 110 adhered at its leading edge only to the cigarette paper of the smoking article 54, is introduced into the space between the upper surface 142 and the lower surface 143. The foldable paper 110 may have been prepared and applied to the smoking article 54 by any convenient method, including the vacuum cutting drum and associated equipment described with respect to Figure 2. When the smoking article 54 enters the space between the upper surface 142 and the lower surface 140, the motion of the belt 143 forming the upper surface 142 in conjunction with the interference fit causes the smoking article 54 to be rolled over the lower surface 140. This rolling motion in turn causes the smoking article 54 to roll over the foldable paper 110 that it is carrying, which is hence wrapped around the outside of the smoking article 54 and adheres to the cigarette paper because of the glue applied to it. In this way, the smoking article is provided with its overhanging foldable paper.

The lower surface 140, at a point downstream from where the smoking article 54 enters the space between the surfaces 140, 142 sufficient to allow the foldable paper 110 to be wrapped around the smoking article 54, is provided with a series of upstanding teeth 146. Each tooth 146 provides a surface that flush with the end of the

tobacco rod of the smoking article 54. As the smoking article 54 continues to roll over the lower surface 140, the teeth 146 in turn engage a part of the overhanging foldable paper and push it over against the end of the tobacco rod to create a fold, in a similar manner to the folding teeth described with respect to Figure 7. Each tooth creates one fold, to give a overlapping iris-style fold.

The teeth 146 may be omitted from the apparatus so that it just provides the function of wrapping the glued foldable paper 110 around the smoking article 54. Also, the lower surface 140 may be a fixed surface, or it may comprise a rotating endless belt 143 similar to that of the upper surface 142 that rotates at a different speed or direction to the upper surface belt 143 so as to provide the required rolling of the smoking article 54. Further, the moving upper surface may be provided by components alternative to an endless belt rotating on rollers. Any combination of suitable spaced upper and lower surfaces that produce the required relative motion to roll the smoking article can be employed. Additionally, the rolling can be used to carry the smoking article past folding devices other than the teeth 146 can be used, for example a plough folder similar to that in Figure 6.

Further configurations of fold can be employed by adapting any of the above-described apparatus (or using entirely different apparatus) to fold the foldable paper other than into an envelope fold, an iris fold or a three-way fold.

Figure 18A shows an end view of a smoking article having foldable paper that has been closed over the tobacco by the simple technique of crushing the foldable paper inwards without making distinct individual folds. A suitably configured apparatus may crush the paper such that an embossed pattern or design is applied to the paper end.

Figure 18B shows an end view of a smoking article in which the foldable paper has been folded using a pinch and twist fold, in this case with three folds. The overhanging foldable paper is pinched into a point with a plurality of folds, three in

this example. The folds are then twisted round to lay flat against the end surface of the smoking article.

Figure 18C shows an end view of a smoking article with a foldable paper that has been folded using a two-way fold with subsequent trimming of the overhanging wings. Two opposite sides of the foldable paper are folded inwards, as for the two initial folds of an envelope fold. The two remaining parts of the paper are then folded outwards into the position shown by the dotted lines (instead of inwards as for an envelope fold), before being trimmed off. This gives a clean one-line appearance to the end of the smoking article.

If desired, a further processing step can be added to any technique used to fold over the overhanging foldable paper, including all the above techniques. It may be found that after folding, the foldable paper springs slightly open and away from the flush folded position in which the folds lie flat against the end of the tobacco rod. This can be addressed by pressing slightly into the folded end with a pin or rod that has a diameter less than that of the smoking article. The pin is moved in towards the end of the smoking article along the direction of the longitudinal axis of the smoking article, and by pressing inwards, the folded paper is depressed beyond the flush folded position (since the underlying tobacco will yield slightly under the applied pressure of the pin) and inverted or crushed to a small amount. This inversion has been found to be sufficient to hold the various folds in place better than folding that is not followed by pressing with a pin. This is preferable to holding the folds in place with adhesive, since it is desirable to minimise the amount of adhesive used in a smoking article. Also, pressing the end of the smoking article with a pin is likely to be a simpler process than applying adhesive to the various folds or parts of the overhanging paper at the relevant times, and also does not require any on-going supply of materials.

Any practical method and apparatus may be employed to achieve the pressing. For example, a simple reciprocating pin mounted on a mechanism that can move it into the pressing position and out again could be used, with each smoking article held

stationary while the pin moves. However, this will be a relatively slow step in a process which can otherwise be implemented with continuous motion of the smoking articles (such as with the apparatus of Figure 12, for example). It is therefore proposed that the pressing pin be movable along the travel path of the smoking articles so the pressing can be performed without halting the smoking articles.

One way of achieving this it to utilise a swash plate, which is a known apparatus for use with rotating drums for carrying smoking articles. The swash plate comprises a disk in the form of a circular rim portion having a flat face, the rim being connected to a central hub by a plurality of springs arranged like the spokes of a wheel. The swash plate is rotatably mounted with its axis of rotation coincident with the axis of rotation of a rotating drum, and its flat face substantially parallel with the end face of the drum. In use, the swash plate is advanced towards the drum while both rotate in the same direction, and the flat face pushes against the ends of smoking articles carried by the drum to bring them all into alignment in the longitudinal direction, so that the ends are all positioned in a chosen plane. The spring-mounting of the rim allows any initial unevenness in the alignment of the smoking articles to be accommodated without any individual smoking article receiving significantly more pressure than the others; this reduces damage to the smoking articles. Further, the rotation of the swash plate in time with that of the drum avoids sideways forces (drag) on the smoking articles which would also cause damage.

To implement pressing into the end of folded paper with a pin according to the present embodiment, it is proposed that a swash plate be provided with a plurality of pins, one pin aligned with each flute on the associated rotating drum in an appropriate position to press into the centre of the end of the smoking article held in the flute. The swash plate is moved in towards the rotating drum by a sufficient distance to press the pins into the folded paper by the required amount, and the rotation of the swash plate and its spring-mounting allow the pins to be brought to bear on the smoking articles without sideways drag or uneven pressure between smoking articles.

Figure 19A shows a schematic representation of a side view of a rotating drum with an associated pin-bearing swash plate. The drum 130 carries a plurality of smoking articles in the flutes around its circumference, and the swash plate 132 is mounted to rotate about the same axis as the drum, and at the same speed. A plurality of pins 134, aligned with the flutes and the smoking articles 54, are arranged on the flat face of the swash plate 132, extending from the flat face towards the end surface of the drum 130. The drum 130 and the swash plate 134 rotate together, as indicated by the curved arrows in Figure 19A, and the swash plate 134 moves in towards the drum by action of a bearing 133 which moves the plate 134 towards the drum 130, as indicated by the straight arrow. The pins 134 press into the ends of the smoking articles 54, and when they have protruded into the smoking articles 54 by a sufficient distance to invert the folded paper by the require amount to inhibit unfolding, the swash plate 132 is retracted away from the drum 130.

Figure 19B shows a schematic representation of an alternative apparatus for pressing pins into the folded paper. The apparatus comprises a rotating drum 130 carrying a plurality of smoking articles 54 in flutes around its circumference, as in Figure 19B. In this example, however, the pins 134 extend radially outwards from the surface of a second rotatable drum or disc 135 which is arranged with its axis of rotation orthogonal to that of the rotating drum 130 carrying the smoking articles 54. The pins 134 lie in a plane tangential to the rotating drum 130 so that the rotation of the disc 135 together with the rotation of the drum 130 bring each pin 134 in turn into contact with the end of a smoking article 54, the spacing of the pins 134 and the smoking article 54 and the speed of rotation of the drum 130 and the disc 135 being selected accordingly. The disc 54 is spaced from the drum 130 by a distance to allow each pin 134 to protrude slightly into the folded paper to produce the required pressing effect, before being withdrawn as the rotations move the pin and the smoking article apart. The relative rotating motion of the drum 130 and the disc 135 bring the pins 134 to bear on the smoking articles 54 with little or no sideways drag.

Figure 20 shows a schematic cross-sectional view through the end of a smoking article 54 with a pin 134 on a swash plate 132 or disc/drum 135 bearing on the folded paper 110 that covers the end of the tobacco in the smoking article 54, so as to slightly depress and invert the folded paper 110.

In the event that it is acceptable to use adhesive to secure the folds of the folded end in place, the foldable paper can have a self-adhesive format. One or more areas of self-adhesive glue can be provided on the overhanging part of the foldable paper (preferably before it is applied to the smoking article). Depending on the adhesive type, the act of folding may be sufficient to cause the foldable paper to adhere to itself. Otherwise, an adhesive that requires the application of heat and/or pressure can be used. After folding, the folds can be pressed with pins using any of the pin arrangements described above. The pins may be heated if the adhesive is heat-activated, for example using electrical heating elements within the pins. If it is not necessary that the folds be pressed inwards by pins, the ends of the smoking articles may be contacted with a heated flat plate or plates (such as a heated swash plate) to set the adhesive.

The various folding techniques discussed above may be implemented using an overhang of foldable paper that has a straight edge, i.e. before folding the foldable paper extends beyond the end of the tobacco rod by the same amount at all points around the circumference of the smoking article. In many cases, this will give an acceptable appearance to the finished folded end. Optionally, however, the edge of the foldable paper may be shaped. This can be used to reduce the amount of paper that has to be folded over the end of the tobacco rod, by removing paper in those areas where two or more layers of paper would otherwise overlap. The resulting folded end may be easier to light, owing to the reduced amount of paper covering the tobacco, and may have an improved appearance, or a particular desired appearance.

A foldable paper with a shaped edge may be more easily implemented with techniques that apply the foldable paper to the smoking articles by wrapping

individual pieces of foldable paper around individual smoking articles, as in Figure 2, for example. The process of applying the foldable paper described with respect to Figure 3 may also be used to provide a shaped edge, but two cutting stages will probably be required, one using a shaped blade to provide the shaped edge to the overhanging foldable paper, and one using a straight blade to provide a straight edge to the foldable paper at the opposite end of the tobacco rod.

Figure 21 shows some useful shapes for shaped edge foldable papers: A: scalloped edge; B: castellated edge; C: edge with extending segment shapes, curved to match the curvature of the end of the smoking article. The number of scallops, segments, etc, will depend on the number of folds to be used. Edges with other shapes may be also be used.

Figure 22 shows a plan view of an example of a foldable paper 110 to which adhesive has been applied, for example by the apparatus of Figure 2. The foldable paper 110 is sized to extend a short distance along the length of a tobacco rod. Its shorter sides are the dimension that extends along the tobacco rod and beyond its end to form the overhang, and its longer sides are the dimension that encircles the tobacco rod. The adhesive is applied in three areas. Area A extends across the full width of the paper 110 in the encircling direction, and about halfway up the length of the paper 110. This is the area that contacts the cigarette paper of the tobacco rod, so the foldable paper will adhere to the cigarette paper all around its circumference, with no adhesive from this area being on the overhanging foldable paper. Area B is a narrow strip of adhesive running along a length edge of the paper 110. This corresponds to the area of overlap when the paper 110 is wrapped around a tobacco rod, and sticks the overlapping edges of the paper together to form a tube extending beyond the end of the tobacco rod. Area C is a narrow strip of adhesive running across the width of the paper close to the edge that will become the far end of the overhang. This sticks the various folds in place as they are created by the folding devices. The adhesive in area C can be omitted if the folds stay sufficiently in place without it, or if pressing in the

folded paper, for example with a pin as in Figures 19A, 19B and 20 provides adequate holding. Similarly, the areas A and B may have adhesive applied in other distributions, such as spots or stripes rather than the continuous distribution of Figure 22.

Alternatively, the folds may be secured in place using adhesive that is applied during the folding process. For example, for an envelope fold such as shown in Figure 5D, the first two folds may be made, following which adhesive is applied to the two opposite remaining unfolded parts of the overhanging paper before they are folded over. The adhesive then holds these two outside folds in place, thereby securing the folded end as a whole. However, for any fold arrangement, adhesive may be applied to any or all of the unfolded flaps or portions before they are folded over. To achieve this, a gluing unit may be positioned adjacent to the apparatus carrying the smoking articles during the folding process. For example, the gluing unit may include one or more glue guns operable to apply a small amount of adhesive to each flap before folding. Adhesive may be applied to two or more flaps or portions simultaneously. In the above example of the envelope fold, two glue guns may simultaneously apply glue to the two opposite unfolded parts. As another example, the gluing unit may comprise a gravure-style gummer timed to operate in synchronism with the operation of the folding apparatus.

Once the folded end of the smoking article has been completed (possibly including gluing and/or pressing the folds inwards as described above), it may be desirable to check the quality of the folded end, so that smoking articles with folds which are below standard can be ejected from the production line. Quality checking can be achieved by including an inspection system at the end of folding apparatus; this may be, for example a camera-based inspection system. One or more cameras can capture images of each folded end, and provide a signal to the apparatus to reject the smoking article if a defective fold is detected. Detection may be, for example, by a pattern recognition or image comparison technique, in which the captured images are compared with stored images of non-defective folded ends. If there is an insufficient

match between the captured and stored images, a rejection signal is generated and sent to the apparatus to reject the relevant smoking article. Any rejection system can be used, depending on the way in which the smoking articles are carried past the inspection system. For example, if the smoking articles are carried in the flutes of a rotating vacuum drum, the vacuum in a flute carrying a defective smoking article can be switched off, thereby allowing the smoking article to drop away from the drum.

Figure 23 shows a simplified schematic view of an inspection system, seen from above. In this example, a rotating drum 200 carries a plurality of smoking articles 202 with folded ends past an inspection system 203. The inspection system 203 comprises a first camera 206 and a second camera 208 arranged next to the drum 200, and both connected to a control unit 210. The first camera 206 is positioned to record an end view of the folded end of each smoking article 202, as the smoking articles 202 are carried past the camera 206 by the rotation of the drum 200. The second camera 208 is positioned to record a side view of each folded end. In this way, a large number of defects in the folded end can be picked up, including defects in the attachment of the overhanging paper to the smoking article. However, an inspection system may include just one camera, arranged to capture an end view or a side view, or a view intermediate between the side and the end.

The images from the first camera 206 and the second camera 208 are sent to the control unit 210 for processing, such as by comparison with stored images of non-defective folded ends. In the event that the processing detects a defect, the control unit 210 generates a reject signal, which is sent by a control line 212 to a controller 204 of the rotating drum 200 to cause operation of a rejection mechanism that rejects the defective smoking article. The images should be captured in a timed manner with regard to the rotation of the drum, so that the rejection mechanism operates on the correct smoking article.

Any of the techniques described herein for providing a smoking article with an overhanging foldable paper may be combined with any of the techniques described

herein for folding the overhanging foldable paper. Moreover, any of the described techniques may be combined with techniques similar to those described to achieve the described end result of a smoking article having an overhanging foldable paper that is folded over to cover the tobacco. Further, techniques similar to those described may be used to achieve the described end result. In addition, the techniques described herein for folding the overhanging foldable paper may alternatively be used to fold overhanging paper that is not a separately applied foldable paper such as that described herein, but is instead an extending portion of the cigarette paper that wraps the tobacco of the tobacco rod.

When considering the various embodiments of apparatus described herein, components for adhering the foldable paper to the smoking articles may be thought of as a first sub-apparatus, components for folding the overhanging foldable paper may be thought of as a second sub-apparatus, components for pressing pins into the folded paper to enhance the folding effect may be thought of as a third sub-apparatus, and any further components employed to attach filter units to any smoking articles that are only partially complete when the foldable paper is adhered may be thought of as a fourth sub-apparatus. To increase the speed of production, the number of first and/or second sub-apparatuses in the apparatus as a whole may be increased. For example, two folding apparatuses or two apparatuses for adhering the foldable paper may be arranged in parallel to supply twice the quantity of smoking articles to the downstream parts of the apparatus.

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CLAIMS

1. A method of making a smoking article, comprising:

providing a fully or partially fabricated smoking article comprising at least a tobacco rod of tobacco wrapped in cigarette paper;

adhering a foldable paper to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and

folding the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod.

2. A method according to claim 1, in which the foldable paper is adhered to the outside of the cigarette paper.

3. A method according to claim 1 or claim 2, in which the foldable paper is a porous paper.

4. A method according to claim 3, in which the foldable paper has a porosity greater than 3,000 CU, or greater than 6,000 CU, or greater than 12, 000 CU, or greater than 24,000 CU.

5. A method according to claim 3 or claim 4, in which the foldable paper is porous plug wrap paper.

6. A method according to any one of claims 1 to 5, in which the foldable paper is embossed with one or more crease lines along which the overhanging foldable paper is folded.

7. A method according to any one of claims 1 to 6, further comprising, before adhering the foldable paper to the cigarette paper, embossing the foldable paper with one or more crease lines along which the overhanging foldable paper is to be folded.

8. A method according to any one of claims 1 to 7, in which the foldable paper encircling the tobacco rod extends over only part of the length of the tobacco rod.

9. A method according to any one of claims 1 to 7, in which the foldable paper encircling the tobacco rod extends over substantially the whole length of the tobacco rod.

10. A method according to any one of claims 1 to 9, in which adhering the foldable paper to the cigarette paper comprises:

applying adhesive to the foldable paper,

bringing the smoking article into contact with the foldable paper such that an edge of the foldable paper adheres to the cigarette paper; and

carrying the smoking article in a vacuum flute on the outer surface of a rotating drum, the smoking article arranged with its longitudinal axis parallel to the rotation axis of the drum, so as to bring the smoking article into contact with a curved static plate spaced apart from the drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, the rolling causing the foldable paper to wrap around the smoking article.

11. A method according to claim 10, in which the foldable paper is shaped along an edge such that the overhanging foldable paper has an edge profile that gives a reduced amount of overlapped paper after folding compared to a straight edge.

12. A method according to claim 9, in which adhering the foldable paper to the cigarette paper comprises:

arranging the smoking article in a sequence of smoking articles arranged end to end but spaced apart by a distance equal to the desired length of the overhanging foldable paper;

feeding the sequence of smoking articles onto a continuous length of foldable paper, the foldable paper having a width at least equal to the circumference of the smoking articles;

wrapping the foldable paper around the smoking articles to encircle the tobacco rods, and adhering it in place; and

cutting through the foldable paper flush to an end of each smoking article, to separate the tobacco rods and form the overhanging foldable paper.

13. A method according to claim 9, in which adhering the foldable paper to the cigarette paper comprises:

arranging the smoking article in a sequence of smoking articles arranged end to end in pairs where the articles in each pair abut at their adjacent ends and the pairs are spaced apart by a distance equal to twice the desired length of the overhanging foldable paper;

feeding the sequence of smoking articles onto a continuous length of foldable paper, the foldable paper having a width at least equal to the circumference of the smoking articles;

wrapping the foldable paper around the smoking articles to encircle the tobacco rods, and adhering it in place; and

cutting through the foldable paper where the smoking articles in each pair abut and also at the midpoint of the spaces between the pairs, to separate the smoking articles and form the overhanging foldable paper.

14. A method according to any preceding claim, in which folding the overhanging foldable paper comprises:

carrying the smoking article in a vacuum flute on the outer surface of one or more rotating drums so as to bring the overhanging foldable paper into contact with one or more folding devices that bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod.

15. A method according to claim 14, in which the one or more folding devices comprise a reciprocating tucker with a width less than the diameter of the smoking article that extends partially over the end of the tobacco rod flush with the tobacco therein to create a first fold and then retracts, a fixed tucker with a width less than the diameter of the tobacco rod and a surface that is flush with the tobacco against which the end of the tobacco rod passes to create a second fold opposite the first fold, and a pair of static plough folders providing surfaces flush with the tobacco and having oppositely disposed converging edges, against which the end of tobacco rod passes to form third and fourth folds opposite one another and orthogonal to the first and second folds.

16. A method according to claim 14, in which the one or more folding devices comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a plough folder fixed to the plate and comprising a surface flush with the end of the tobacco rod that has an edge that converges towards the drum in the direction of rotation of the drum such that as the smoking article rolls over the plate the end of the tobacco rod passes against the surface and the overhanging foldable paper is engaged by the converging edge and is gradually folded inwards over the tobacco in a continuous fold.

17. A method according to claim 14, in which the one or more folding devices comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a sequence of teeth extending from the plate towards the drum and having surfaces flush with the end of the tobacco rod, each tooth engaging a part of the overhanging foldable paper and creating a fold as the smoking article rolls over the plate, each fold overlapping the previous fold.

18. A method according to claim 14, in which the one or more folding devices comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotatable cam associated with each vacuum flute on the rotating drum, each cam having a surface flush with the end of the tobacco rod and configured to sweep across the end of the tobacco rod as the smoking article rolls over the plate, the edge of the cam pushing against the overhanging foldable paper to fold it inwards over the tobacco.

19. A method according to claim 18, in which the cam has a smooth edge that creates a continuous fold.

20. A method according to claim 18, in which the cam has a toothed edge that creates a series of overlapping folds.

21. A method according to claim 14, in which the one or more folding devices comprises a pair of adjacent rotatable surfaces flush with the end of the tobacco rod

that sweep outwardly over the end of the tobacco rod from the rear of the smoking article as it is carried by the rotating drum to create first and second adjacent folds, and a static tucker having a surface flush with the end of the tobacco rod against which the end of the tobacco rod passes to create a third fold.

22. A method according to claim 14, in which the one or more folding devices comprise a curved static plate spaced apart from the rotating drum by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotating threaded screw positioned with its axis of rotation orthogonal to the axis of rotation of the rotating drum and substantially tangential to the perimeter of the drum, and the threaded surface flush with the end of the tobacco rod such that the screw thread engages with the overhanging foldable paper as the smoking article rolls across the plate and the rotation of the screw folds the paper inwards over the tobacco.

23. A method according to claim 14, in which the one or more folding devices comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, and a pair of static plough folders providing oppositely disposed surfaces flush with the end of the tobacco rod and having converging edges, against which the end of tobacco rod passes to create third and fourth folds opposite one another and orthogonal to the first and second folds.

24. A method according to claim 14, in which the one or more folding devices comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, and a pair of reciprocating folders that sweep inwardly over the end of the tobacco rod and then retract to create third and fourth folds opposite one another and orthogonal to the first and second folds.

25. A method according to claim 14, in which the one or more folding devices comprise a protrusion in a vacuum flute of a first rotating drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, a further protrusion in a vacuum flute of a second, adjacent, rotating drum to which the smoking article is transferred from the first drum, the further protrusion pushing part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the flute to create a second fold opposite the first fold, a fixed folder disposed at the side of a vacuum flute of a third, adjacent, rotating drum to which the smoking article is transferred from the second drum which engages with the overhanging foldable paper as the smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a third fold orthogonal to the first and second folds, and a further fixed folder disposed at the side of a vacuum flute of a fourth, adjacent, rotating drum to which the smoking article is transferred from the third drum which engages with the overhanging foldable paper as the smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a fourth fold opposite to the third fold.

26. A method according to any one of claims 23 to 25, in which one or both of the said protrusion and the further protrusion are configured to move between an extended position for effecting the first or second fold as the smoking article enters the vacuum flute, and a retracted position after the fold is effected in which the protrusion does not protrude into the flute.

27. A method according to claim 14, in which the one or more folding devices comprises a first pair of pincers longitudinally aligned with a vacuum flute of a first rotating drum, and biased in an open position to receive the overhanging foldable paper of a smoking article in the vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and a second pair of pincers longitudinally aligned with a vacuum flute of a second rotating drum, and biased in a open position to receive the overhanging foldable paper of the smoking article when transferred to the vacuum flute after folding in the vacuum flute of the first rotating drum, the pincers operable to close on the remaining overhanging foldable paper and push the opposite parts of the paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

28. A method according to claim 14, in which the one or more folding devices comprises a first pair of pincers longitudinally aligned with a vacuum flute of a first rotating drum, and biased in an open position to receive the overhanging foldable paper of a smoking article in the vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and one or more supplementary folding devices associated with a second rotating drum arranged to receive the smoking article after folding with the first drum, and operable to fold the remaining

opposite parts of the paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

29. A method according to any one of claims 1 to 9, in which adhering the foldable paper to the cigarette paper comprises:

applying adhesive to the foldable paper;

bringing the smoking article into contact with the foldable paper such that an edge of the foldable paper adheres to the cigarette paper; and

introducing the smoking article onto a lower surface that is spaced apart from an upper surface by a distance less than the diameter of the smoking article, the upper surface moving relative to the lower surface along a direction parallel to the surfaces and orthogonal to the longitudinal axis of the smoking articles such that contact with the surfaces causes the smoking article to rotate about its longitudinal axis so that it rolls over the lower surface as the upper surface moves, the rolling causing the foldable paper to wrap around the smoking article.

30. A method according to claim 29, in which the upper surface comprises an endless belt rotating around a pair of rollers.

31. A method according to claim 29 or claim 30, in which folding the overhanging paper comprises using the rolling of the smoking article over the lower surface to bring the overhanging foldable paper into contact with one or more folding devices that bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod.

32. A method according to claim 31, in which the one or more folding devices comprise a series of teeth extending from the lower surface towards the upper surface and having surfaces flush with the end of the tobacco rod, each tooth engaging a part

of the overhanging foldable paper and creating a fold as the smoking article rolls over the lower surface, each fold overlapping the previous fold.

33. A method according to any one of claims 1 to 14, in which folding the overhanging foldable paper comprises pushing part of the paper inwards to create a first fold, pushing a further part of the paper inwards to create a second fold opposite the first fold, and trimming off some or all of the remaining, unfolded paper.

34. A method according to any preceding claim, and further comprising, after folding the overhanging foldable paper, pushing against the end of the tobacco rod with a pin having a width less than the diameter of the smoking article to depress the folded paper and cause it to better maintain its folded position.

35. A method according to any preceding claim, in which the foldable paper is provided with adhesive on all or part of the inner surface of the overhanging portion, and the method further comprises, after folding the overhanging paper, pressing against the end of the tobacco rod to cause the folded paper to become adhered in its folded position.

36. A method according to claim 35, in which the adhesive is heat-activated, and pressing against the end of the tobacco rod includes applying heat to the end of the tobacco rod.

37. A method according to any preceding claim, and further comprising, in the event that the smoking article is a partially fabricated smoking article, attaching a filter unit to the end of the tobacco rod opposite to the end intended to be lit.

38. A method according to claim 37, in which the filter unit is attached to the end of the tobacco rod simultaneously with the adhering and/or folding of the foldable paper.

39. A method according to any one of claims 1 to 38, further comprising, after folding the overhanging paper:

inspecting the folded overhanging paper for defects; and

rejecting a smoking article found to have a defective folded overhanging paper.

40. A method according to claim 39, in which the inspecting comprises:

capturing one or more images of the folded overhanging paper; and

comparing the one or more captured images with one or more stored images of non-defective folded overhanging paper.

41. A method according to claim 40, in which the one or more captured images comprise at least one of an end view of the folded overhanging paper and a side view of the folded overhanging paper.

42. Apparatus configured to perform a method of making a smoking article according to any one of claims 1 to 41.

43. A smoking article comprising:

a tobacco rod of tobacco wrapped in cigarette paper; and

a foldable paper adhered to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit, the overhanging foldable paper folded to substantially cover the tobacco at the end of the tobacco rod.

44. A smoking article according to claim 43, in which the foldable paper is adhered to the outside of the cigarette paper.

45. A smoking article according to claim 43 or claim 44, in which the foldable paper is a porous paper.

46. A smoking article according to claim 45, in which the foldable paper has a porosity of greater than 3,000 CU, or greater than 6,000 CU, or greater than 12,000 CU or greater than 24,000 CU.

47. A smoking article according to claim 45 or claim 46, in which the foldable paper is porous plug wrap paper.

48. A smoking article according to any one of claims 43 to 47, in which the foldable paper is embossed with one or more crease lines along which the overhanging foldable paper is folded.

49. A smoking article according to any one of claims 43 to 48, in which the foldable paper encircling the tobacco rod extends over only part of the length of the tobacco rod.

50. A smoking article according to any one of claims 43 to 48, in which the foldable paper encircling the tobacco rod extends over substantially the whole length of the tobacco rod.

51. A smoking article according to any one of claims 43 to 50, in which the foldable paper is shaped along an edge such that the overhanging foldable paper has

an edge profile that gives a reduced amount of overlapped paper after folding compared to a straight edge.

52. A smoking article according to any one of claims 43 to 51, in which the overhanging foldable paper is folded with a first fold, a second fold opposite the first fold, a third fold orthogonal to the first and second folds, and a fourth fold opposite the third fold.

53. A smoking article according to any one of claims 43 to 51, in which the overhanging foldable paper is folded with a plurality of folds, each fold overlapping the adjacent fold.

54. A smoking article according to any one of claims 43 to 53, and further comprising a filter unit attached to the end of the tobacco rod opposite to the end intended to be lit.

55. Apparatus for making a smoking article comprising:

a first sub-apparatus operable to receive a fully or partially fabricated smoking article comprising at least a rod of tobacco wrapped in cigarette paper and to adhere a foldable paper to the cigarette paper such that the foldable paper encircles the tobacco rod and overhangs the cigarette paper at an end of the tobacco rod that is intended to be lit; and

a second sub-apparatus operable to receive a smoking article with an overhanging foldable paper produced by the first sub-apparatus and to fold the overhanging foldable paper to substantially cover the tobacco at the end of the tobacco rod.

56. Apparatus according to claim 55, in which the first sub-apparatus is operable to adhere the foldable paper to the outside of the cigarette paper..

57. Apparatus according to claim 55 or claim 56, further comprising one or more embossing devices through which the foldable paper is passed before being supplied to the first sub-apparatus, the one or more embossing devices operable to emboss the foldable paper with one or more crease lines along which the overhanging foldable paper is to be folded by the second sub-apparatus.

58. Apparatus according to any one of claims 55 to 57, in which the first sub-apparatus is configured to adhere the foldable paper to the cigarette paper such that the foldable paper encircling the tobacco rod extends over only part of the length of the tobacco rod.

59. Apparatus according to any one of claims 55 to 57, in which the first sub-apparatus is configured to adhere the foldable paper to the cigarette paper such that the foldable paper encircling the tobacco rod extends over substantially the whole length of the tobacco rod.

60. Apparatus according to any one of claims 55 to 59, in which the first sub-apparatus comprises:

a dispenser for dispensing foldable paper from a continuous roll;

an adhesive applicator for applying adhesive to foldable paper dispensed from the roll, the adhesive distributed appropriately for securing the foldable paper to a cigarette paper such that it encircles a tobacco rod;

a vacuum cutting drum rotatable about a first axis of rotation and having a plurality of blades extending radially from its circumference, rotation of the vacuum cutting drum engaging the blades in turn with the dispensed foldable paper to which

adhesive has been applied to cut the dispensed foldable paper into individual foldable papers, the vacuum cutting drum further having suction holes through which a vacuum is applied to hold the individual foldable papers on the surface of the vacuum cutting drum with the adhesive facing outwards;

a first rotatable drum rotatable about a second axis of rotation parallel to the first axis of rotation and having around its circumference a plurality of vacuum flutes for receiving smoking articles with their longitudinal axes parallel to the second axis of rotation, the first rotatable drum positioned with respect to the vacuum cutting drum such that a smoking article carried in a flute of the first rotatable drum contacts an individual foldable paper on the vacuum cutting drum such that an edge of the foldable paper adheres to the smoking article;

a second rotatable drum rotatable about a third axis of rotation parallel to the first axis of rotation and having around its circumference a plurality of vacuum flutes for receiving smoking articles with their longitudinal axes parallel to the third axis of rotation, the second rotatable drum positioned with respect to the first rotatable drum such that a smoking article with an adhered foldable paper carried in a flute of the first rotatable drum can be passed to a flute on the second rotatable drum; and

a curved static plate spaced apart from the second rotatable drum by a distance less than the diameter of the smoking article, such that rotation of the second rotatable drum brings a smoking article with an adhered foldable paper carried in a flute of the second rotatable drum into contact with the curved static plate, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, the rolling causing the foldable paper to wrap around the smoking article.

61. Apparatus according to claim 59, in which the first sub-apparatus comprises:

a dispenser for dispensing foldable paper from a continuous roll, the foldable paper having a width at least equal to the circumference of a smoking article;

an adhesive applicator for applying adhesive to foldable paper dispensed from the roll, the adhesive distributed appropriately for securing the foldable paper to a cigarette paper such that it encircles a tobacco rod;

a smoking article feeder operable to feed onto a continuous length of foldable paper dispensed from the roll a sequence of smoking articles arranged end to end but spaced apart by a distance equal to the desired length of the overhanging foldable paper;

a tube into which the dispensed foldable paper with applied adhesive and the sequence of smoking articles thereon may be fed, the tube causing the foldable paper to wrap around the smoking articles to encircle the tobacco rods and adhere in place; and

a cutter arranged after the tube and operable to cut through the foldable paper as it emerges from the tube at positions flush to an end of each smoking article, to separate the smoking articles and form the overhanging foldable paper.

62. Apparatus according to claim 59, in which the first sub-apparatus comprises:

a dispenser for dispensing foldable paper from a continuous roll, the foldable paper having a width at least equal to the circumference of a smoking article;

an adhesive applicator for applying adhesive to foldable paper dispensed from the roll, the adhesive distributed appropriately for securing the foldable paper to a cigarette paper such that it encircles a tobacco rod;

a smoking article feeder operable to feed onto a continuous length of foldable paper dispensed from the roll a sequence of smoking articles arranged end to end in pairs such that the articles in each pair abut at their adjacent ends and the pairs are spaced apart by a distance equal to twice the desired length of the overhanging foldable paper;

a tube into which the dispensed foldable paper with applied adhesive and the sequence of smoking articles thereon may be fed, the tube causing the foldable paper

to wrap around the smoking articles to encircle the tobacco rods and adhere in place; and

a cutter arranged after the tube and operable to cut through the foldable paper as it emerges from the tube at positions where the smoking articles in each pair abut and also at the midpoint of the spaces between the pairs, to separate the smoking articles and form the overhanging foldable paper.

63. Apparatus according to any one of claims 55 to 62, in which the second sub-apparatus comprises;

one or more adjacent rotatable drums rotatable about parallel axes of rotation, each drum having around its circumference a plurality of vacuum flutes for receiving smoking articles with their longitudinal axes parallel to the axis of rotation of the drum; and

one or more folding devices for folding the overhanging foldable paper, and positioned such that the overhanging foldable paper of a smoking article carried in a vacuum flute of the one or more drums can be brought into contact with the one or more folding devices to bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod.

64. Apparatus according to claim 63, in which the one or more folding devices comprise a reciprocating tucker with a width less than the diameter of the smoking article that extends partially over the end of the tobacco rod flush with the tobacco therein to create a first fold and then retracts, a fixed tucker with a width less than the diameter of the tobacco rod and a surface that is flush with the tobacco against which the end of the tobacco rod passes to create a second fold opposite the first fold, and a pair of static plough folders providing surfaces flush with the tobacco and having oppositely disposed converging edges, against which the end of tobacco rod passes to

form third and fourth folds opposite one another and orthogonal to the first and second folds.

65. Apparatus according to claim 63, in which the one or more folding devices comprise a curved static plate spaced apart from one of the one or more rotatable drums by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a plough folder fixed to the plate and comprising a surface flush with the end of the tobacco rod that has an edge that converges towards the drum in the direction of rotation of the drum such that as the smoking article rolls over the plate the end of the tobacco rod passes against the surface and the overhanging foldable paper is engaged by the converging edge and is gradually folded inwards over the tobacco in a continuous fold.

66. Apparatus according to claim 63, in which the one or more folding devices comprise a curved static plate spaced apart from one of the one or more rotatable drums by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a sequence of teeth extending from the plate towards the drum and having surfaces flush with the end of the tobacco rod, each tooth engaging a part of the overhanging foldable paper and creating a fold as the smoking article rolls over the plate, each fold overlapping the previous fold.

67. Apparatus according to claim 63, in which the one or more folding devices comprise a curved static plate spaced apart from one of the one or more rotatable drums by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotatable cam associated with each

vacuum flute on the rotatable drum, each cam having a surface flush with the end of the tobacco rod and configured to sweep across the end of the tobacco rod as the smoking article rolls over the plate, the edge of the cam pushing against the overhanging foldable paper to fold it inwards over the tobacco.

68. Apparatus according to claim 67, in which the cam has a smooth edge that creates a continuous fold.

69. Apparatus according to claim 67, in which the cam has a toothed edge that creates a series of overlapping folds.

70. Apparatus according to claim 63, in which the one or more folding devices comprise a pair of adjacent rotatable surfaces flush with the end of the tobacco rod that sweep outwardly over the end of the tobacco rod from the rear of the smoking article as it is carried by the rotatable drum to create first and second adjacent folds, and a static tucker having a surface flush with the end of the tobacco rod against which the end of the tobacco rod passes to create a third fold.

71. Apparatus according to claim 63, in which the one or more folding devices comprise a curved static plate spaced apart from one of the one or more rotatable drums by a distance less than the diameter of the smoking article, contact with the plate causing the smoking article to rotate about its own longitudinal axis so that it rolls over the plate as the drum rotates, and a rotatable threaded screw positioned with its axis of rotation orthogonal to the axis of rotation of the rotatable drum and substantially tangential to the perimeter of the drum, and the threaded surface flush with the end of the tobacco rod such that the screw thread engages with the overhanging foldable paper as the smoking article rolls across the plate and the rotation of the screw folds the paper inwards over the tobacco.

72. Apparatus according to claim 63, in which the one or more folding devices comprise protrusions in the vacuum flutes of a first rotatable drum that push part of the overhanging foldable paper inwards over the tobacco when a smoking article enters the vacuum flute to create a first fold, further protrusions in the vacuum flutes of a second, adjacent, rotatable drum to which a smoking article may be transferred from the first drum, the further protrusions pushing part of the overhanging foldable paper inwards over the tobacco when a smoking article enters the flute to create a second fold opposite the first fold, and a pair of static plough folders associated with a third, adjacent, rotatable drum to which a smoking article may be transferred from the second drum, the plough folders providing oppositely disposed surfaces flush with the end of the tobacco rod and having converging edges, against which the end of a tobacco rod of a smoking article carried by the third drum passes to create third and fourth folds opposite one another and orthogonal to the first and second folds.

73. Apparatus according to claim 63, in which the one or more folding devices comprise protrusions in a vacuum flutes of a first rotatable drum that pushes part of the overhanging foldable paper inwards over the tobacco when the smoking article enters the vacuum flute to create a first fold, further protrusions in the vacuum flutes of a second, adjacent, rotatable drum to which a smoking article may be transferred from the first drum, the further protrusions pushing part of the overhanging foldable paper inwards over the tobacco when a smoking article enters the flute to create a second fold opposite the first fold, and a pair of reciprocating folders associated with a third, adjacent, rotatable drum to which a smoking article may be transferred from the second drum, the folders operable to sweep inwardly over the end of a tobacco rod of a smoking article carried by the third drum and then retract to create third and fourth folds opposite one another and orthogonal to the first and second folds.

74. Apparatus according to claim 72 or claim 73, further comprising a curved static plate spaced apart from the second rotatable drum by a distance less than the diameter of a smoking article, contact with the plate causing a smoking article carried by the second drum to rotate about its own longitudinal axis by substantially ninety degrees before being transferred to the third rotatable drum.

75. Apparatus according to claim 63, in which the one or more folding devices comprise protrusions in the vacuum flutes of a first rotatable drum that push part of the overhanging foldable paper inwards over the tobacco when a smoking article enters the vacuum flute to create a first fold, further protrusions in the vacuum flutes of a second, adjacent, rotatable drum to which a smoking article may be transferred from the first drum, the further protrusions pushing part of the overhanging foldable paper inwards over the tobacco when a smoking article enters the flute to create a second fold opposite the first fold, fixed folders disposed at the side of each vacuum flute of a third, adjacent, rotatable drum to which the smoking article is transferred from the second drum which engages with the overhanging foldable paper as a smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a third fold orthogonal to the first and second folds, and further fixed folders disposed at the side of each vacuum flute of a fourth, adjacent, rotatable drum to which a smoking article may be transferred from the third drum which engages with the overhanging foldable paper as the smoking article enters the vacuum flute and pushes the paper inwards over the tobacco to create a fourth fold opposite to the third fold.

76. Apparatus according to any one of claims 72 to 75, in which the said protrusions and/or the further protrusions are configured to move between an extended position for effecting the first or second fold as a smoking article enters the vacuum flute, and a retracted position after the fold is effected in which the protrusion does not protrude into the flute.

77. Apparatus according to claim 63, in which the one or more folding devices comprise first pairs of pincers longitudinally aligned with each vacuum flute of a first rotatable drum, each first pair of pincers biased in an open position to receive the overhanging foldable paper of a smoking article in its associated vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and second pairs of pincers longitudinally aligned with each vacuum flute of a second rotatable drum, each second pair of pincers biased in an open position to receive the overhanging foldable paper of a smoking article when transferred to its associated vacuum flute after folding in a vacuum flute of the first rotatable drum, the pincers operable to close on the remaining overhanging foldable paper and push the opposite parts of the paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

78. Apparatus according to claim 63, in which the one or more folding devices comprise first pairs of pincers longitudinally aligned with each vacuum flute of a first rotatable drum, each first pair of pincers biased in an open position to receive the overhanging foldable paper of a smoking article in its associated vacuum flute, the pincers operable to close on the received overhanging foldable paper and push opposite parts of the paper inwards over the tobacco to create opposite first and second folds, and one or more supplementary folding devices associated with a second rotatable drum arranged to receive smoking article after folding with the first rotatable drum, and operable to fold the remaining opposite parts of the overhanging foldable paper inwards over the tobacco to create opposite third and fourth folds orthogonal to the first and second folds.

79. Apparatus according to any one of claims 55 to 59, in which the first sub-apparatus comprises:

a dispenser for dispensing foldable paper;

an adhesive applicator for applying adhesive to the dispensed foldable paper, the adhesive distributed appropriately for securing the foldable paper to a cigarette paper such that it encircles a tobacco rod;

a smoking article carrier for bringing a smoking article in contact with the foldable paper such that an edge of the foldable paper adheres to the cigarette paper;

a lower surface; and

an upper surface spaced apart from the lower surface by a distance less than the diameter of a smoking article, the upper surface movable relative to the lower surface along a direction parallel to the surfaces;

wherein a smoking article with an adhered foldable paper can be introduced onto the lower surface with its longitudinal axis orthogonal to the direction along which the upper surface moves, such that contact with the surfaces causes the smoking article to rotate about its longitudinal axis so that it rolls over the lower surface as the upper surface moves, the rolling causing the foldable paper to wrap around the smoking article.

80. Apparatus according to claim 79, in which the upper surface comprises an endless belt rotatable around a pair of rollers.

81. Apparatus according to any one of claims 55 to 62, claim 79 or claim 80, in which the second sub-apparatus comprises:

a lower surface; and

an upper surface spaced apart from the lower surface by a distance less than the diameter of a smoking article, the upper surface movable relative to the lower surface along a direction parallel to the surfaces, wherein a smoking article with an

overhanging foldable paper can be introduced onto the lower surface with its longitudinal axis orthogonal to the direction along which the upper surface moves, such that contact with the surfaces causes the smoking article to rotate about its longitudinal axis so that it rolls over the lower surface as the upper surface moves; and

one or more folding devices that bend the overhanging foldable paper inwards over the tobacco at the end of the tobacco rod of a smoking article, the folding devices positioned such that the rolling of a smoking article over the lower surface brings the overhanging foldable paper into contact with the one or more folding devices.

82. Apparatus according to claim 81, in which the one or more folding devices comprise a series of teeth extending from the lower surface towards the upper surface and having surfaces flush with the end of the tobacco rod, each tooth engaging a part of the overhanging foldable paper and creating a fold as a smoking article rolls over the lower surface, each fold overlapping the previous fold.

83. Apparatus according to any one of claims 55 to 82, and further comprising a third sub-apparatus operable to receive a smoking article with a folded overhanging foldable paper from the second sub-apparatus and to push a pin having a width less than the diameter of the smoking article against the folded overhanging foldable paper to depress the folded paper and cause it to better maintain its folded position.

84. Apparatus according to claim 83, in which the third sub-apparatus comprises:

a rotatable drum rotatable about an axis of rotation and having around its circumference a plurality of vacuum flutes for receiving smoking articles with their longitudinal axes parallel to the axis of rotation;

a rotatable plate adjacent to the drum and rotatable about the said axis of rotation, and having on its surface a plurality of pins equal to the number of vacuum flutes, the pins extending towards to the rotatable drum and having a spatial

distribution matching that of the vacuum flutes, the drum and the plate rotatable in the same direction at the same speed; and

a bearing operable to move the plate towards the drum when both are rotating by a distance that cause the pins to press into the folded paper at the ends of smoking articles carried in the vacuum flutes, and to then retract the plate from the drum.

85. Apparatus according to claim 84, in which the rotatable plate comprises a swash plate.

86. Apparatus according to any one of claims 83 to 85, in which the or each pin is heated so as to activate a heat-activated adhesive on the overhanging foldable paper when the folded overhanging foldable paper is depressed.

87. Apparatus according to any one of claims 55 to 82, and further comprising a third sub-apparatus operable to receive a smoking article with a folded overhanging foldable paper from the second sub-apparatus, and to apply pressure and/or heat to the folded overhanging foldable paper to activate adhesive on the overhanging foldable paper and cause it to become adhered in its folded position.

88. Apparatus according to claim 83, in which the third sub-apparatus comprises:

a rotatable drum rotatable about a first axis of rotation and having around its circumference a plurality of vacuum flutes for receiving smoking articles with their longitudinal axes parallel to the axis of rotation; and

a rotatable disc adjacent to the drum and rotatable about an axis of rotation orthogonal to the first axis of rotation, and having around its edge a plurality of spaced apart pins extending radially outwards by a distance such that a pin directed towards the drum may press into the folded paper of a smoking article carried in a vacuum flute, the spacing of the pins and the speed of rotation of the drum and disc being such

as to bring consecutive pins into pressing contact with consecutive smoking articles carried in the vacuum flutes.

89. Apparatus according to any one of claims 55 to 88, and further comprising a fourth sub-apparatus operable to attach a filter unit to the end of a tobacco rod of a partially fabricated smoking article, opposite to the end intended to be lit.

90. Apparatus according to claim 89, in which the fourth sub-apparatus is operable to attach the filter unit to the smoking article simultaneously with the first sub-apparatus adhering a foldable paper to the smoking article and/or with the second-sub-apparatus folding the overhanging foldable paper of the smoking article.

91. Apparatus according to any one of claims 55 to 90, further comprising an inspection system operable to inspect the folded overhanging paper for defects and reject a smoking article found to have a defective folded overhanging paper.

92. Apparatus according to claim 91, in which the inspection system comprises:

one or more cameras operable to capture one or more images of the folded overhanging paper;

a control system operable to compare the one or more captured images with one or more stored images of non-defective folded overhanging paper and to generate a rejection signal if a defective folded overhanging paper is found; and

a rejection mechanism operable to receive the rejection signal from the control system and remove the smoking article having the defective folded overhanging paper from the apparatus.

93. Apparatus according to claim 92, in which the one or more cameras comprise at least one of a first camera arranged to capture an end view of the folded

overhanging paper and a second camera arranged to capture a side view of the folded overhanging paper.

94. A method of making a smoking article substantially as described herein with reference to the accompanying drawings.

95. Apparatus for making a smoking article substantially as described herein with reference to the accompanying drawings.

96. A smoking article substantially as described herein with reference to the accompanying drawings.

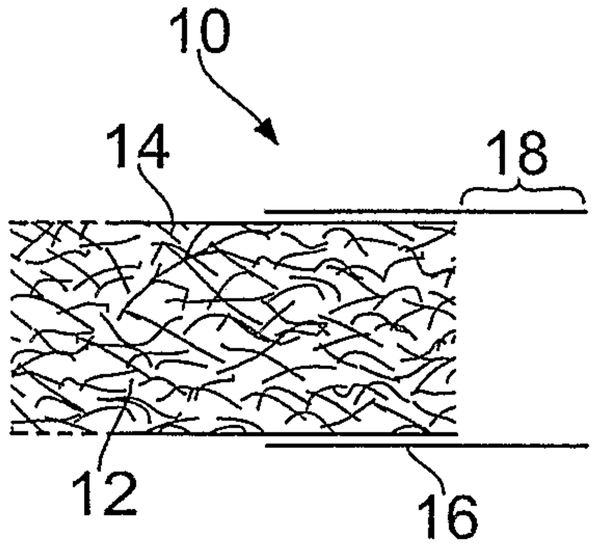


FIG. 1A

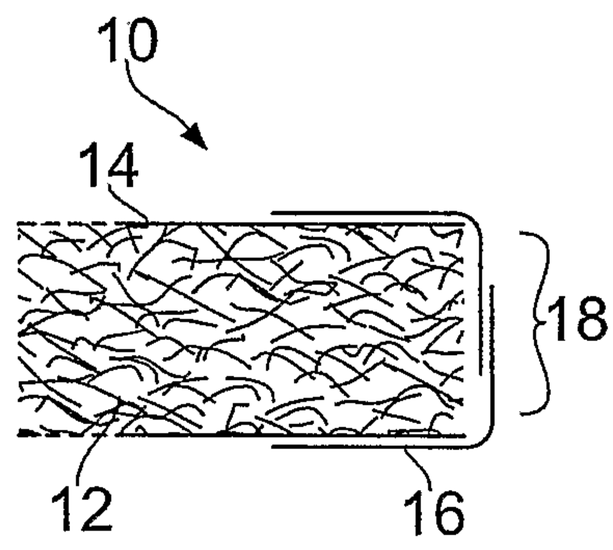


FIG. 1B

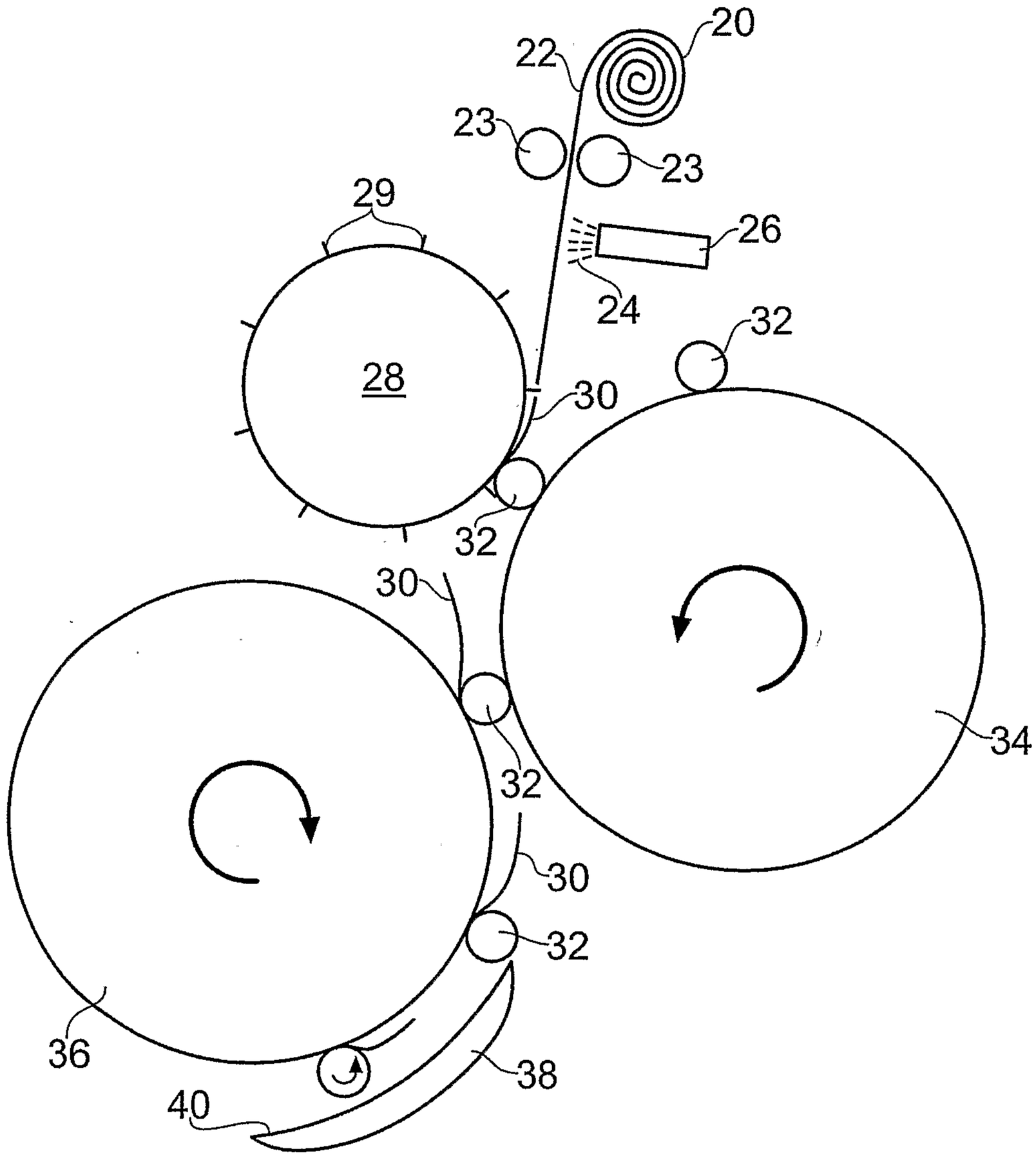


FIG. 2

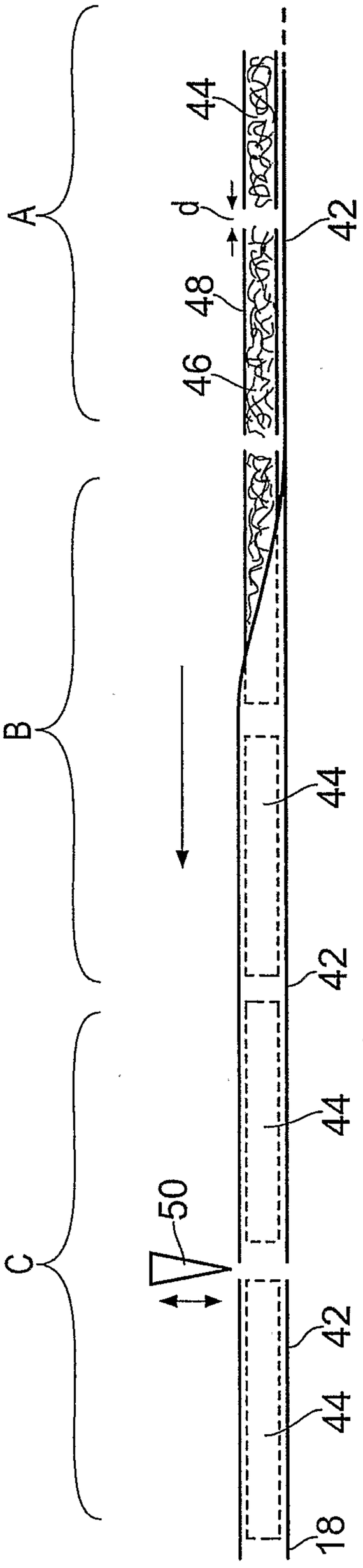


FIG. 3A

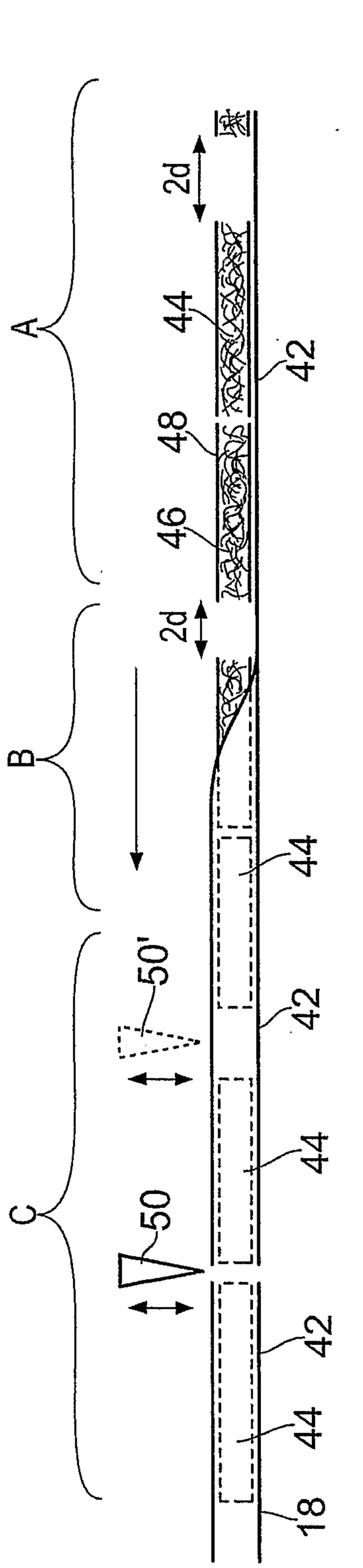


FIG. 3B

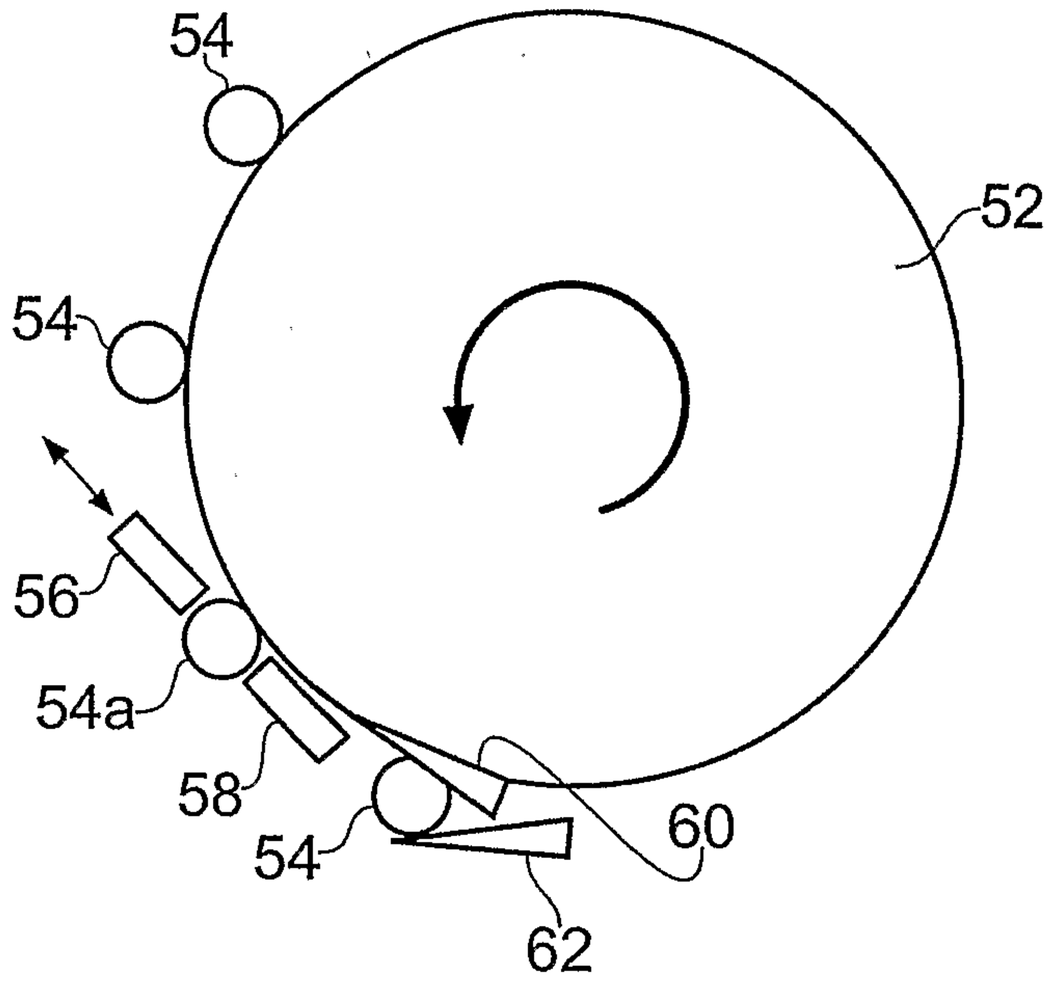


FIG. 4

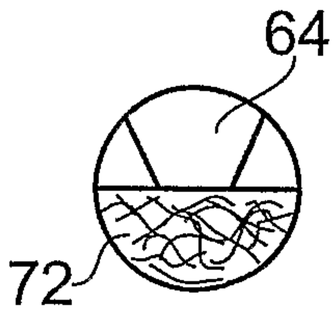


FIG. 5A

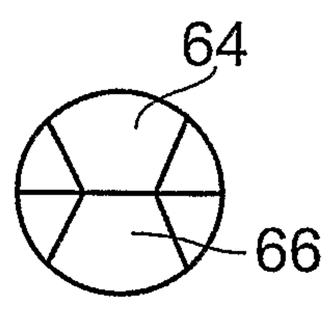


FIG. 5B

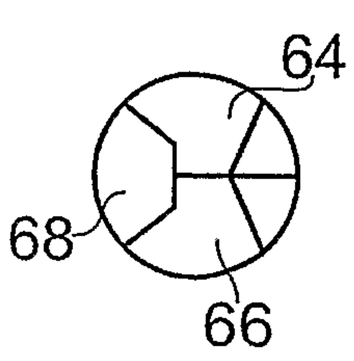


FIG. 5C

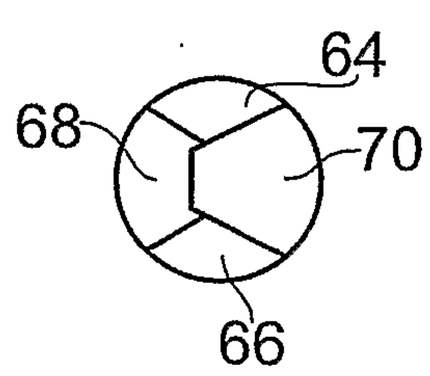


FIG. 5D

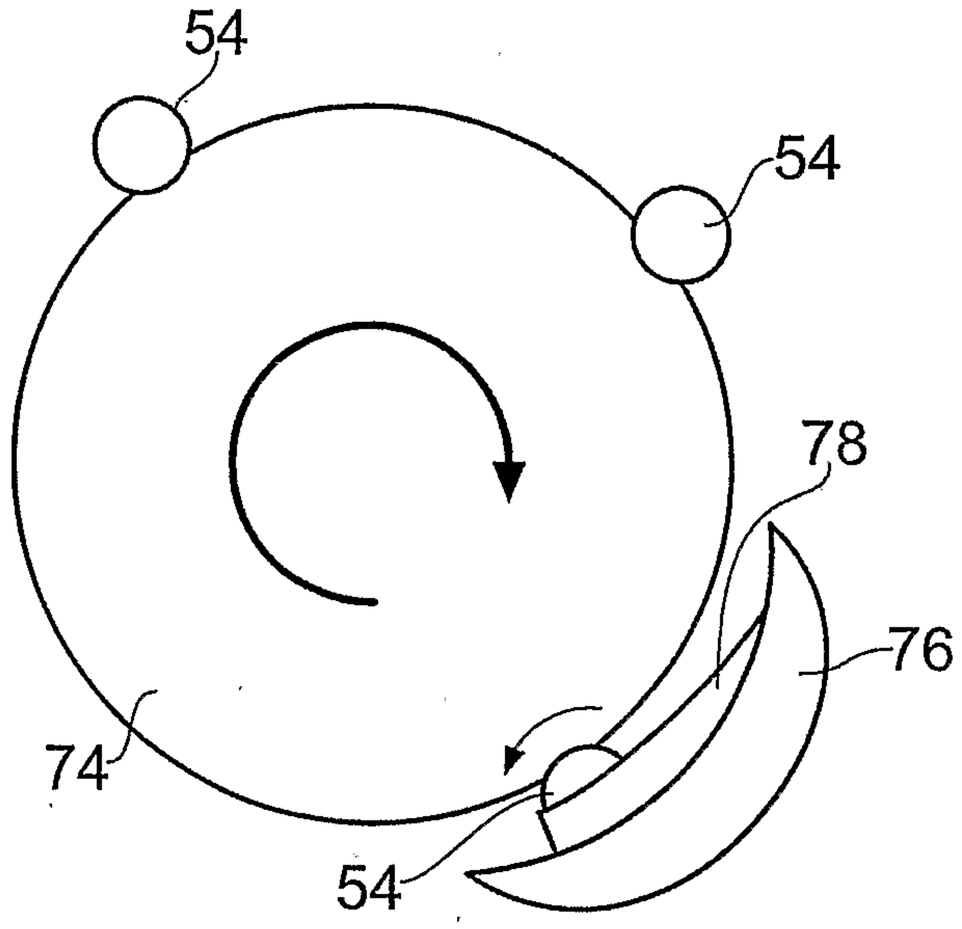


FIG. 6

FIG. 7

FIG. 8

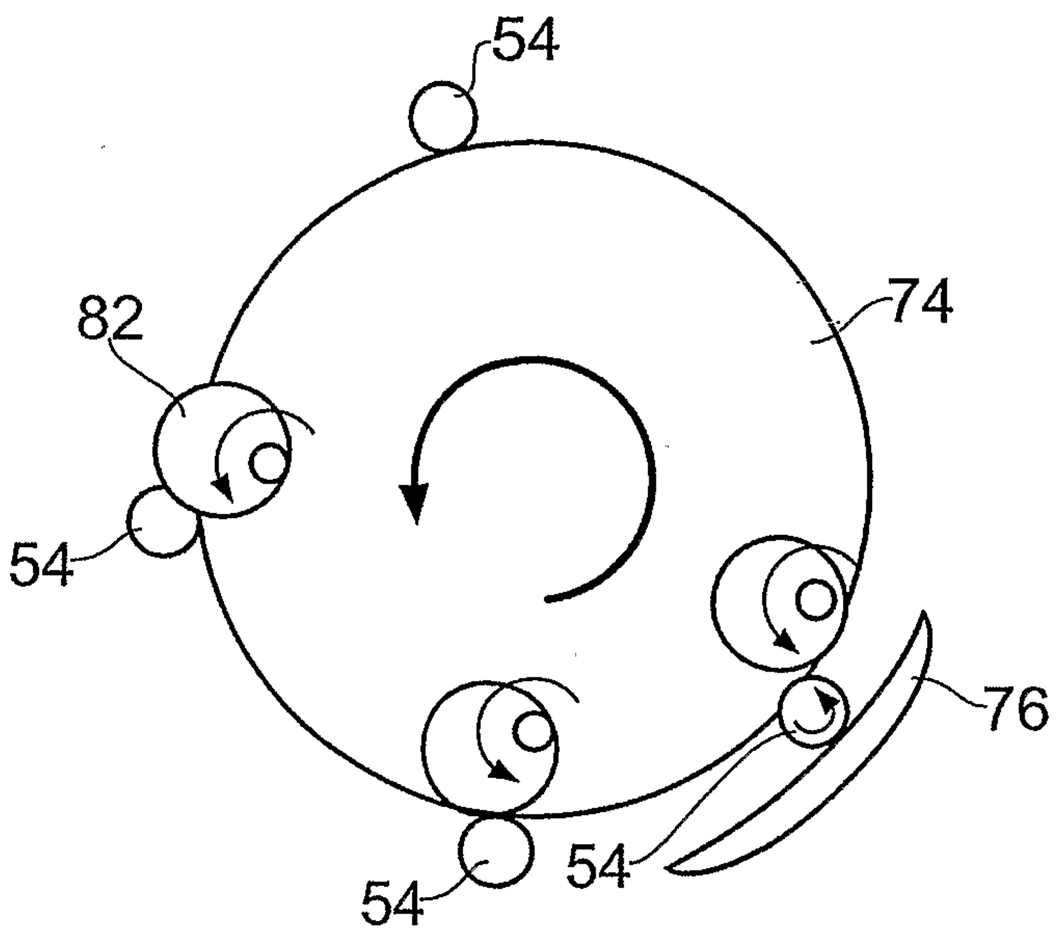


FIG. 9

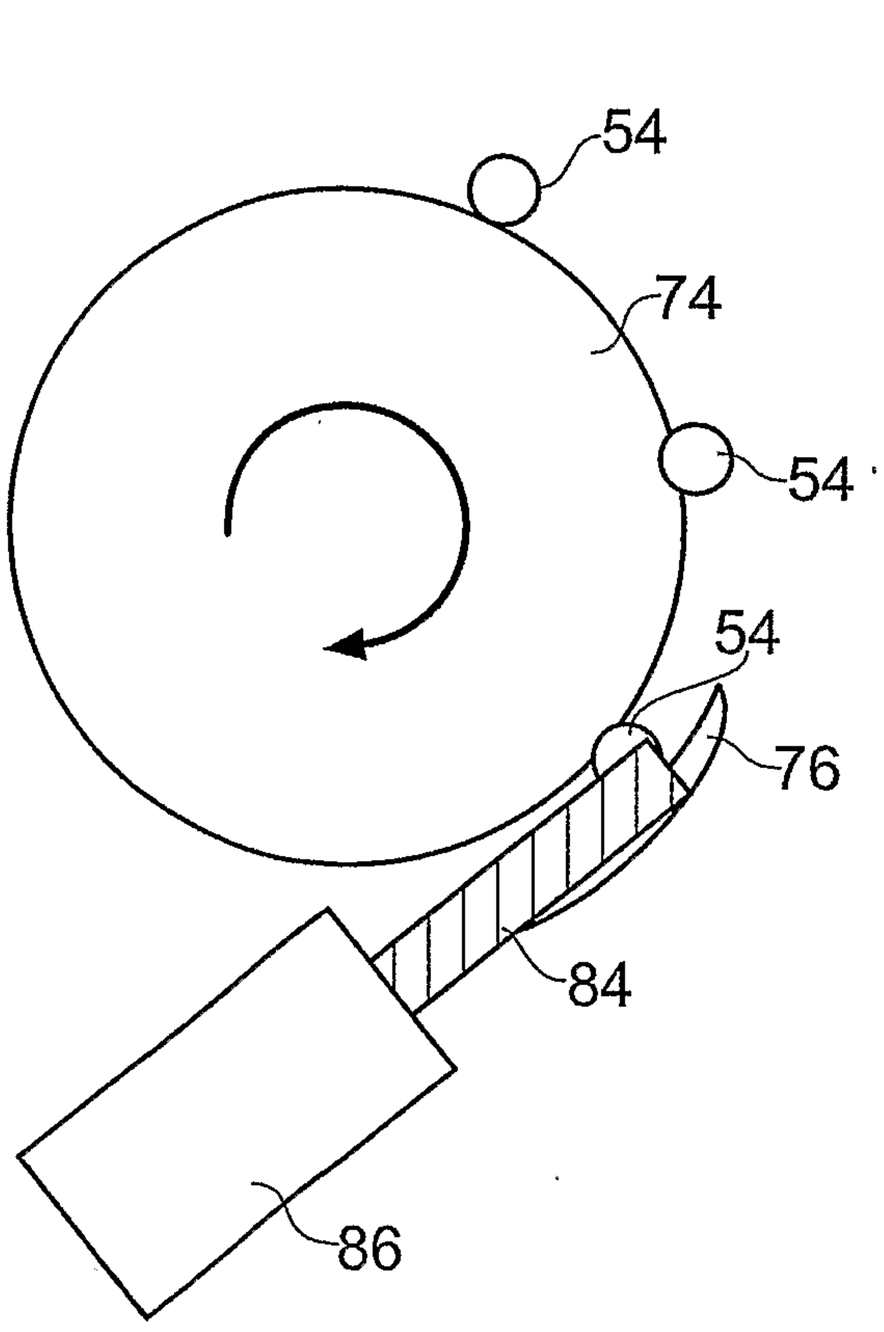


FIG. 10

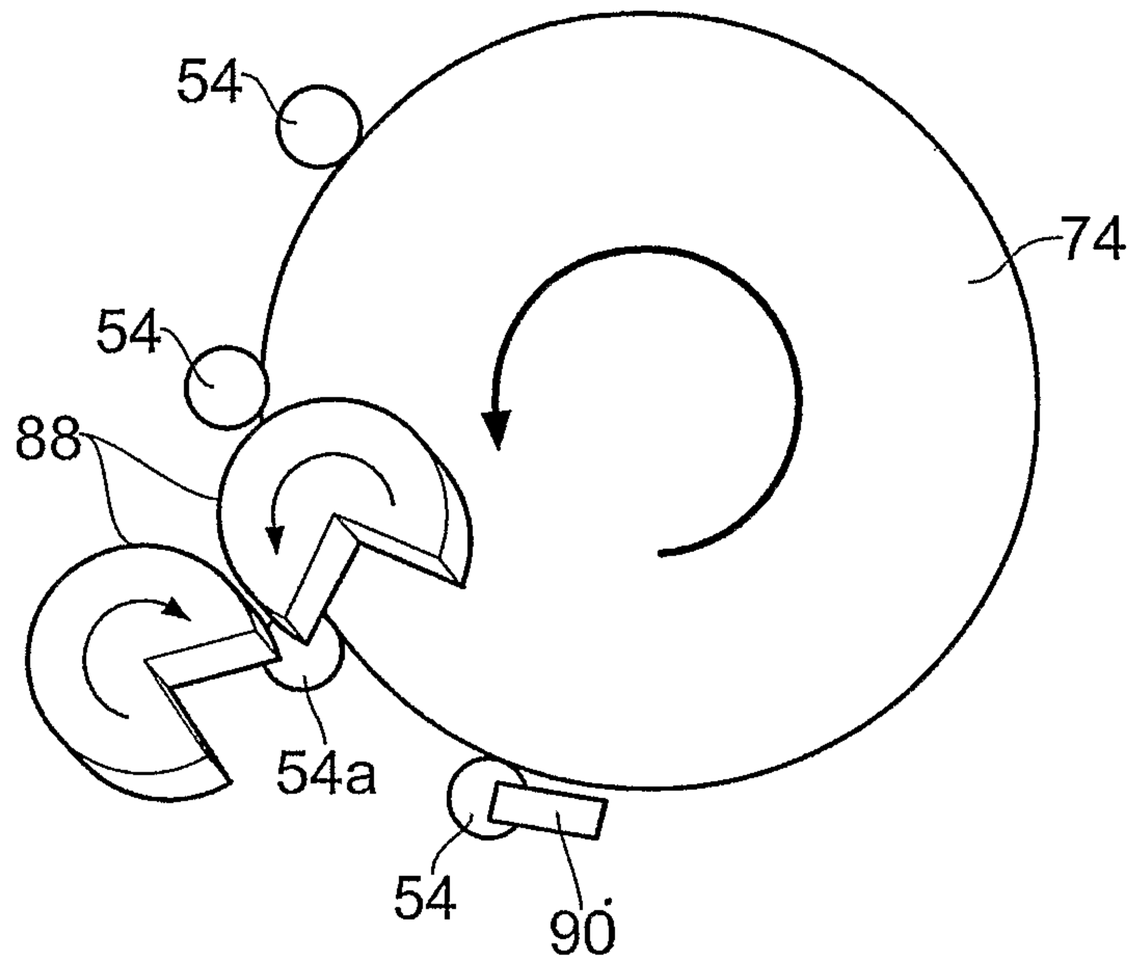


FIG. 11

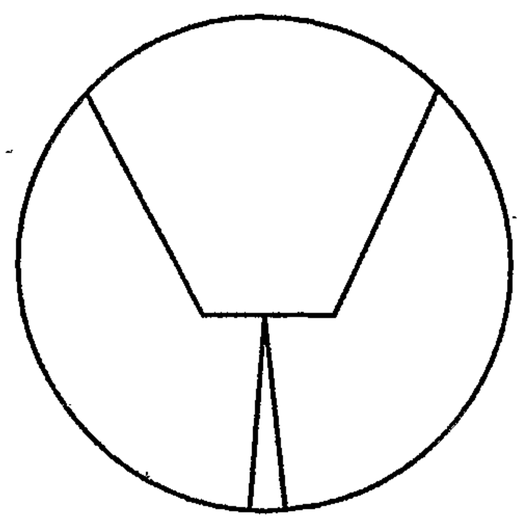


FIG. 11A

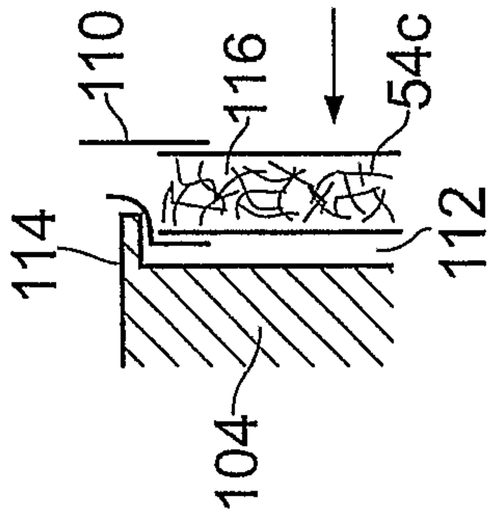


FIG. 13A

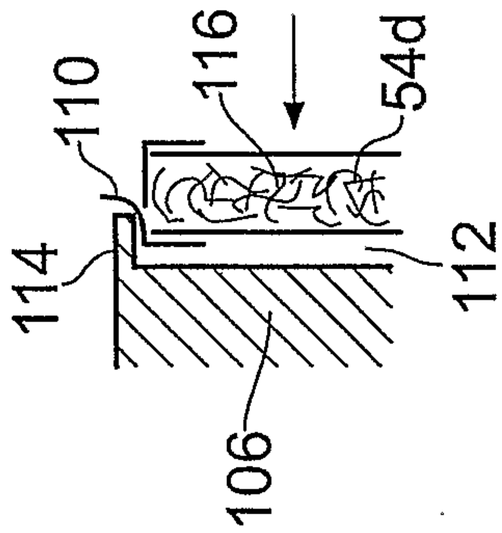


FIG. 13B

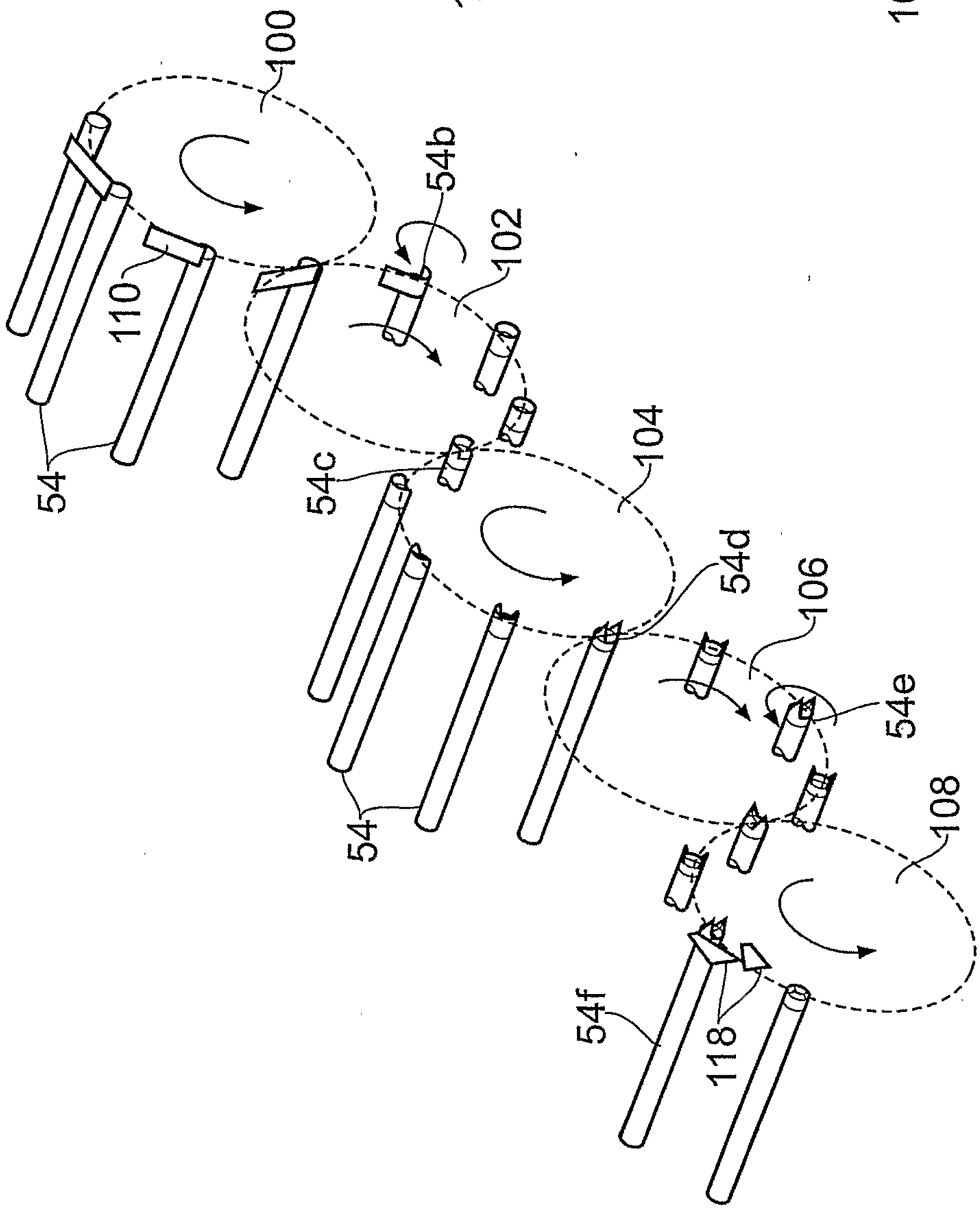
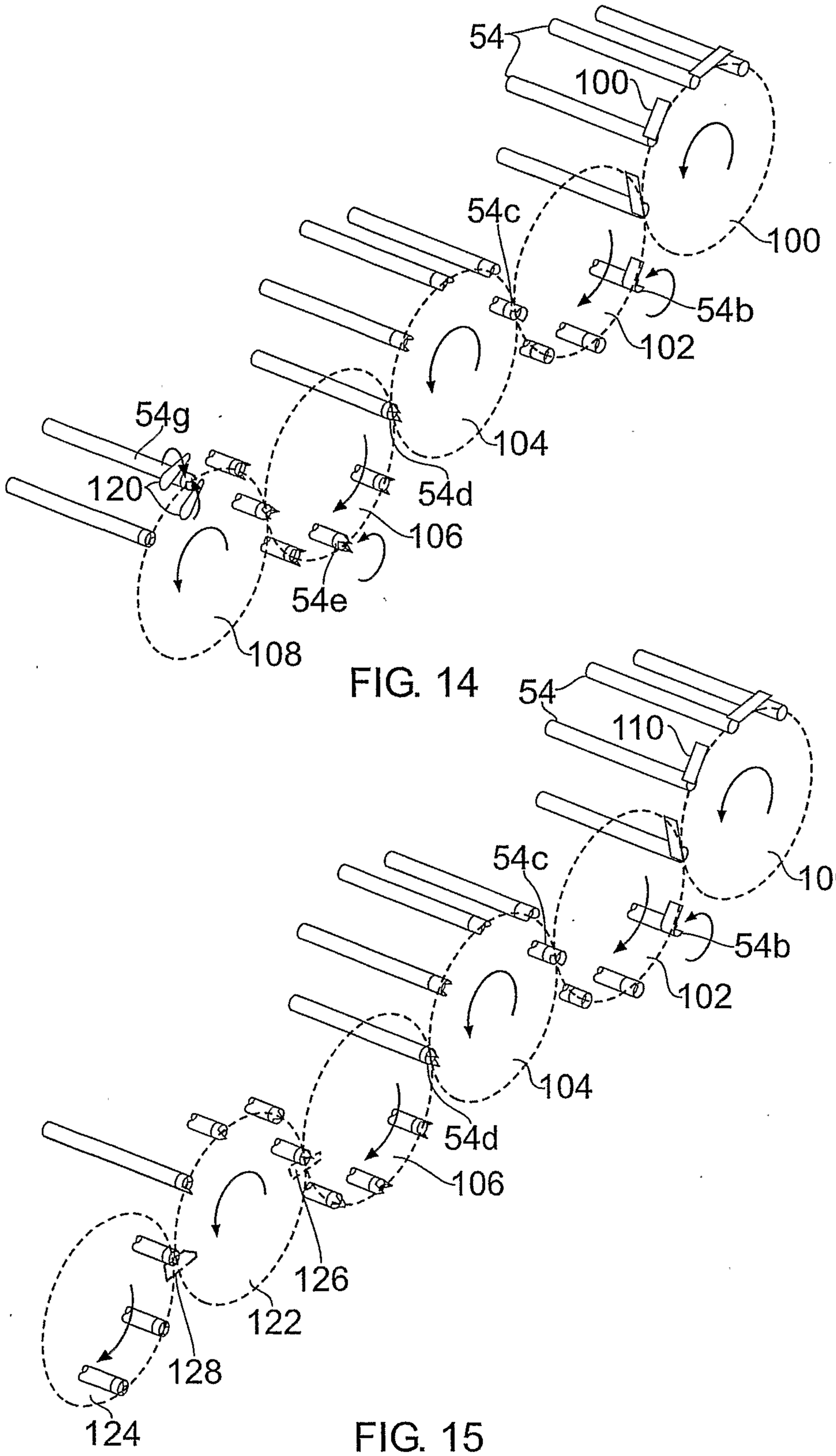


FIG. 12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54g
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54d
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FIG. 14

FIG. 15

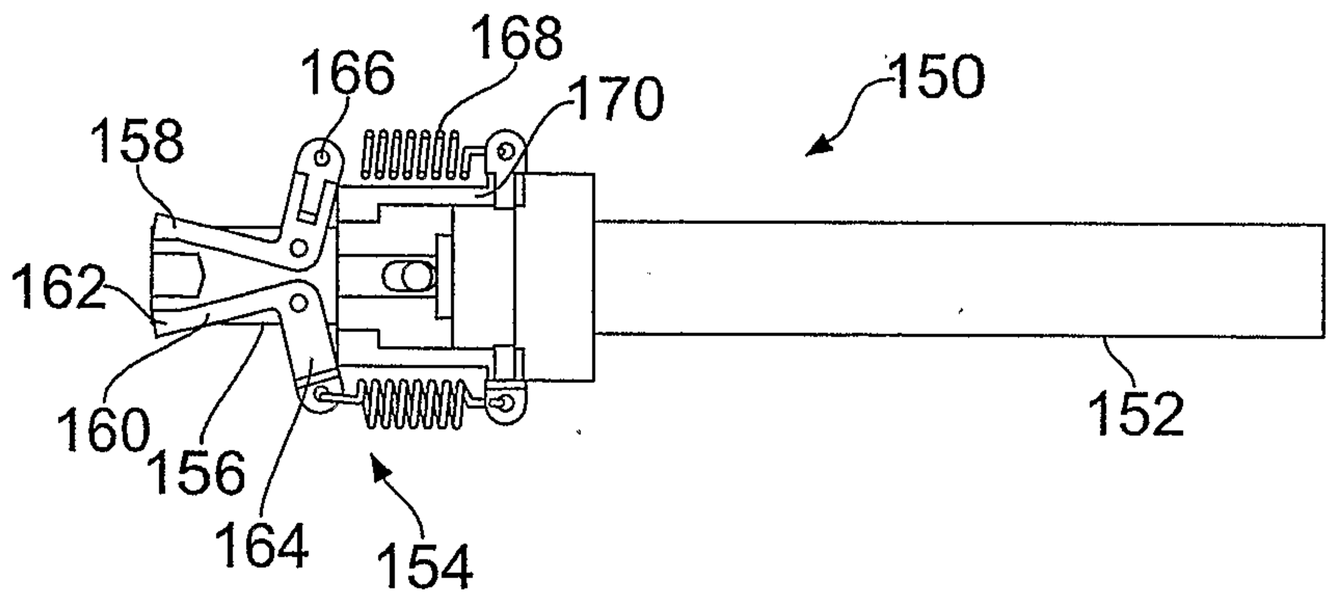


FIG. 16A

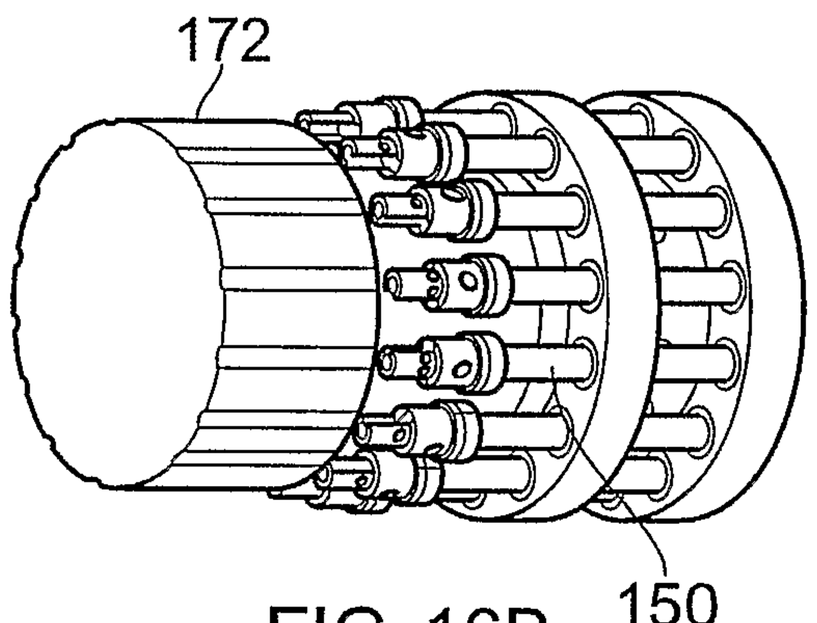


FIG. 16B

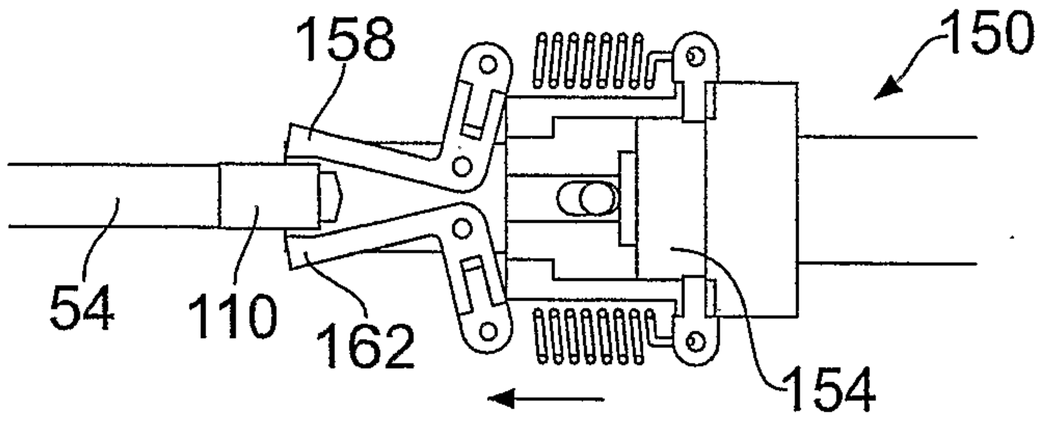


FIG. 16C

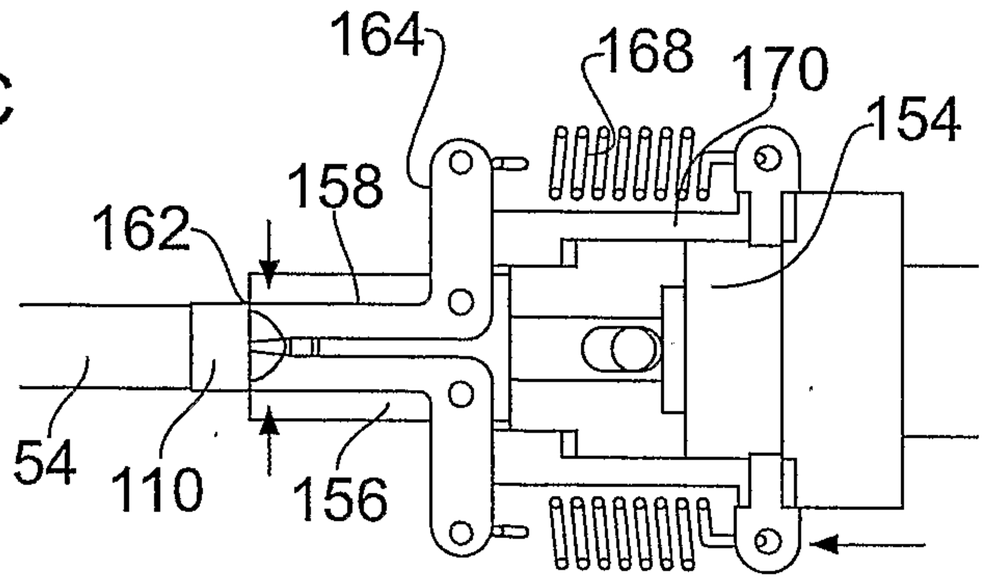


FIG. 16D

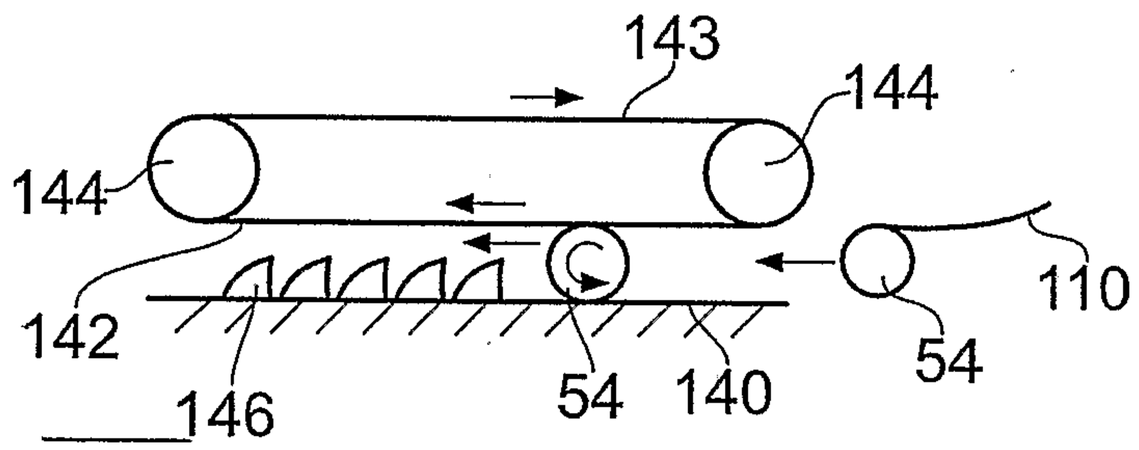


FIG. 17

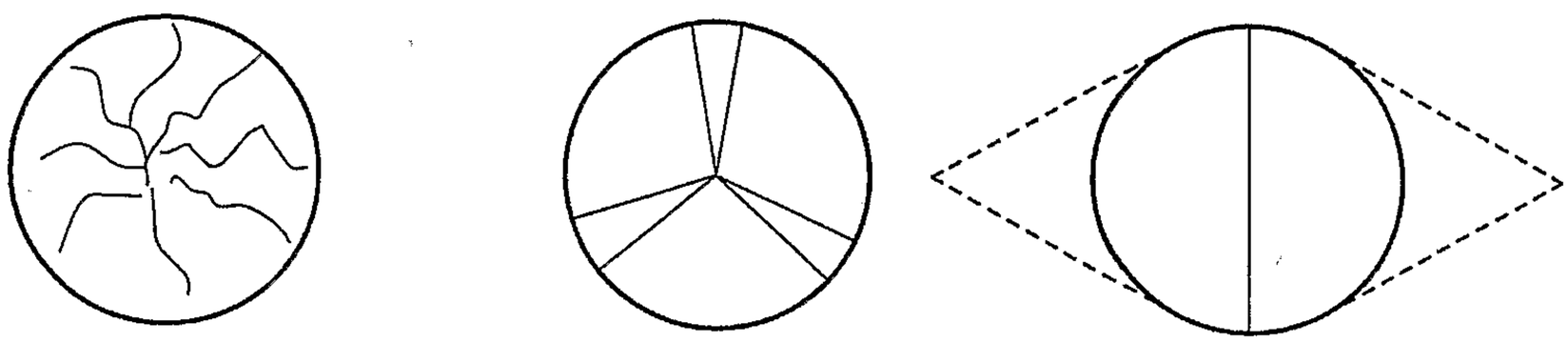


FIG. 18A FIG. 18B FIG. 18C

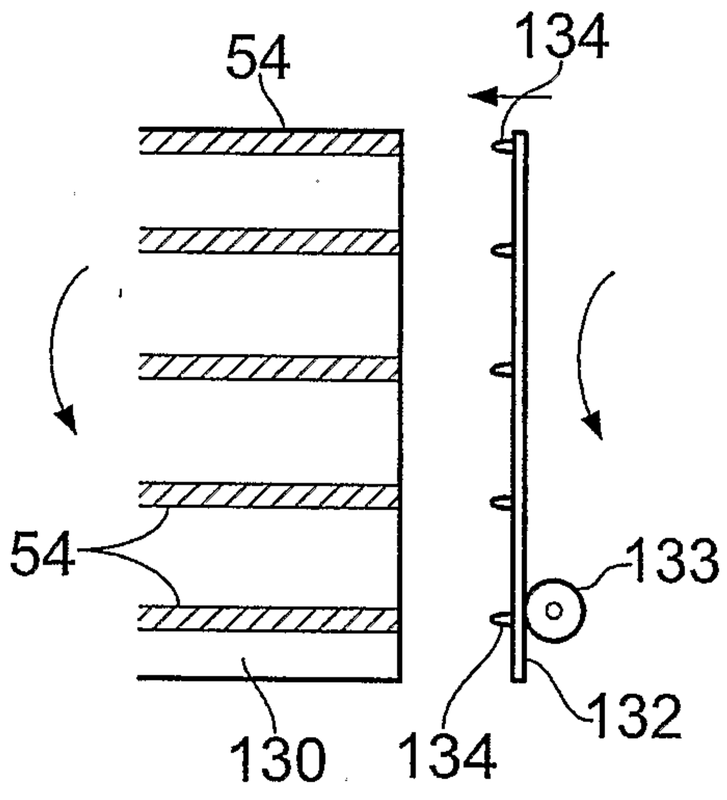


FIG. 19A

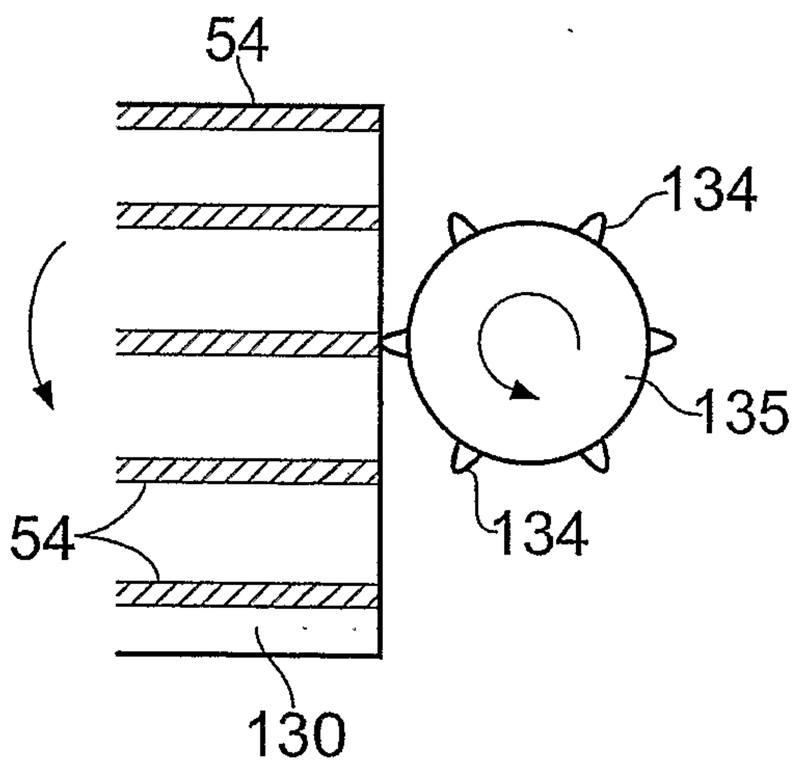


FIG. 19B

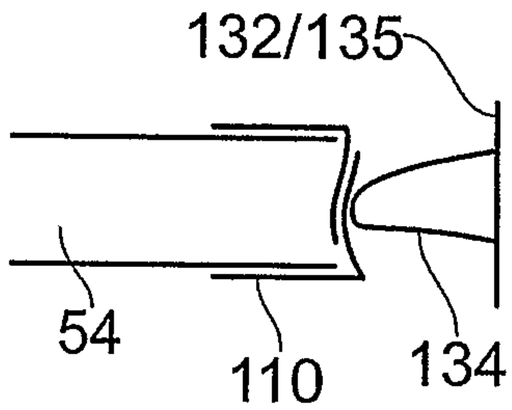


FIG. 20

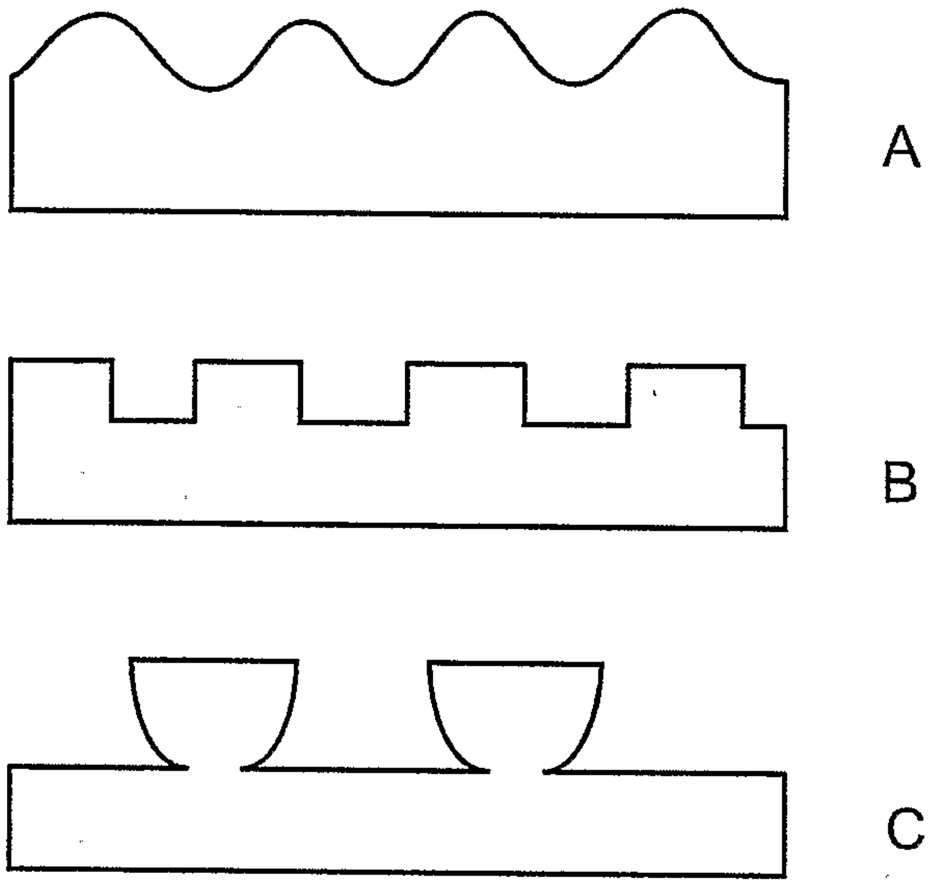


FIG. 21

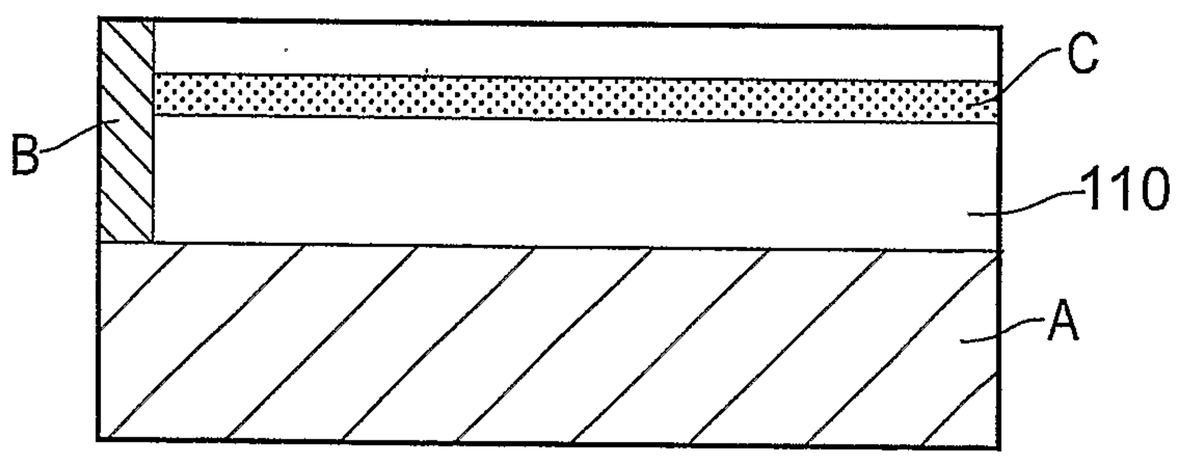


FIG. 22

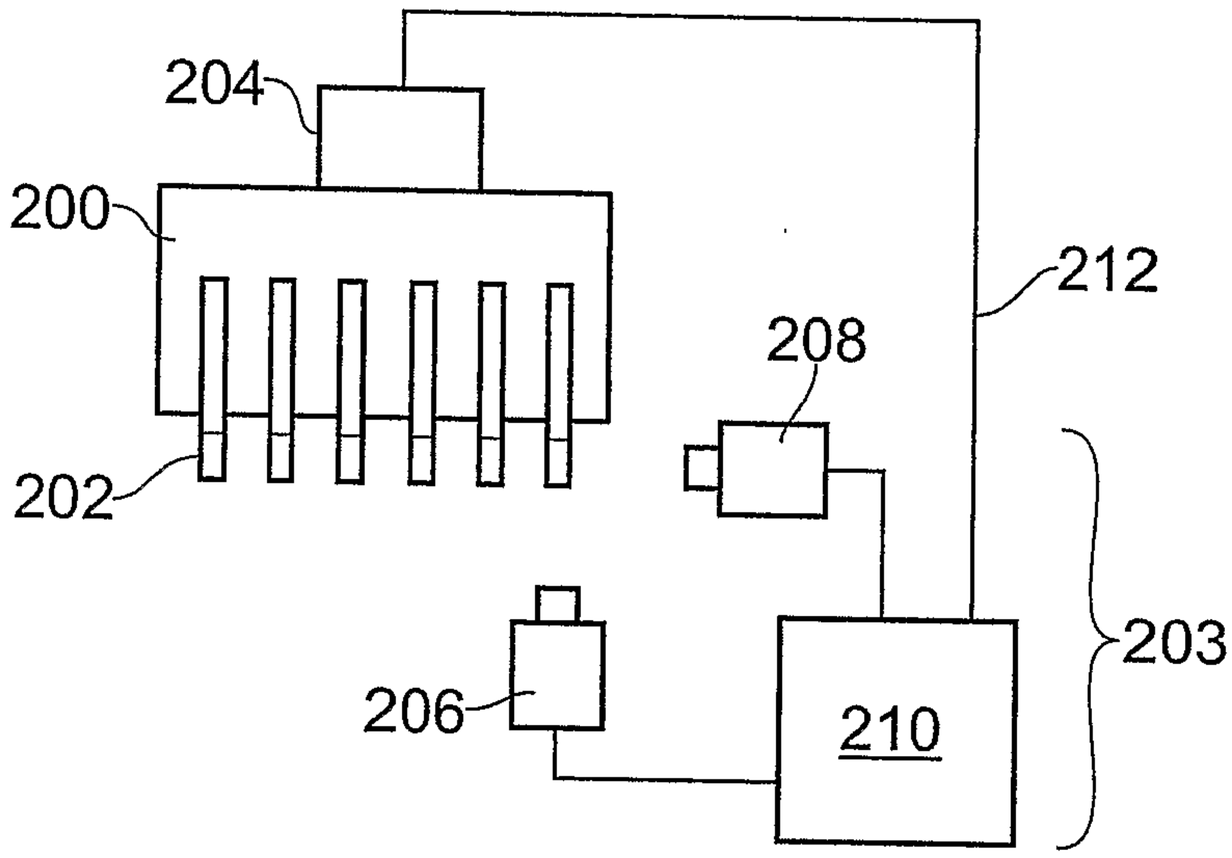
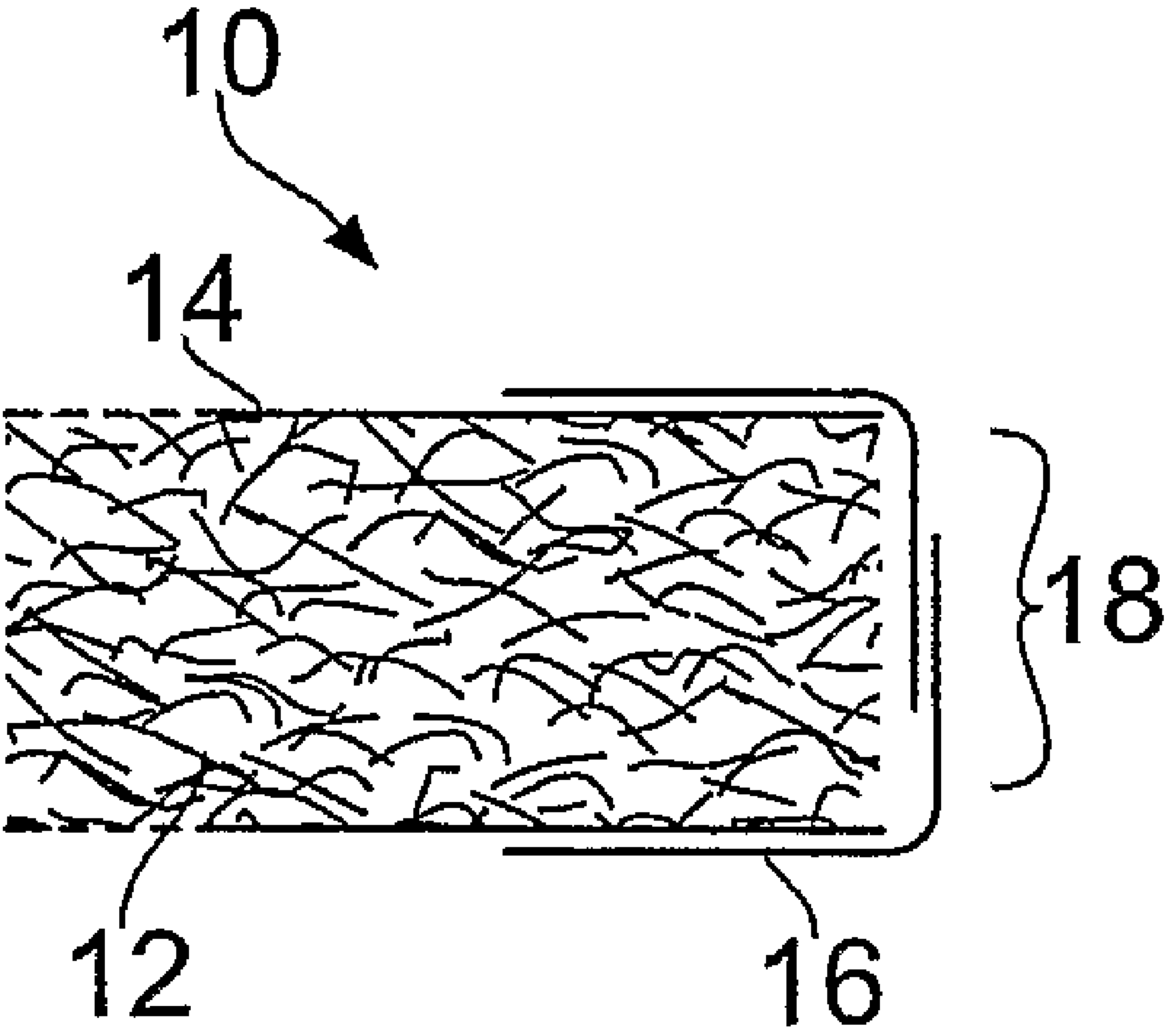


FIG. 23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