

[54] **CIGARETTE FILTERS**

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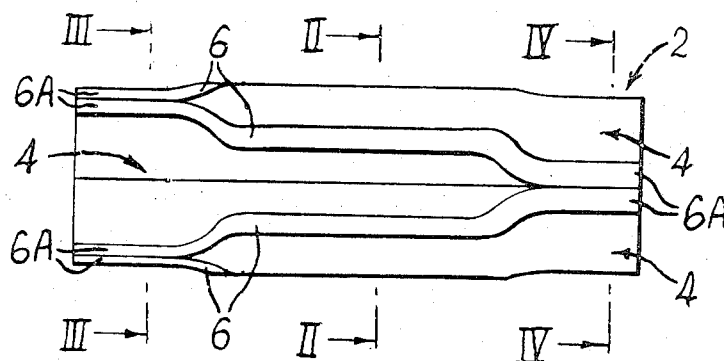
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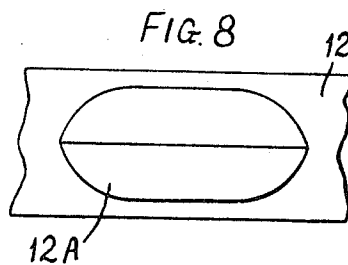
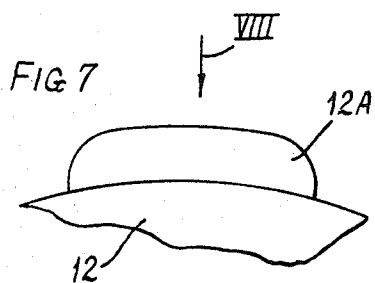
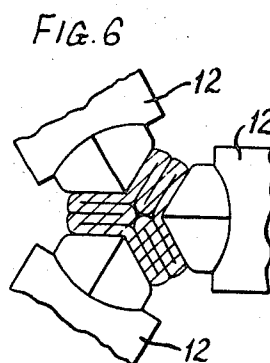
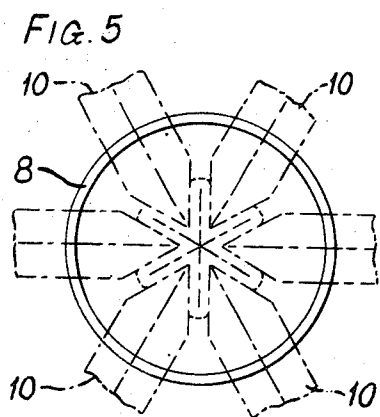
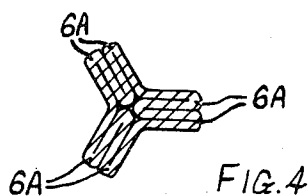
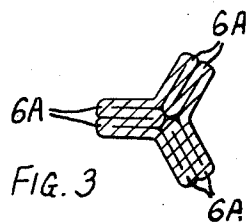
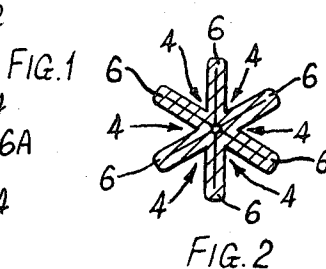
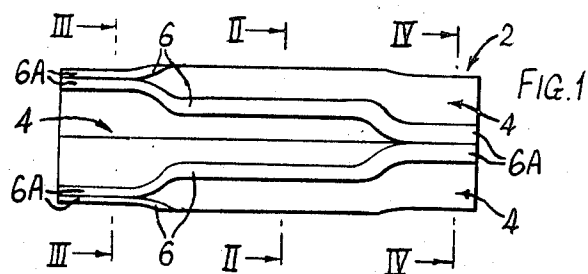
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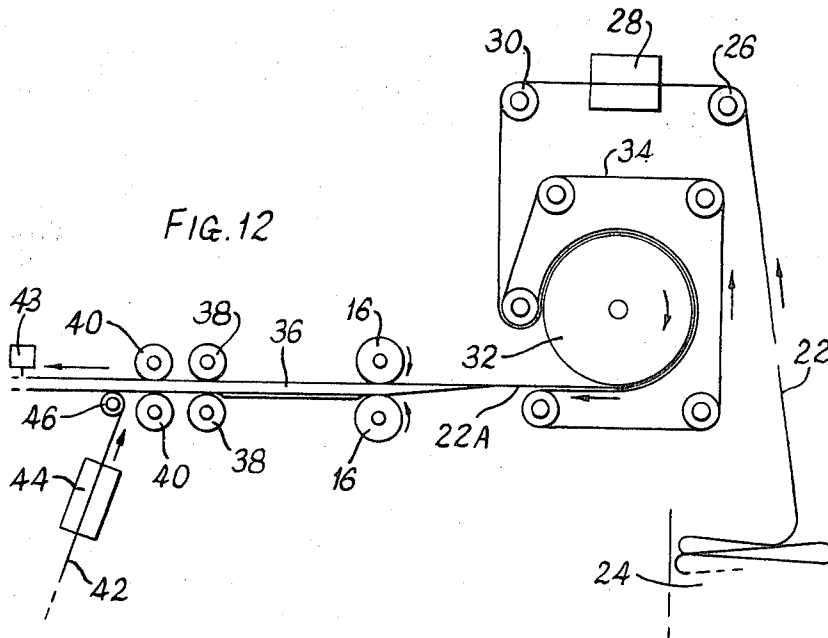
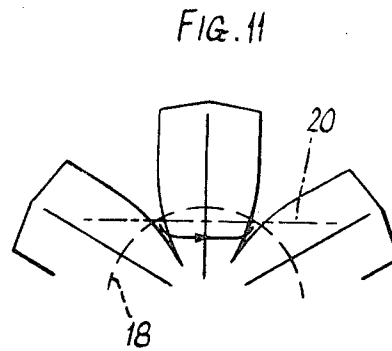
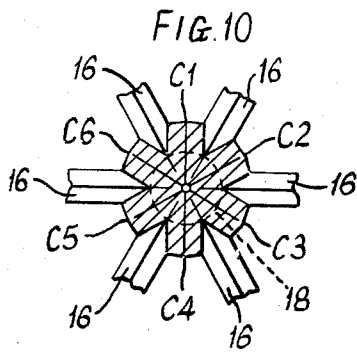
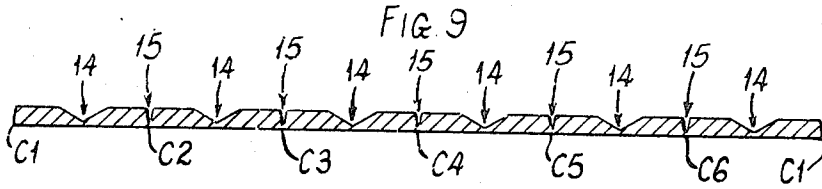
ABSTRACT

Cross-flow filter elements for cigarettes are made by forming a continuous rod of filter material including a number of substantially axial grooves separated by rib portions; closing alternate grooves at regular intervals by pinching together the ribs; and cutting the rod at regular intervals to form a succession of cross-flow filter elements. The rod is preferably formed by folding inwards circumferentially spaced regions of a continuous tube which itself is formed by bringing together the edges of a continuous web of filter material.

7 Claims, 12 Drawing Figures







CIGARETTE FILTERS

This invention is concerned with filters for cigarettes and other similar articles (i.e. for smoking), comprising a filter element formed with a number of axially extending peripheral grooves of which alternate grooves are closed at opposite ends, so that the smoke enters the filter through one set of alternate grooves and leaves the filter through the other set of grooves after passing transversely through the rib portions between the grooves. A filter in this form will be referred to as a "cross-flow filter".

According to one aspect of this invention, filter elements for cross-flow filters are made by forming a continuous rod of filter material including a number of substantially axial grooves separated by rib portions; closing alternate grooves at regular intervals by pinching together the ribs; and cutting the rod at regular intervals to form a succession of cross-flow filter elements.

If the filter elements are needed for filter-tipped cigarettes, the rod is preferably enclosed in a tubular wrapping before it is cut to form individual filters; these filters can then be joined to cigarettes in the usual way. Alternatively a filter element made in this way could, for example, be inserted into a plastic mouthpiece which a user can himself push over the end of a cigarette before smoking it.

The continuous grooved rod is preferably formed by folding inwards circumferentially spaced regions of a continuous tube. The tube may be formed by extruding filter material (e.g. fibrous cellulose acetate with an appropriate bonding agent) into a tubular section. Preferably, however, the continuous tube is formed by bringing together the edges of a continuous web of filter material, for example of fibrous cellulose acetate or paper; in this case the web may be shaped in cross-section or may be scored longitudinally (especially in the case of paper) so as to promote folding along the required lines.

Filter material consisting of continuous crimped fibers of cellulose acetate may, for example, be used with a thermoplastic resinous bonding agent or with a bonding agent in the form of a volatile solvent. In the former case heat is applied at an appropriate region to melt the bonding agent, which then sets and joins the cellulose fibers after cooling. In the case of a bonding agent in the form of a volatile solvent (sometimes referred to as a "plasticizer") the surfaces of the fibers are made tacky by the solvent and are then set by driving off the solvent by means of heat.

After the ribs have been pinched together at the appropriate regular intervals, the filter element may be set by the application of heat (especially in the case of cellulose acetate provided with a plasticizer). Alternatively, they may be set by means of an adhesive (especially in the case of paper) which may be applied between the pinched-together rib portions to hold these portions together; heat may be applied to set or activate the adhesive.

According to another aspect of this invention a cross-flow filter element comprises a rod formed with substantially axial grooves separated by rib portions which contact one another at the ends of the rod so as to close alternate grooves at opposite ends of the rod.

Examples according to the present invention will now be described with reference to the accompanying drawings. In these drawings:

FIG. 1 is a side view of a cross-flow filter element according to this invention;

FIGS. 2 to 4 are sections respectively on the lines II—II, III—III and IV—IV in FIG. 1;

FIG. 5 shows how the filter element is initially formed by folding a tube of circular cross-section;

FIG. 6 shows how alternate ribs are pinched together to close the axial grooves at regular intervals;

FIG. 7 is a side view of one of the wheels which pinches the ribs together;

FIG. 8 is a view in the direction of the arrow VIII in FIG. 7;

FIG. 9 is a cross-section of a prepared web which may be used for forming the tube;

FIG. 10 shows how the web is folded to form a peripherally grooved rod of uniform cross-section;

FIG. 11 shows a modified rod cross-section; and

FIG. 12 shows diagrammatically a complete apparatus for making filters from the web shown in FIG. 9.

The filter element shown in FIG. 1 consists of a rod section 2 having six axially extending peripheral grooves 4 separated by ribs 6 which are of uniform thickness and extend radially, as shown in FIG. 2. End portions 6A of the ribs are pinched together to close alternate grooves 4 at opposite ends. Accordingly, when the filter element is surrounded, for example, by a cylindrical paper wrapper (not shown), alternate grooves form axial passageways through which smoke can enter the filter from one end; this smoke then passes transversely through the ribs into the other axial passageways formed by the other grooves, and from there passes axially out of the other end of the filter.

FIGS. 5 and 6 show how the filter element is formed. A continuous tube 8 of filter material is first folded inwards at circumferentially spaced positions by means of six wheels 10 while the tube is moving axially, the axes of rotation of the wheel 10 being in a common plane normal to the axis of the tube. The continuous rod thus formed is of uniform cross-section like the section shown in FIG. 2. During further movement of the rod, two sets of pinching wheels engage in the grooves and splay the ribs apart so as to close the grooves at appropriate positions.

FIG. 6 shows a set of three pinching wheels 12 which engage in alternate grooves. A further set of similar wheels engage in the other grooves in a position downstream of the first set, this set being inclined at 60° to the first set (that is to say about the axis of the rod). The pinching wheels may be heated so as to apply heat to the pinched-together rib portions to cause or assist these rib portions to stick together.

FIGS. 7 and 8 show further views of one of the pinching wheels and in particular show that the pinching wheel has a number of circumferentially spaced V-sectioned lobes 12A which engage in the grooves to splay the ribs apart.

The continuous rod thus formed consists of a succession of filter elements. The rod is finally cut into individual filter elements at regular intervals through the pinched rib portions 6A. However, before the rod is cut, it is preferably enclosed in a paper wrapper so that the final rod can be joined to a cigarette by means of an encircling band or "cork" to form a filter-tipped cigarette. As an alternative, each cross-flow filter element may be placed end-to-end with a short length of conventional filter material of circular cross-section, and these two pieces may be joined together by a paper

wrapper; the composite filter thus formed may then be joined to a cigarette, with the cross-flow filter element lying between the conventional filter element and the cigarette, so that the mouth end of the finished cigarette is formed by the conventional filter.

The tube 8 from which the filter element is formed may for example be of cellulose acetate or other fibrous filter material with a bonding agent to bond together the fibers and set the filter in the final shape, possibly with the aid of heat. Alternatively it may for example be formed from one or more layers of filter paper, for example such as Myria, which may be fed as a web and formed into a tube with a longitudinal seam, before being folded inwards to form the rod section shown in FIG. 2. A further possibility is that the web which is formed into the tube may include one or more layers of granular, powdery or other particulate material (for example collagen or a collagen-filled sheet material) sandwiched between layers of paper or other sheet material. Alternatively the web may, for example, be a collagen-filled sheet material, for example consisting of a substantially homogenous mixture of cellulose fibers and collagen.

A further way of forming the tube is shown in FIGS. 9 and 10. The tube in this case is formed from a prepared web of uniform cross-section shown in FIG. 9. The web cross-section includes six relatively wide V-sectioned grooves 14 and five narrower grooves 15 which extend longitudinally along the web. After the web has been formed into a tube by bringing together its edges, the tube is folded inwards at the grooves 14 by means of six wheels 16 shown in FIG. 10. This folding operation is the same as in FIG. 5, except that the web is shaped to promote the folding. The outer edges of the ribs of the rod thus formed lie at points C1 to C6 on the web. At the points C2 to C6, as a result of the narrow grooves 15, the web has thin hinge portions to promote the necessary folding.

The filter material formed into the web shown in FIG. 9 is preferably of uniform density so that the resistance to the flow of smoke transversely through the ribs is substantially uniform at all distances from the axis of the filter element. In order to increase the utilization of the filter material lying within the core contained within the dotted outline 18 shown in FIGS. 10 and 11, the web may be formed slightly differently so that the grooved rod cross-section is as shown in FIG. 11. This enables smoke to flow more easily, below the line 20 in FIG. 11, in the direction of the arrow. In other words, the grooves in the filter element are slightly deepened. In this case, as the thickness of the rib is not uniform but decreases towards the center of the rod (i.e. below the line 20), the web material may be made more dense in the region of the grooves 14, to compensate for the reduction in rib thickness.

FIG. 12 shows how a complete succession of filter elements may be made. A fairly wide and loose web 22 of filter material (e.g. fibrous cellulose acetate) is drawn from a bale 24 and is passed round a pulley 26, through a device 28 in which the tow is sprayed with a bonding agent, and round a pulley 30 which deflects it towards a drum 32. This drum is formed with a series of axially spaced circumferential ribs so as to have a peripheral cross-section corresponding to the upper surface of the web as shown in FIG. 9. The tow is pressed against the drum 32 by a band 34 which is driven at a speed corresponding to the peripheral speed of the

drum 32. As a result the finished web 22A emerges horizontally at the bottom of the drum 32, the cross-section of the web being as shown in FIG. 9. During the passage of the web 22 from the bale 24 to the drum 32, the width of the web is reduced towards that of the final web shown in FIG. 9. As the web 22 enters the forming channel between the drum 32 and the band 34, it is thicker than the final section, and it is compressed evenly to its final section.

While the web 22 is being fed towards the drum 32 and is being reduced in width, a number of converging ribs extending along the web may be provided to enter the thickness of the web in positions corresponding to the grooves 14 and 15, so that the grooves in the final web are not formed merely by compressing the finished web section by means of circumferential ribs on the drum 32. In other words, the thickness of the web just before it enters the shaping passage between the drum 32 and the band 34 may vary appropriately so that the density of the final web in the region of the grooves is substantially the same as the density elsewhere.

When the finished web 22A emerges from the bottom of the drum 32, it is formed into a tube by bringing together the edges at C1, and is then folded by means of the wheels 16, which are shown diagrammatically in FIG. 12. The peripherally grooved rod 36 which then emerges from the shaping passage between the wheels 16 passes between two sets of wheels 38 and 40, each set consisting of three wheels like the wheels 12 shown in FIGS. 6 to 8. One set of wheels engages in alternate grooves, and the other set is inclined at 60° to the first set (i.e. about the axis of the rod) so as to engage in the other grooves. The grooves are thus closed at the appropriate regular intervals, as previously described. A paper web 42 is fed via an adhesive unit 44 and round a pulley 46 to a position below the filter rod, and is then wrapped and sealed round the rod 36. The continuous wrapped rod thus formed is cut into a succession of rod sections by a cut-off device 43. The unit 44 may apply adhesive not only to the edges of the paper web 42 but also along regularly spaced longitudinal bands so as to seal the paper to the outer edges of the ribs 16.

Adhesive may also be applied to the web 22A to glue together the parts of the tube at the center of the tube in order to prevent smoke passing straight through the center of the filter.

Upstream of the set of wheels 16 there may be a die arrangement consisting of parts inside and outside the tube for progressively folding the tube towards its final peripherally grooved shape. The inner die member would in this case project into the tube from a position to the right of the wheels 16 and would taper to a point, so as to end just upstream of the wheels 16. The outer die member would have a circular internal cross-section at its upstream end, just larger than the tube 8, and its internal cross-section would progressively change towards the external cross-section of the finished rod as shown in FIG. 10. In this case, the wheels 16 may simply apply the finishing touch to the folding operation, or they may be omitted; if the wheels 16 are omitted then the wheels 12 may, between the lobes 12A, have a cross-section similar to the wheels 16.

Between the wheels 16 and the wheels 38, the rod may be confined to its folded shape by being passed through a close-fitting tube of circular cross-section. Adhesive may be applied to the abutting inner faces of the two sections of the web which form each rib, but as

an alternative the tube between the wheels 16 and 38, and the tube formed further on by the paper wrapper, may be relied upon to hold the web to its final cross-section simply by preventing expansion of the folded form.

In order to bond together the fibers of the material forming the web, the drum 32 may be heated. In addition, or as an alternative, the web may be passed through a heating chamber just before entering the forming space between the drum 32 and the band 34; in this heating chamber, hot air or steam may be circulated to melt the bonding agent (in the case of a thermoplastic adhesive) or to drive off the bonding agent if the bonding agent is a plasticizer.

Instead of the two sets of wheels 38 and 40 being used to close alternate grooves, there may be one set consisting of six narrow circumferentially spaced wheels each rotating about an axis inclined to the axis of the rod so that successive wheels overlap one another.

As already mentioned, instead of a shaped web (i.e. as shown in FIG. 9) being formed into the tube which is subsequently folded to form the rod, the web may be of uniform thickness and may be formed from one or more layers of filter paper. In this case the folding of the tube may be done entirely by means of inner and outer die members as already described. A set of wheels like the wheels 16 may then be used simply or mainly to apply adhesive to the flanks of the ribs at regular intervals corresponding to the positions at which the pinching wheels 38 and 40 are arranged to close alternate grooves. Thus if the adhesive applied by the wheels 16 is a hot-melt adhesive, this adhesive would begin to set by the time the rod reaches the pinching wheels 38 and 40 and may form an adequate bond after appropriate parts of adjacent ribs are brought together by the pinching wheels 38 and 40.

Instead of the rod section having six peripheral grooves, it may for example have eight or 10 grooves or any other even number of grooves.

Instead of each finished filter element being as shown in FIG. 1, it could be twice as long. For example, the

continuous rod could be cut through alternate sets of pinched-together rib portions; alternatively the finished filter elements could be of the same length (i.e., twice the distance between successive sets of pinched-together rib portions) with the ends being mid-way between the sets of pinched-together rib portions. In the first example the smoke from the cigarettes passes twice through the ribs.

We claim:

1. Apparatus for making cross-flow filter elements for cigarettes and other similar articles, comprising means for forming a continuous rod of filter material including a number of substantially axial grooves separated by rib portions; means for closing alternate grooves at regular intervals by pinching together the ribs; and means for cutting the rod at regular intervals to form a succession of cross-flow filter elements.

2. Apparatus according to claim 1 in which the continuous grooved rod is formed by folding inwards circumferentially spaced regions of a continuous tube.

3. Apparatus according to claim 2 in which the continuous tube is formed by bringing together the edges of a continuous web of filter material.

4. Apparatus according to claim 3, including means for forming in the web longitudinal grooves along which the web is folded to form the grooved rod.

5. Apparatus according to claim 4 in which the grooves are formed by pressing the web material against a drum formed with circumferential ribs.

6. Apparatus according to claim 2, in which the tube is folded inwards with the aid of a number of wheels which have a peripheral cross-section corresponding to the cross-section of the grooves in the rod, and which rotate with a peripheral speed substantially equal to the speed of the rod.

7. Apparatus according to claim 1 in which alternate grooves are pinched together by co-operating wheels which rotate with a peripheral speed equal to the speed of the rod and have lobes which enter the grooves at regular intervals to deform outwards the adjacent portions of the ribs.

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