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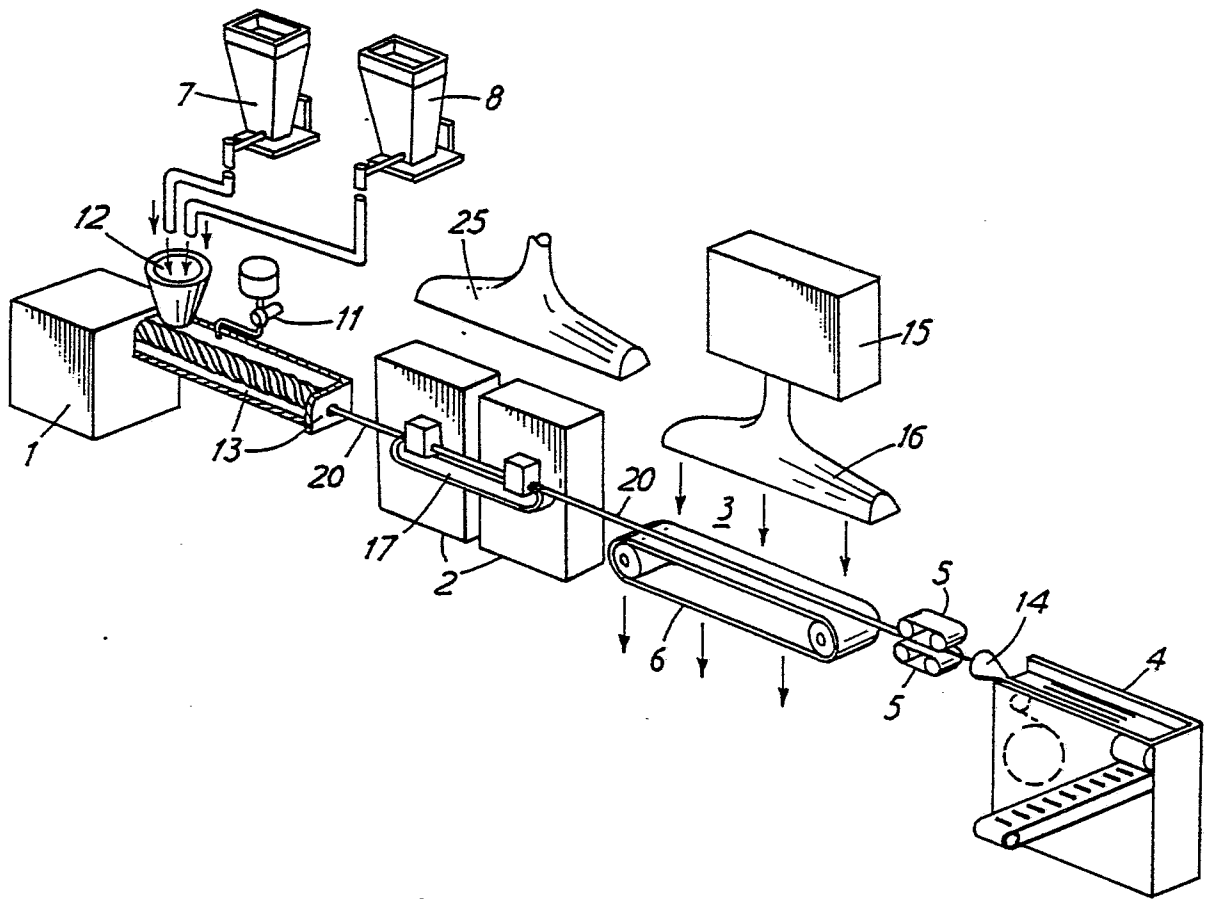
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(54) **Processing continuously-extruded tobacco-containing material.**

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(57) A continuous rod 20 of foamed tobacco-containing material is delivered by extruder barrel 13 which is fed with tobacco from supply 7, binder from supply 8, and water from supply 11. To enable the rod 20 to be fed directly to a cigarette-making machine 4 it is first dried by passage through microwave driers 2, volatile materials being removed by vacuum hood 25. Rod 20 then passes along conveyor 6 and is cooled by refrigerated air driven by fan 16. The surface temperature is reduced below the bulk temperature, which has a case-hardening and stiffening effect.



PROCESSING CONTINUOUSLY-EXTRUDED TOBACCO-CONTAINING MATERIAL

The present invention relates to the processing of continuously-extruded tobacco-containing material to enable smoking articles to be manufactured from such material.

One example of the formation of smoking articles by extrusion is described in U.S. Patent Specification 4,510,950. The smoking article described in that specification is typically substantially cylindrical and is extruded under conditions such that the water in the wet blend fed to the extruder die is converted to steam, thereby foaming the article. The article is monolithic, that is, it is extruded as a single strand with a diameter of typically about 8mm if the article is a cigarette.

Another approach is to extrude the wet blend out of a die having a plurality of small apertures to form an extruded, coherent, multi-strand, tobacco-containing, generally cylindrical smoking article comprising a plurality of co-extruded strands that extend generally along the longitude of the smoking article and are adhered to one another, preferably randomly, so as to leave flow passageways between the strands along the longitude of the smoking article. This approach is disclosed in a European patent application published under No. EP-A-0167370 on 8th January 1986. The configuration of the strands and passageways of these foamed articles provide sufficient heat transfer area or sufficient residence time or both for the hot gases drawn towards the proximal end of the smoking article by a smoker to cool and to exit the proximal end at a temperature comfortable for the smoker.

These foamed, extruded tobacco materials are formed from tobacco particles, binder, water, and optionally fillers or other desired additives. They are generally hot, moist, soft, and flexible thermoplastic-like materials as they exit the die. The temperature of the extruded materials is typically in the range from 40-150°C. Working the tobacco-containing material at too high a temperature can result in overworking or cooking of the material, which degrades the quality of the product. Extruding the material at too low a temperature will not foam the material at typical extruder pressures, resulting in too dense a product. The moisture content, measured in terms of oven volatiles or OV, is typically in a range from 15 to 50%, depending on the product formulation and process conditions. This moisture content is above the tobacco equilibrium content of about 10-15%. The terms "moisture content" or OV refers to the liquid in which the tobacco and other materials are mixed before extrusion. Typically, the liquid is water, but organic or alcoholic liquids may be used.

Such continuously formed foamed rod-like extruded materials are too hot, moist, and pliable to be formed directly into smoking articles at high rates of speed by, for example, passing the rods into an automated smoking article "maker" machine such as a Mark 8 Cigarette Maker manufactured by the Molins Company or the like. These materials do not have enough structural integrity to be wrapped and formed into smoking articles without further processing.

The known methods of post extrusion processing of extruded materials include drying the extruded materials to reduce the OV to about the equilibrium OV of tobacco. Drying occurs commonly by allowing the liquid used in the pre-extruded slurry, e.g., water or other agents such as alcohols that aid in evaporation, to evaporate in air at atmospheric or reduced pressures. In some cases suction devices may be used to remove the solvent before drying. In other cases, the extruded materials are dried by infra-red heaters, steam, or hot air, in a conventional drying oven.

The foregoing techniques are inadequate for commercial utilization of continuously extruded materials, particularly foamed extruded materials, because they require long periods of time to reduce the OV to the desired level. These techniques require storage facilities or drying ovens (which can extend hundreds of feet) to sufficiently dry the material, each of which are impractical and costly to maintain in a commercial operation. With very slow rates of drying or low temperature drying, a foamed structure can collapse under its own weight, develop undesirable flat spots against a supporting structure, or otherwise result in a product having a non-uniform density. This adversely affects the burn qualities and consumer acceptance of the smoking article. Attempts to heat rapidly the materials, particularly foamed rods, result in case hardening the outer portions of the extruded material, which in turn inhibits the interior section from drying sufficiently. Case hardening can increase the drying time by an order of magnitude, e.g. from minutes to hours, or hours to days. Over-drying the exterior to dry the interior can result in a brittle product that crumbles when manipulated. Over-drying also can lead to a wrinkled or cracked product or an unduly stiff product, each of which is unacceptable to the consumer.

In accordance with the present invention a method of processing continuously-extruded tobacco-containing material wherein the extruded material coming from the extrusion die is dried by exposure to microwave energy is characterized in that the OV level of the extruded material is re-

duced by the microwave drying to a level at or below the equilibrium OV level and the extruded material is subsequently cooled so that the surface temperature is decreased substantially below the bulk temperature, thereby providing the extruded material with a structure adequately rigid and stable dimensionally for forming into smoking articles.

The present invention is directed to drying and cooling extruded tobacco-containing smoking materials rapidly, under conditions that will enable the extruded material to be passed directly from the extruder die to apparatus for forming the smoking material into the desired product. The invention applies to both foamed and unfoamed tobacco-containing extruded material.

The extruded material is first dried to volatilize the water or other liquid present in the extruded material and thereby reduce the moisture content to a level at about or preferably below the equilibrium OV level of the tobacco-containing product. Drying also can initiate or continue a foaming operation, when used, by volatilizing, gassing, or decomposing any agent present used to foam the extruded material. Foaming is a result of the moisture, other foaming agent, or gas within the extrudate changing from a super-heated liquid or compressed gas to a gas at essentially atmospheric pressure either as the extruded material leaves the high-pressure environment behind the die inside the extruder and enters the atmospheric environment just downstream of the die openings, or after extrusion, by passing the material through a drying chamber for heating the material so that it foams. The resulting dried material is a hot and pliable thermoplastic material which may be tacky on contact.

After drying, the material is immediately cooled to lower the temperature of the extruded material. Two temperature definitions used herein are (1) surface temperature, i.e., the temperature detected at the surface of the extruded material; and (2) bulk temperature, i.e., the average temperature of a selected quantity of the tobacco material mass after equilibration in a calorimeter. Cooling the dried extruded material requires reducing the bulk temperature at least somewhat and the surface temperature substantially to give the extruded material an adequately rigid structure, to substantially minimize the tackiness of the surface, and to dimensionally fix or set the extruded material for subsequent forming by the maker apparatus.

The temperature to which the extruded material must be cooled to obtain an adequately rigid structure is a function of the specific ingredients of the thermoplastic tobacco-containing mass and the rate of cooling, and will generally be between about -196°C and 85°C for the surface temperature, and between about 20°C and 90°C for the bulk tem-

perature. In general, the more cooling achieved, the firmer and better the resulting product. Limits on cooling are principally equipment limitations, the heat capacity of the cooling medium applied and how good an insulator the extruded material is. The dried and cooled mass will likely continue to change dimensions very slightly as it equilibrates with ambient or other controlled conditions.

Preferably, cooling reduces the bulk temperature to about, and the surface temperature sufficiently below, the glass transition temperature of the material to provide a case hardened periphery that is semi-rigid for easy handling by automatic maker machines. Unlike the prior art methods, such a case hardening does not interfere with drying the interior of the material or the equilibration of the finished smoking product to the desired conditions because the material is about equilibrated (except thermally) before it becomes case hardened.

Further, cooling the material below the volatilization temperatures for the flavor generating components also may prevent certain flavors, both natural in tobacco and added, from volatilizing during a long cooling down period. This enhances the subjective characteristics of the finished article. With foamed materials, the surface and bulk temperatures are preferably lowered to below the flash point of the particular foaming agent used, thereby halting any foaming action caused by drying or residual heat stored in the extruded material during the drying step.

The cooled, dried material may then be fed directly into apparatus for producing the desired smoking article. In one embodiment, the tobacco-containing material could be extruded as a sheet which is dried, cooled, and cut up for use as tobacco filler like conventional tobacco leaf or reconstituted tobacco. Alternately, and preferably, the material could be extruded in a rod-like shape having a cylindrical cross section and passed directly from the cooling apparatus into the garniture of a commercially available maker. Optionally, the material may be wrapped with cigarette or cigar wrapper or coated with a formulation capable of forming an outer sheath using coextrusion or post extrusion techniques, before being fed to the maker.

A primary advantage of the present invention is the ability to process the hot pliable extruded material into a material that can be formed into a smoking article on a continuous basis.

In one embodiment, the tobacco containing material includes particles of tobacco mixed in a medium such as water to form a slurry which is extruded, and microwave energy is used to dry the extruded material substantially uniformly throughout the material as it passes through an appropriately dimensioned microwave cavity. The cavity

dimensions and microwave frequency are preselected to obtain the required depth of penetration for the given cross sectional area and configuration of the material to excite and volatilize the medium and thereby dry the extruded material. The energy level propagated into the cavity is selected based on the rate of advance of the extruded material, the exposure time and OV (or amount of medium) in the extruded material as it enters the drying cavity and the desired OV as it exits the cavity. Optionally, vents may be provided in or adjacent to the microwave drying cavity to exhaust the steam or other vaporized materials generated by the drying action. Thus, the extruded material is dried uniformly, with the vapors generated from the interior portions replenishing the moisture vaporized from the surface regions to give the material a substantially uniform density while reducing the overall OV level to the desired level without case hardening or embrittling the extruded material.

In a preferred embodiment, two spaced apart microwave cavities may be used in tandem to dry the material passing therethrough. Using two cavities permits venting the vapors between the cavities as well as the input and outputs to the drying section, and permits more precise control over the energy level applied to dry the material. Further, the spacing between the cavities can be adjusted to permit the material to equilibrate somewhat between microwave exposures. Also, the orientation of the microwave cavities can be selected, for example, to be oriented in parallel, or with one cavity rotated about the axis of the extruded material relative to the other cavity to better average the microwave energy and modal power distribution within the extruded material. Thus, using two or more microwave cavities permits drying the material more evenly with somewhat greater control than would be possible with a single microwave drying chamber.

Following the drying step, the extruded material is cooled. In one embodiment, the extruded material is passed through a cooling cavity flushed with refrigerated air, preferably exchanged continuously. Ambient air also may be included in the airflow. Refrigerated air, when used, may be generated by, for example, a conventional air conditioning system, passing ambient air over cooling coils chilled to about 4°C, dry ice, or the like. The temperature of the refrigerated air is selected in view of the rate of speed of the extruded material and total exposure time in the cooling chamber to reduce the surface and bulk temperatures of the extruded material sufficiently to fix dimensionally the material for subsequent handling. Thus, the material must be cooled to be adequately rigid for feeding directly to a wrapper and maker apparatus to make smoking articles.

The extruded material may be advanced through the cooling chamber by means that will permit cooling of the extruded material, preferably by a perforated supporting belt or opposing belts permitting continuously exchanged refrigerated (and optionally ambient) air to contact the hot extruded material. Alternately, an air cushion could be used to support the extruded material as it passes through the cooling chamber. Other conventional conveyance means also could be used.

In another embodiment, the cooling step could be conducted by passing the extruded material through a tunnel having a plurality of air jets so that air exiting the jets at high velocity impinges on the surface of the extruded material. The high velocity air acts to remove the solvent or water and cool the extruded material sufficiently.

In another embodiment, the cooling step could be conducted by contacting the hot extruded material with a cooled member, such as one or more cooled rollers, a continuously advanced cooled belt, or cooled particulates. In yet another embodiment, cooling could be achieved by contacting or spraying the hot extruded material with a liquid, such as water or alcohol, nitrogen, or a solid, such as dry ice particles, that will vaporize on contact (substantially without being absorbed) and thereby cool the material. In yet another embodiment, cooling could be achieved by passing the material through a cryogenic chamber that contains, for example, liquid nitrogen. In any case, the contacting temperature or quantity of cooling material applied is selected in view of the overall residence time to provide the desired uniform cooling. Any of the foregoing methods could be used singly or in combination, as necessary to cool rapidly the exterior surface temperature of the extruded material to provide a structure that is sufficiently stiff to pass the product through a cigarette type maker device. Further, the cooling chamber could be at least partially evacuated to aid in cooling.

DETAILED DESCRIPTION OF THE DRAWING

The Figure is a schematic view of an embodiment of the tobacco processing apparatus of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the Figure, an illustrative embodiment of the tobacco processing apparatus of the present invention is shown. The apparatus of the present invention includes drying cavity 2, and cooling chamber 3, placed in tandem, downstream of extruder 1 and the output of extruder barrel 13,

and upstream from smoking article forming device 4. Finely divided tobacco materials are input to input port 12 of extruder 1 at a controlled rate, from supply 7. Binder materials also are input to input port 12 of extruder 1 at a controlled rate. Water, from water supply 11, is input to extruder barrel 13 as necessary to maintain the desired moisture content in the mixing chamber. In other embodiments, the materials are mixed in a different order and fed to different input ports as discussed elsewhere herein in connection with prehydration mixing techniques. A means for advancing extruded material 20 through drying cavity 2 and cooling chamber 3 is provided. The advancing means is preferably adjusted to advance extruded material 20 at the selected rate of extrusion with substantially no relative movement between extruded material 20 and the contacting or supporting member of the advancing means. Alternately there may be some relative movement where constant tension on or compression of the extruded material is desirable.

The advancing means may comprise one or more conveyor belts operating at the same linear speed. The conveyor may be a supporting belt, a single belt that is folded about to envelope the extruded material, or opposing belts configured to retain and advance the material. Following the cooling section, puller means 5 may be used to feed and advance the leading edge of extruded material 20 into extruded material receiving funnel 14 attached to the input of conventional smoking article maker device 4. Puller 5 may be disengaged once the extruded material is advancing directly into maker device 4.

The method of the invention comprises drying the wet and pliable extruded tobacco-containing material in drying means 2 to about or below the ambient or other controlled level of moisture for the tobacco-containing material, cooling the dried extruded material in cooling means 3 to lower the surface temperature of the extruded material below the bulk temperature to form the tobacco containing material into an adequately rigid material that can be wrapped and severed cleanly into smoking articles. The surface temperature is typically lowered to between about -196°C and 85°C and the bulk temperature lowered to between about 20°C and 90°C. Cooling provides the surface that extends about the periphery of the extruded material with a case hardened semi-rigid structure so that it can be thereafter formed into smoking articles by maker device 4.

In one embodiment, the method of the invention includes mixing together finely divided tobacco materials, binder materials, water (or other solvent) and other desired additives in extruder 1 to create a thoroughly mixed slurry, extruding the slurry out the die at the end of the mixing chamber or barrel

13 of extruder 1 to form a cohesive extruded material, preferably having a rod-like configuration, drying the extruded material in drying cavity 2, cooling the extruded material in cooling chamber 3, and advancing the extruded material into maker device 4 for forming the desired smoking articles of, for example, substantially uniform dimensions.

In the preferred embodiment, the method of the present invention is adaptable for use in forming foamed extruded smoking articles comprising (a) from about 5 to about 98 wt.% of tobacco particles having a particle size of up to about 5 mesh, (b) from 0 to about 60 wt.% of a filler having a particle size of up to about 350µm, (c) from 0 to about 1.0 wt.% of a residual foaming agent, (d) from about 2 to about 40 wt.% of a binder selected from the groups of (1) cellulosic binders consisting of hydroxypropyl cellulose, carboxymethyl cellulose and its sodium, potassium, and ammonium salts, cross-linked carboxymethyl cellulose and its sodium, potassium, and ammonium salts, hydroxyethyl cellulose, ethyl hydroxyethyl cellulose, hydroxypropyl methyl cellulose, methyl cellulose, ethyl cellulose, and mixtures thereof; or (2) natural binders, modified natural binders, and synthetic binders consisting of pectin and its ammonium, sodium, and potassium salts, starch, guar, chitin, chitosan, and derivatives thereof, hemicellulose, xanthan, curdlan, a salt of xanthomonas gum, carageenan, alginic acid and its ammonium, sodium, and potassium salts, chitosan and its water soluble salts, oxycellulose, polyvinyl maleic acid polymer and its ammonium, sodium, and potassium salts, micro-crystalline cellulose, dextran, dextrin, malto-dextrin, fibrous cellulose, and mixtures thereof; or (3) a mixture of cellulosic, natural, modified natural, or synthetic binders, all the preceding ingredients being measured on a dry weight basis, and (e) from about 5 to about 20 wt.% water, the article having a density within the range of from about 0.05 to about 1.5 g/cc.

The tobacco used herein may be any type of tobacco and will generally be comminuted tobacco selected from the group consisting of bright, burley, oriental, and mixtures thereof, comminuted reconstituted tobacco, comminuted stems, tobacco dust or fines, and mixtures thereof. The tobacco may have been previously subjected to a stiffening or expansion process to increase its filling power. When tobacco particle sizes greater than 35 mesh are employed, it may be necessary to add a polyfunctional acid, such as citric or phosphoric acid and their ammonium, sodium, and potassium salts, during formation of the wet blend in order to achieve the desired appearance and foaming of the extruded article. The polyfunctional acid or its salts is added in an amount such that the smoking article contains from about 0.1 to about 15 wt.%

thereof, preferably from about 2 to about 10 wt.%. A typical binder combination is 5 wt.% hydroxypropyl cellulose, 2.5 wt.% carboxymethyl cellulose, and 2.5 wt.% starch. Another typical combination is 1 wt.% hydroxypropyl cellulose, 4 wt.% hydroxypropyl guar and 5 wt.% starch.

The article may also include as a filler any particulate material having a particle size of up to about 350 μ m that is compatible with the other components of the blend. The filler is preferably selected from the group consisting of calcium carbonate, magnesium carbonate, calcium oxide, magnesium oxide, calcium hydroxide, magnesium hydroxide, metallic aluminum, alumina, hydrated alumina, clay, diatomaceous earth, silica, and mixtures thereof and preferably is calcium carbonate.

The dried or equilibrated smoking article contains from about 5 to about 20 wt.% OV, preferably from about 8 to about 16 wt.%.

The smoking article comprises a porous structure that permits static burning and the passage of smoke (gas/aerosol) through the article to the smoker. The density of the article is related to the porous structure and the open cellular structure created in a single strand extruded product, or the voids created between the strands in a multistranded extruded product, and an article having a density within the specified range and having either type of air passageway provides good burn rate and transmission of smoke to the smoker.

The smoking articles may also include from about 0.001 to about 1 wt.% of an alcohol in which the cellulosic binder is soluble. That alcohol is selected from the group consisting of ethanol, methanol, isopropanol, n-propanol, and mixtures thereof. The alcohol present in the smoking article may result from adding alcohol during the formation of the article to lower the moisture content of the extrudate at the die or may be residual alcohol as a result of adding flavor casings.

The smoking article may also contain from about 0.1 to about 40 wt.%, preferably from about 0.5 to about 20 wt.%, of a cross-linking or stiffening agent. The stiffening agent which is preferably added prior to extrusion and then cross-linked during extrusion is selected from the group consisting of alginic acid, carboxymethyl chitin, pectinic acid, chitosan, carboxymethyl chitosan, water soluble salts thereof, malto-dextrins and mixtures thereof. From about 0.1 to about 10.0 wt.% of a water soluble salt of calcium, magnesium, and/or aluminum may also be used.

The smoking articles are preferably extruded and formed as generally cylindrical, coherent, single or multistrand articles having a diameter of from about 2 to about 35 mm, preferably from about 4 to about 25 mm. Alternate cross-sectional configurations may be made with an appropriate

die, for example, oval, star-shaped, cylindrical, and the like, or shaped appropriately in an additional post-extrusion process. A post-extrusion sizing die also may be used. These rods are typically made in conventional cigarette or cigar lengths and may be wrapped with cigarette paper, a cigar wrapper, or a co-extruded shell of combustible material or the like. The articles may be thus marketed as non-filtered "cigarettes" or as "cigars". A conventional filter may be joined to the "cigarette" by tipping paper to form a filtered smoking article.

Various flavorants and/or humectants that are commonly employed in the manufacture of smoking articles may be added prior to extrusion or may be subsequently added to the extruded article, for example, after the cooling step. An example of adding flavorants to a smoking material prior to being fed to a maker apparatus which is applicable to the present invention is found in European patent application No. 85305139.9, published on 26th February 1986 under No. 0172654. Other known methods also may be used, as known to those of skill in the art.

These tobacco containing articles are preferably made by mixing or blending together the tobacco particles with binder, filler, foaming agent, cross-linking or stiffening agent, and any other desired ingredient with water or other liquid to form a wet blend, and extruding the wet blend through a selected die in accordance with one of the following extrusion conditions such that (1) as the wet blend is extruded the moisture or other foaming agent in the blend is converted to steam or other gaseous product so as to foam the extruded material as it exits the die of the extruder; or (2) the wet blend is extruded to form a plurality of strands which are processed in a drying chamber under conditions that cause the moisture or other foaming agent in the extruded material to be converted to steam or other gaseous product, thereby foaming the material. When multistranded extrudates are formed, each strand must be foamed and randomly adhered to neighboring strands along their length, either by the foaming action or by the application of an adhesive in post extrusion processing.

Mixing may be carried out in any conventional mixing device and the resulting mixture is to be a wet blend containing from about 15 to about 50 wt.% of water.

As indicated in the Figure, the extruded material may be formed by (a) dry blending tobacco particles with binder, filler, foaming agent, cross-linking or stiffening agent, and any other desired ingredient; (b) admixing this dry blend with water to form a wet blend; and (c) extruding the wet blend

through a die having one or a plurality of holes in accordance with one of the extrusion conditions set forth above so as to foam the extruded material as it exits the die.

Alternately, the extruded material may be formed by (1) dry blending tobacco particles with filler, foaming agent, cross-linking or stiffening agent, and any other desired ingredient, (2) prehydrating the binder material with water or similar solvent to activate the adhesive character of the binder, (3) admixing the dry blend and the prehydrated binder to form a wet blend, and (4) extruding the wet blend through a die under any of the extrusion conditions set forth above, preferably so as to substantially foam the extruded material as it exits the die.

This procedure is used in conjunction with a twin screw positive mass displacement extruder having multiple feed ports (not shown). Step (2) prehydration is performed by adding the binder materials to a first feed port of the extruder and by adding the water or similar solvent to a second feed port a distance downstream of the first feed port so that as a charge of binder is inserted, it is processed, sheared, and homogenized as it progresses down the extrusion barrels. Then it is admixed with the water as it passes the second port, prehydrating the binder as the materials are displaced down the extruder barrel. Step (1), dry blending the tobacco, filler, and other materials occurs in a conventional mixing device and is added in a blended state to the extruder barrel by a third feed port, a distance downstream of the second port. Thus the prehydrated binder material from step (2) is admixed with the tobacco and other materials from step (1) in a continuous feed process. Because some extruder and mixing apparatus cannot generate the forces necessary to process and extrude the smoking article in accordance with the preferred procedure, it may be advantageous to dry blend with the binder a small amount of tobacco particles, preferably an amount less than 5 wt.% of the tobacco, a small amount of filler, or other added component, and then prehydrate the blended binder and tobacco or other components. The resultant wet blend will have a lower viscosity than if no tobacco or other component were present and may be more easily processed without significantly raising the moisture content of the mass.

Also, because the viscous prehydrated binder can become very sticky and adhere to the mixing equipment, it is advantageous to dry blend with the binder a small amount of tobacco particles, filler material, or both. The amount of tobacco added is preferably less than about 5 wt. % of the tobacco. The dry blend is then prehydrated, resulting in a

wet blend that has a reduced tendency to stick to the processing equipment and is relatively easier to process uniformly, as the material progresses from one step to the next.

Alternately, a portion of the binder may be dry blended with the tobacco and the balance of the binder prehydrated. Because of the relative surplus of water or similar solvent (later taken up by the dry blended tobacco and binder), the viscosity will be lower and the mass easier to handle. Although having a somewhat higher OV content than without cross mixing tobacco and binder in steps (1) and (2), the more efficient activation of the binder results in a dryer and stronger extrudate than that made without prehydrating the binder.

Optionally, a foaming agent may be added to the mixture, preferably selected from the group consisting of air, nitrogen, carbon dioxide, nitrous oxide, ammonium carbonate, ammonium carbamate, ammonium and/or sodium or potassium bicarbonate, an azide, a hydrazide, pentane, hexane, heptane, a halogenated fluorocarbon, pyrrole, acetone, ethanol, a peroxide, and azodicarbonamide. Some of these foaming agents may require the addition of an acid or a base for decomposition, and the use of a foam stabilizer and/or a suitable surfactant such as licorice, yucca or yucca extracts, sodium lauryl sulfate, etc.

Extruder 1 may be any conventional extruder having input apertures for materials, mixing chamber or barrel 13 for thoroughly mixing the tobacco slurry ingredients and a die output. Typical extruders include, for example, Wenger Model X-20 single screw cooker/extruder, a Manley collet-type extruder, or twin screw extruders such as those made by Werner and Pfleiderer, C. L. Simon, and Baker Perkins (Models MPF-50D and MPF-50L).

The ingredients of the selected tobacco containing slurry are mixed together in accordance with any procedure and extruded as a cohesive mass, preferably as a foamed product. The extruded material, foamed or not, is moist and pliable, typically having an OV content in the range of 17-28%, depending on the processing conditions used. Particular methods, alternate formulations, and additional details regarding foamed, extruded materials are discussed in U.S. Patent No.4 510 950 and European Specification EP-A-0167370.

The preferred foamed extruded material foams as it exits the die, giving off large quantities of steam, which may have a slight cooling effect on the extruded material, but the bulk temperature will be typically at about, and probably just below, the flash point of the liquid used. These hot, moist materials exhibit little or no rigidity and have tacky surfaces. They deform easily and cannot be wrapped or manipulated into smoking articles having a substantially uniform density or consistency.

In accordance with the present invention, these extruded materials are immediately passed through drying chamber 2 to lower the moisture content to at or below the equilibrium moisture content level. Microwave drying is preferred because: (1) it dries the material fast and uniformly; (2) it can cause any foaming agent or residual foaming agent present to volatilize to foam, or additionally or more completely foam, the product; (3) it rapidly dries the material without adversely affecting the foamed structure once all the foaming is complete; (4) it can be used to dry materials extruded at high rates of speed, for example, 50-250 meters per minute, in a short period of time using equipment occupying little floor space, e.g. 3 meters; and (5) it is more energy efficient than prior art drying ovens because the energy required to dry the material is applied directly to the material at the necessary energy density and is not wasted in having to also heat long chambers or large volumes of air.

In the preferred embodiment, where the extruded material is in the range from about 10-20mm upon exiting the die (8mm in final diameter), two substantially identical microwave energy sources and cavities are used, for example Model 56F, manufactured by Cober. These models each have a power capacity of about 6kw and operated at 2450 MHz. The microwave cavity dimensions also are the same being about 127 mm × 82.55 mm × 146.05 mm, having the input and output apertures of both cavities in axial alignment and a distance of about 864 mm separates the output and input walls of the two adjacent cavities. Equivalent models or a single microwave unit having the equivalent total power capacity may be used in the alternative. For other configurations of extruded materials, e.g., sheets, greater power may be required to dry adequately the extruded material, as may be determined empirically.

Other known frequencies capable of exciting the resonant frequency of the molecules of the moisture or other liquid or foaming agent in the extruded material for volatilizing these molecules could be used. Vent means 25 is provided to exhaust the moisture, liquid or other foaming agent volatilized during drying, and foaming, if any, to thereby facilitate drying. Endless conveyor 17, comprising a nonconductive material that does not appreciably interfere with the passage of microwave energy therethrough, e.g., polyester, nylon, etc., may be used to support the extruded material as it passes through the drying cavity.

Cooling chamber 3 may comprise air conditioner 15, air fan 16 and conveyor belt 6. Air conditioner 15 may be any conventional air conditioner capable of providing refrigerated air such as, for example, a Comfort Aire, 3 ton unit, manufactured by Heat Controller Inc., Jackson, Michigan.

Air fan 16 is designed to distribute the refrigerated air at a selected flow rate along and preferably perpendicular to the path extruded material 20 follows as it advances across endless conveyor belt 6. Conveyor belt 6 is preferably perforated. The distribution of refrigerated air may be relatively uniform or it may be graduated so that there is more or cooler air at one location along cooling chamber 3 than another. In an alternate embodiment, the direction of cool air flow may be incident or parallel to the extruded material. Air fan 16 and air conditioner 15 may be incorporated into a single unit.

In an alternate embodiment, cooling chamber 3 may be an air impinging tunnel such as an Air Miser manufactured by Huestis Machine Corporation, Bristol, Rhode Island. Such a device could be used to impinge air at high velocity on the surface of the extruded material through a plurality of air jets, to cool the air and dry and cool the extruded material. Other cooling means could be used such as cryogenic baths, cold contacting members and other techniques for removing heat from the extruded material.

In one embodiment, the drying and cooling are coordinated so that the resulting product has an OV content below the equilibrium OV content. This permits wrapping the extruded material with a conventional wrapper while it is in a more dry condition so that when the extruded material equilibrates, the extruded material will absorb some moisture and expand slightly and tighten against the wrapper. This will substantially prevent the wrapper from falling off the smoking article, e.g., in low humidity environments, and give the product the look and feel of a conventional cut tobacco-filler smoking article.

The present invention is particularly adaptable to preserving tobacco flavors and characteristics originally present in the tobacco that heretofore have been lost due to volatilization during extrusion and heating. The flavors are preserved by cooling the extruded material rapidly after drying and thereby reducing the temperature below the volatilization temperature of the flavors. This minimizes the volatilization of the flavors that previously were lost. Further, flavors or other additives that would not or do not survive the extrusion, foaming and drying conditions and temperatures can be added to the extruded material immediately after the cooling step, without significant loss due to volatilization. These additives can be metered onto the passing extruded material in an efficient manner by conventional equipment.

Foamed products create a thermal barrier that somewhat inhibits cooling the interior of the extruded material. By cooling the exterior rapidly, a thermal gradient is created across the cross sec-

tion. Thus, by maintaining the exterior relatively cooler than the interior, the natural flavors of the original tobacco and the additives and flavours in or added to at least the substantially cooler periphery of the extruded material may be preserved. The loss of flavors from the relatively interior extruded material is therefore less significant and can be compensated for accordingly.

Maker device 4 may be any commercially available cigarette manufacturing device, such as a Mark 8 or a Mark 9 Cigarette Maker manufactured by the Molins Company, or an equivalent Hauni Model, modified appropriately by, for example, removing the hopper. Other smoking article forming devices (not shown) could include apparatus such as grinders, slitters, shredders or the like used for processing the dried and cooled extruded material, preparatory for use in forming typical smoking products, e.g., pipe, smokeless, cigarette or cigar tobacco. In the preferred embodiment, the extruded material is fed directly from cooling chamber 3 into the garniture of a Mark 8 Cigarette Maker which was modified by removing the chimney section and replacing it with funnel 14 disposed for receiving the extruded material in either a single or multi-stranded rod-like form, before or after the rod like material is wrapped conventionally, if at all, and fed into the garniture. After the garniture, the rod is severed by the cut off knife into substantially uniform lengths appropriate for formation into smoking articles and removed by the revolving take off wheel for subsequent handling in accordance with conventional cigarette-type smoking article forming methods and apparatus.

Puller apparatus 5 may be a pinch roll feed type puller or a pair of opposing endless advancing belts designed and operated for use in start up conditions for feeding the leading edge of the extruded material into funnel 14. Puller 5 operates to maintain slight tension on the extruded material across cooling chamber 3 during start up. Once the extruded rod has been fed into funnel 14, and into the garniture so that the garniture pulls on the rod, puller 5 is typically disengaged and the opposing belts separated to prevent damaging the extruded material by exerting forces on the material as the material advances. Commercially available pullers are available from Versa Machinery Division, Foster & Allen Inc., Sommerville, New Jersey, e.g., Model CM22.

The driven apparatus, conveyor belt 17, conveyor belt 6, puller 5, maker device 4, and extruder 1 may all be synchronized by a tachometer (not shown) or equivalent timing means to the drying capacity of microwave cavity 2. The drying capacity can be adjusted for the desired process conditions and the desired extruded material moisture characteristics, primarily by changing the power

level of microwave energy propagated into the microwave cavities. Additional cooling means may be required at higher rates of speed when large amounts of microwave energy are used to dry the material. Thus, for the given rate of advance of the extruded material, and the related residence time of the extruded material in the microwave heating cavity, the desired OV level can be achieved. For example, drying extruded material having about an $8.0 \pm .1$ mm diameter and advancing at about 182 meters per minute from 20% OV to less than 6% OV can be achieved using a total of about 10 kw of power distributed between the two microwave cavities. Using 9kw of power resulted in an OV content of about 8%.

The method of this invention further contemplates performing the foregoing operations using the described apparatus at high rates of speed so that the tobacco slurry ingredients can be continuously mixed, extruded, dried, cooled, and formed into smoking articles continuously in a single work station area on the factory floor. The foamed extruded material of the preferred embodiment can be produced at rates from zero to in excess of about 200 meters per minutes in a rod of about 8 mm in diameter. These rates are well within the capacity of conventional cigarette maker devices.

EXAMPLE

To illustrate further the present invention, the following representative example is presented.

The formulation of minute, finely divided tobacco particles, binder materials, and water were fed to their respective input ports of a Baker Perkins Model MPF-50L twin screw extruder. The tobacco was fed at a rate of about .82 kg/min of tobacco dust. The binder mixture was 1% klucel, 4% hydroxypropyl guar, and 5% starch, premixed to form a blend that was fed at a rate of .09 kg/min. The tobacco and binder were mixed together and added to a common port of the extruder mixing barrel. Water was added downstream at a rate sufficient to maintain about 20-23% OV in the mixing barrel of the extruder. The OV content of the extruded material as it exited the die was measured to be about 17.2%. The bulk temperature was about 130°C and the surface temperature was about 95°C. The extruded material was passed through twin microwave cavities at a speed of about 124 meters per minute. The drying cavity included a first and second microwave cavity with the first cavity and second cavities set at a combined power level of 7kw. The OV content of the extruded material as it exited the drying cavity was

at about 10.9%. The surface temperature of the extruded material was 61.7°C and the bulk temperature was 91.7°C. The dried extruded material possessed little or no rigidity.

The extruded material was then passed through a cooling section that was about 4.6 meters long. Refrigerated air chilled to 15.5°C was generated and blown perpendicular to the extruded material at a velocity of 104 meters per minute. The extruded material was cooled to a surface temperature of about 46.7°C and a bulk temperature of 85°C. The OV content dropped to 9.9%. At this point, the extruded material possessed sufficient rigidity to be cut and wrapped using the modified Mark 8 maker. The bulk temperature of the resulting wrapped cigarette rods of dried and cooled extruded material was about 57°C.

In the course of experimentation, it was discovered that the total microwave energy absorbed by the extruded material was more important than whether the two microwave cavities produced the same energy level, or which unit provided more power. For example, substantially the same results were found when the first unit produced 3kw and the second unit produced 4kw, as when the first unit produced 4kw and the second unit produced 3kw. Similar results were found with the power divided into 2kw in one unit and 5kw in the other unit. It was also discovered that for every additional kilowatt of microwave energy absorbed, the OV content would be lowered by about 1.2%. Lowering the power similarly resulted in a higher OV content. Typical extrusion rates for the preferred tobacco-containing materials include from 270 to 455 meter/min, but faster or slower rates are possible within the limits of the equipment. These materials can be dried to desired moisture levels of between about 8% and 14% by using from about 5 kw to 10 kw, distributed between the two microwave cavities. Cooling the extruded materials using refrigerated air cooled to temperatures in the range of from about 1°C to 16°C and blown across the material at velocities of from about 50 to 150 meter/min was sufficient to cool the dried extruded material for wrapping and forming.

Claims

1. A method of processing continuously-extruded tobacco-containing material wherein the extruded material coming from the extrusion die is dried by exposure to microwave energy, characterized in that the OV level of the extruded material is reduced by the microwave drying to a level at or below the equilibrium OV level and the extruded material is subsequently cooled so that the surface temperature is decreased substantially below the

bulk temperature, thereby providing the extruded material with a structure adequately rigid and stable dimensionally for forming into smoking articles.

2. A method as claimed in claim 1 in which the microwave drying is affected by passing the extruded material in succession through two or more drying chambers supplied with microwave energy at separately controllable power levels.

3. A method as claimed in claim 2 in which the gaseous products produced by exposure of the extruded material to microwave energy are exhausted from between adjacent drying chambers.

4. A method as claimed in claim 1, 2 or 3 in which cooling is effected by passing across the extruded material a flow of air cooled to below room temperature.

5. A method as claimed in any of claims 1 to 4 wherein cooling the extruded material comprises reducing the surface temperature to a temperature in the range between about -196°C and 85°C and reducing the bulk temperature to a temperature in the range between about 20°C and 90°C.

6. A method as claimed in any of the preceding claims further comprising wrapping the extruded material with a conventional wrapper material after it has been cooled and before it has been formed into smoking articles.

7. A method as claimed in claim 6 wherein the extruded material has been dried to a moisture content below the equilibrium moisture content level before wrapping so that when the extruded material equilibrates it will expand against the wrapper to form a tight wrap.

8. A method as claimed in any of the preceding claims further comprising adding an additive to the extruded material after the extruded material has been cooled to a temperature below the volatilization temperature of the additive, said additive modifying the characteristics of the resultant smoking article.

9. A method as claimed in any of claims 1 to 8 characterized in that the material for extrusion is produced by mixing together from 5 to 98wt.% of tobacco particles having a particle size of up to 5 mesh and an OV value of from 3 to 20%, from 0 to 60 wt.% of a filler having a particle size of up to 350 m, from 0 to 50 wt.% of a foaming agent including any solvent or vehicle other than water, and from 2 to 40 wt.% of a binder all on a dry weight basis and adding water to form a wet blend containing from 15 to 50 wt.% of water.

10. A method as claimed in claim 9 wherein the wet blend is extruded through a die under extrusion conditions of temperature and pressure such that as the wet blend is extruded the moisture or other foaming agent in said blend is converted to steam or other gaseous product as to foam the extrudate.

11. A method as claimed in claim 9 or 10 wherein the wet blend is formed by dry blending the tobacco particles, filler, foaming agent, and binder, and admixing the dry blend with water to form the wet blend.

12. A method as claimed in claim 9 or 10 wherein the wet blend is formed by

(1) dry blending the tobacco particles, the filler and foaming agent,

(2) prehydrating the binder,

and (3) admixing the dry blend from step (1) with the prehydrated binder from step (2) to form the wet blend.

13. A method as claimed in claim 12 wherein a relatively small portion of the binder, in an unhydrated state, is added to and dry blended with the dry blend of step (1) to reduce the viscosity of the prehydrated binder from step (2) and to reduce the tendency of the prehydrated binder to stick to the processing equipment.

14. Apparatus for processing continuously advancing extruded tobacco-containing material having an OV content greater than the equilibrium OV content, comprising:

means for drying the extruded material as they exit the extruder, including a source of microwave energy, a cavity associated with the microwave energy source having an input aperture an output aperture for passing the extruded material therethrough, and means for propagating the microwave energy into the cavity, said drying means being capable of reducing the OV content of the extruded material to an OV level at about or below its equilibrium moisture level as it exits the output aperture;

means for cooling the extruded material, said cooling means being capable of reducing the surface temperature of the extruded material below the bulk temperature to form, a structure adequately rigid and stable dimensionally adaptable for forming into smoking articles; and

means for supporting and conveying the extruded means from the extruder through the drying and cooling means.

15. The apparatus of claim 14 wherein said source of microwaved energy and associated cavity, further comprise a first source and associated cavity and a second source and associated cavity, arranged in tandem, so that the extruded material passes through the first cavity and the second cavity.

16. The apparatus of claim 14 or 15 wherein the cooling means comprises:

a chamber;

a source of refrigerated air; and

a fan for directing the refrigerated air into the chamber and across the advancing extruded material.

The apparatus of claim 14 or 15 wherein the cooling means comprises:

a chamber;

a supply of cooling material capable of being vaporized upon contact with the heated extruded material; and

means for applying an amount of cooling material to the advancing extruded material at a rate that permits the cooling material to be substantially vaporized upon contact with the extruded material and thereby cool the extruded material.

18. The apparatus of claim 14 or 15 wherein the cooling means further comprises:

a refrigerated contacting member capable of absorbing heat from the extruded material; and

means for contacting the extruded material with the refrigerated contacting member and thereby cool the extruded material.

19. The apparatus of claim 14 or 15 wherein the cooling means further comprises:

a vacuum chamber;

means for passing the extruded material through the vacuum chamber; and

means for applying a partial vacuum to the surface of the extruded material inside the vacuum chamber so that a substantial amount of the residual water or other solvent is vaporized, thereby cooling the extruded material uniformly.

20. The apparatus of claim 14 or 15 wherein the cooling means further comprises:

a cryogen bath; and

means for passing the extruded material through said cryogenic bath to cool the extruded material.

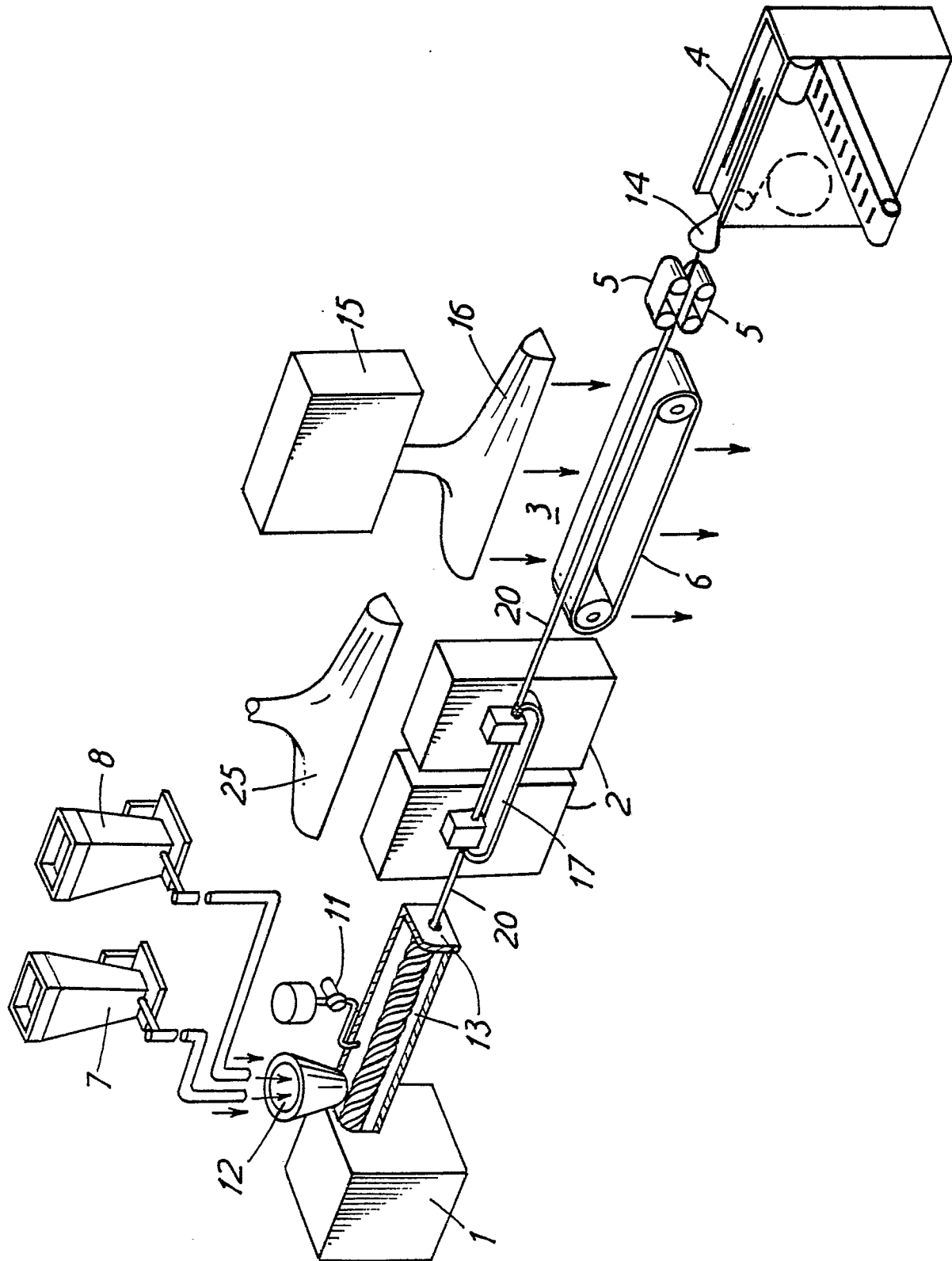
21. The apparatus of claim 14 or 15 wherein the cooling means further comprises:

a chamber through which the extruded material passes;

a source of air;

a plurality of air jets disposed about the chamber and arranged to impinge upon the surface of the extruded material; and

means for passing said air through said plurality of jets to impinge upon the extruded material to dry and cool the extruded material in a uniform manner.





EP 86 30 4214

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A,D	EP-A-0 167 370 (PHILIP MORRIS INC.) * Claims 1,13-15,17; page 23, line 32 - page 24, line 8 *	1,9,10 -14	A 24 B 3/14 A 24 B 15/14
A,D	--- US-A-4 510 950 (KERITSIS) * Abstract; column 8, lines 47-63 *	1,9-11 ,14	
A	--- US-A-3 223 090 (STRUBEL) * Claim 1 *	1,14	
A	--- US-A-3 968 804 (KENNETH KELLY) * Claim 1 *	1,14	
A	--- DE-A-1 757 666 (KORBER) * Page 3, line 16 - page 6, line 2 *	1,14	

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 06-02-1987	Examiner RIEDEL R.E.
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			