United States Patent

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[54] **EXTRUDING TOW FILLED MOUTHPIECE ROD HAVING SERRATED INNER SURFACES CLENCHING THE TOW**
2 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **156/178,** 156/198, 156/199, 156/213, 156/244, 156/294, 131/10
[51] **Int. Cl.** **B32b 5/00**
[50] **Field of Search** 156/166, 178, 244, 293, 294, 303.1, 198, 199, 213; 131/10

[56] **References Cited**

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ABSTRACT: A method with which a continuous length, tubular article filled with a tow of a fibrous material and having serrated or grooved inner surfaces clenching the tow is disclosed. The article is formed by extruding thermoplastic material as a tubular sheath having a smooth inner surface at extrusion around an advancing tow of fibers, the serrations or grooves being formed by spraying a cooling fluid against the inner wall surface of the plastic sheath at circularly spaced locations therein as it leaves the extrusion aperture. The cooling fluid functions to chill and set the inner wall surface sufficiently so that when the tubular sheath is thereafter pulled down from an initial to a final size, the sheath will pull down to a lesser extent at said spaced locations than at the still more plastic surfaces intervening said spaced locations thereby forming longitudinal grooves in the sheath inner wall surface.

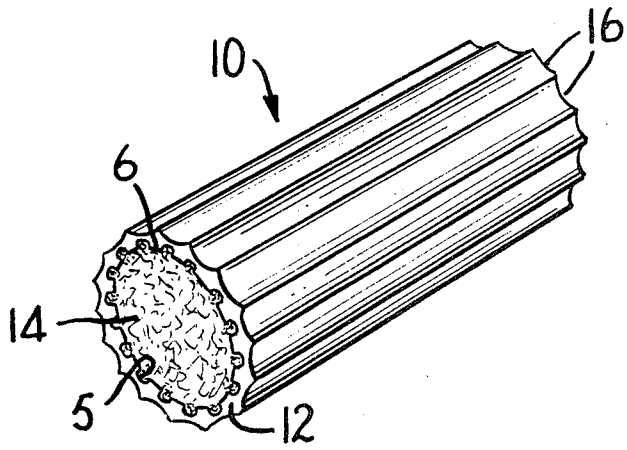
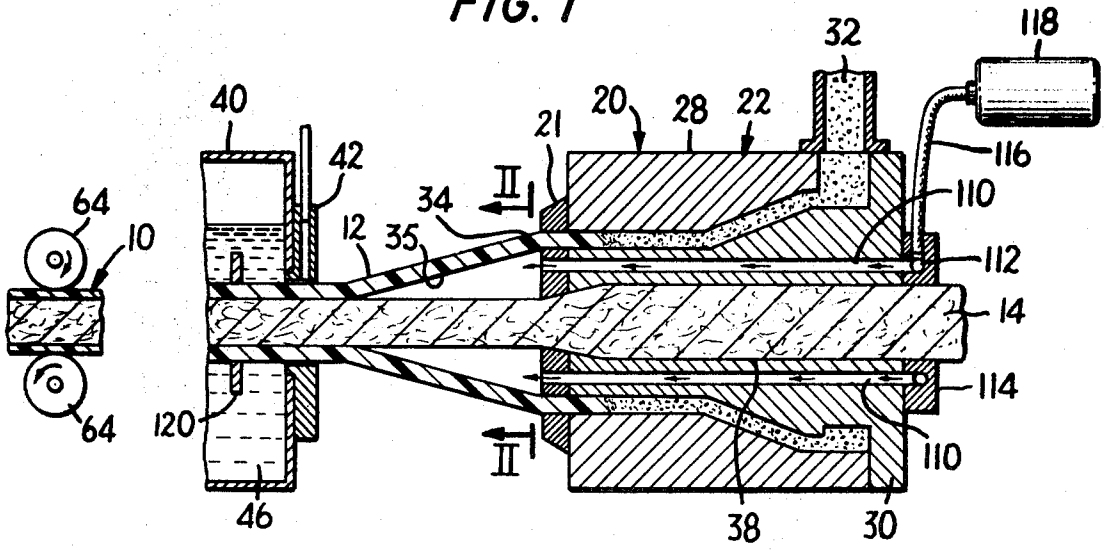


FIG. 1



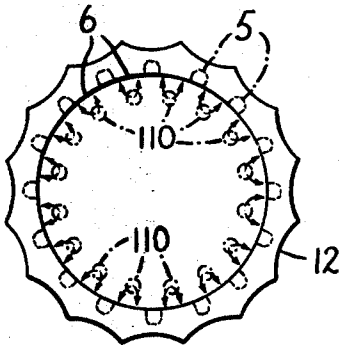


FIG. 2

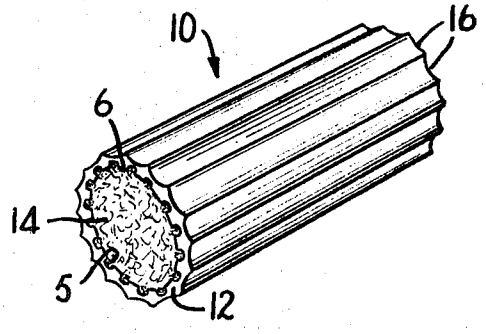


FIG. 3

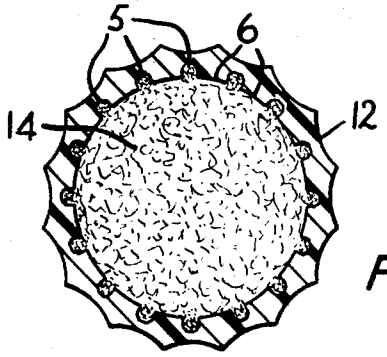


FIG. 4

EXTRUDING TOW FILLED MOUTHPIECE ROD HAVING SERRATED INNER SURFACES CLENCHING THE TOW

BACKGROUND OF THE INVENTION

The present invention is concerned with forming in continuous operation, a filled tubular article, such as cigarette filter rod. It is common practice in the cigarette-making art to form filter rod in a continuous operation by wrapping a continuous tow of filaments of a filter medium, most usually cellulose acetate, in a continuous paper wrapper customarily referred to as "plug wrap." However, this known method of making cigarette filter rod has shortcomings which makes it unsuitable for use in modern cigarette-making technology where very high manufacturing speeds are desirable. For example, the use of an adhesive joint or seam usually limits production line speed to a speed not greater than about 300 feet per minute.

A filter rod overcoming the aforementioned problem is described in presently pending application Ser. No. 747,279 filed July 24, 1968 by Richard N. Thomson et al. The mouthpiece described in said application is made by extruding plastic over a tow of fibers. The advantages of making mouthpiece rod in this manner are numerous particularly with respect to the accurate control of rod size as well as improved uniformity of product manufacture. However, certain uses of the filter rod described in said Thomson et al. application make it desirable that enhanced securement of the tow within the plastic sheath be provided to enable it to withstand higher gas flow pressure therethrough than normally encountered in the smoking of a cigarette.

SUMMARY OF THE INVENTION

The present invention is concerned with a method with which a thermoplastic tubular article filled with a gas or liquid pervious filler such as a tow-filled cigarette filter rod can be produced in continuous length by continuous forming operation, the production of the article being characterized by procedures which enable formation on the inner wall surface of the rod of longitudinally directed grooves which serve to clench or anchor the tow to the plastic in which it is enclosed. The article itself is of novel character and is susceptible to uses for purposes other than merely as a filtering device in a smoking article particularly for such uses as involve passage of fluid at relatively high pressure through a filter device. The invention is further characterized by a constancy of processing in the finished product as well as density of the filter medium enclosed within the tubular plastic workpiece.

In accordance with the present invention, filter rod is made by extruding a tubular, preferably circular section thermoplastic workpiece in continuous operation from an extruder die, the extrudate leaving the die at a diameter somewhat greater than that of the hardened finished workpiece but with an external shape substantially conforming to that of the finished product and with a smooth inner wall surface. Simultaneously, a partially compressed tow of filaments of a filter material is advanced axially into and in codirectional movement with the plastic extrudate as the latter leaves the forming die. The tow of filaments is not connected by the extrudate until the latter has advanced some distance downstream of the exit aperture of the die from whence it issues, the first contact being made when the extrudate is drawn down against the tow, to form a sheath covering the latter and as the two enter the portal gland of a cooling chamber in which heat is removed from the plastic extrudate and the latter is sized so that its external dimension and shape are accurately controlled within prescribed limits. To form longitudinally extending grooves intervened by lands on the inner wall surface of the workpiece, streams of a cooling fluid are sprayed against said inner surface in correspondence to the locations of the lands. Thus the surfaces defining lands immediately are chilled sufficiently to initiate a setting of them. Thereafter when the workpiece is drawn or pulled down from an initial to a final smaller size, the sheath will pull down or stretch to a lesser extent at the surfaces which were sprayed with the cooling fluid than at the wall surfaces intervening the sprayed surfaces. The greater degree of pulldown or stretch of the sheath at the unsprayed surfaces thereby forms circularly spaced grooves on the sheath inner wall surface in which the tow filler becomes anchored. The character of the anchorage of the tow within the sheath is such as to prevent blowout of the tow when subjected to passage through the article of a gas or fluid flow at pressures substantially above those normally encountered in the testing and smoking of cigarettes thereby making the article more suitable for those purposes but also adapted for other uses including filters for media other than smoke. The apparatus and procedure by which the cooling of the extrudate to set its external surface in the manner aforesaid is the same as that described in the presently pending U.S. Pat. application of Charles Gatto, Ser. No. 747,370, filed July 24, 1968.

In accordance with the present invention and also as described in the earlier mentioned Thomson et al. application, various types of material may be used as the filler and various types of thermoplastic material can be utilized for the tubular workpiece in which the filler is sheathed. Most commonly, however, cellulose acetate is employed as the filter medium. For the purpose of providing uniform density and overall cohesive character to the filler, it is customary as is also done in prior art filter rod making methods, to treat the filaments thereof with a plasticizer to thereby promote interfiber bonding of the various filaments comprising the tow.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWING

A fuller understanding of the nature and objects of the invention will be had from the following detailed description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a vertical sectional view of apparatus with which the tow-filled rod of the present invention is formed.

FIG. 2 is a transverse sectional view through the tubular workpiece as it leaves the extrusion aperture of the extruder shown in FIG. 1, the view being taken along line II–II in that Figure.

FIG. 3 is a perspective view of a representative length of the tow-filled filter rod made according to the invention.

FIG. 4 is an end view of the length of rod shown in FIG. 3 illustrating the manner in which the tow is clenched in the grooves of the plastic tubular workpiece.

Throughout the following description like reference numerals are used to denote like parts in the drawing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is concerned with a method for forming filled plastic tubing in continuous operation, as for example, a continuous hollow tube having the bore thereof filled with a tow of fibrous material. It is more particularly concerned with an improvement in the method and article described in the aforementioned Thomson et al. patent application. The article of the present invention is useful as a device for filtering gaseous or liquid media including cigarette smoke, but because of the manner of clenching the tow in the grooves in the plastic sheath, the article is particularly suited for use as a gas or fluid filter wherein high flow pressure is encountered. Furthermore, the article lends itself for use as an ink cartridge, a hospital throwaway antiseptic swab and similar inexpensively mass produced fibrous material filled devices. Turning now to a description of a representative embodiment of the invention reference is made to FIG. 3 wherein it will be noted, the filter rod **10** is comprised of a thin-walled plastic sheath **12** of generally circular section, which encloses a filler **14** such as a tow of filaments of cellulose acetate, the

tow functioning as a filter medium. The overall diameter of the depicted sheath **12**, which is intended for embodiment in a cigarette, is approximately 0.3 inch with a wall thickness ranging between 0.005 inch to 0.015 inch–0.020 inch although it will be understood that variations in these dimensions can occur depending upon the intended use of the article. The rod shown in FIG. **3** for example, can be employed as the mouthpiece component in the ventilated cigarette described in presently pending U.S. Pat. application Ser. No. 632,336 filed Apr. 20, 1967. As will be noted, the sheath **12** is provided at its inner wall surface with an alternating arrangement of grooves **5** and lands **6** intervening said grooves with the grooves **5** serving to receive the filler **14** and functioning as anchorages or clenching means to secure more firmly the filler within the sheath. By providing a greater measure of anchorage of the filler, the filter rod is capable of withstanding considerable fluid or gas pressure flow therethrough.

The rod **10** shown in FIG. **3** desirably has an external dimension within prescribed limits and when used as a filter plug for a ventilated-type cigarette, the circumference of a circle circumscribing the peaks of the flutes **16** preferably should measure 23.9 mm.±0.05 mm. The reasons for controlling this circumferential dimension with such accuracy are set out more elaborately in the earlier mentioned application of Charles Gatto, but in brief it is done so as to minimize conditions which can cause upset in cigarette-making machinery when the filter plugs are joined with tobacco cylinders.

FIG. **1** illustrates apparatus denoted generally at **20** with which cigarette filter rod **10** of the present invention can be made. The apparatus **20** is generally similar to that described in said earlier filed Gatto application being modified to the extent of the construction of the extrusion die details of which will be given shortly herein. As a preliminary to forming the cigarette filter rod **10**, the filter medium which is described in representative form as being a tow of filaments of cellulose acetate is fed through a blooming and coating chamber (not shown) wherein the filaments are coated with a plasticizer comprising by way of example, a solution of 3%–12% (but preferably 9%) triacetin. The plasticizer is employed to promote interfiber bonding in the tow at the points of crossing or contact of the respective fibers and thereby produces cohesiveness in the mass of the tow. The tow is advanced through a suitable feed device to relieve all but a slight tension of about 20–50 grams pull in the tow feed in the longitudinal direction since it is preferable that the tow be processed with but a minimum of tension being present therein. The tow is then partially compressed and shaped in known manner into a generally continuous cylindrical body just prior to delivery of same to the crosshead die. The tow entering the die has a diameter larger than the intended final internal dimension of the sheath **12** but, and for reasons as will appear, has a diameter smaller than the internal diameter of the extrudate leaving the die. The extruder die which is a crosshead-type includes a body part **28** wherein is supported in known manner a mandrel **30**, the mandrel being spaced from the internal bore of the body part **28** so as to define therewith an annular space in the body part in which can be received molten plastic **32** entering the crosshead die laterally from a reservoir (not shown). Depending on the speed with which the extruder screw (not shown) feeding the molten plastic **32** is rotating, a continuous tubular stock **12** of heated plastic issues from and is conveyed away from the mouth or extrusion aperture of the extruder die as at **34** by means of puller rolls **64** downstream in the apparatus line, the extrudate upon exit from the extrusion aperture having cross-sectional dimensions substantially larger than the intended final cross-sectional dimensions of the finished filter rod and being sufficiently heated to be plastically deformed and the inner surfaces as at **35** being tacky or in a plastic state. Also, the extrudate possesses at that point an external surface configuration in substantial conformance with that of the finished product and to that end, the crosshead die **22** may be fitted with a suitable shaping means to impart the required external configuration to the extrudate. As for example, a faceplate or adapter **21** can be removably secured to the housing **28**, the adapter having an extrusion aperture designed to produce the particular internal and external surface configuration on the extrudate. Simultaneously, with the issuance of the tubular workpiece **12** from the die, the compressed tow **14** of filter medium transits through a central cylindrical passage formed in the mandrel as at **38**. The tow upon leaving the die **22** advances axially into and codirectionally with the extrudate, the tow mass having at that point a diameter at least slightly greater than the inside diameter of the sheath when the latter is fully processed. As will be noted the codirectional movement of the extrudate **12** and tow **14** downstream of the point of exit from the crosshead die **22** is for some short distance one in which the hot extrudate does not contact the tow. The foregoing is provided to allow the extrudate to be drawn down in size in that distance of travel with the extrudate making first contact with the tow only as the composite structure enters the closing aperture of portal gland **42** of the cooling chamber **40**. In drawing down the heated extrudate, its overall sectional dimensions can be reduced as much as 100 percent from the initial as extruded dimensions to the smaller final rod dimensions. For example and with respect to rod **10** as used for a cigarette component, the sheath **12** generally will have at extrusion, a wall thickness of 0.050 inch, whereas after drawing down, the sheath at its thicker portions generally has a thickness in the range 0.005–0.015 inch.

In extruding the tubular workpiece or sheath **12**, the present invention makes it possible to form the longitudinally extending grooves **6** on the inner surface thereof as part of the extrusion operation in a relatively simple yet highly effective manner. Mandrel **30** is provided with a circle of passages **110** extending therethrough from end to end and being in communication at one end with a manifold **112** formed in plate **114** and outletting as ports **121** at the other end adjacent the aperture from whence issues workpiece **12**, such outlet being at the inside of the workpiece. Manifold **112** is connected by means of a conduit **116** with a source **118** of compressed air or other fluid under pressure. Such other fluid of course would be one compatible with the overall forming procedure. For example, the plasticizer with which the tow is coated might be used for the purpose of cooling although it will be understood that gaseous coolants are preferred. Thus, it will be noted that as the heated extrudate **12** issues from the extrusion aperture, cooling streams of air are sprayed against the smooth inner wall surface thereof at a circle of locations as shown in FIG. **2** in correspondence to the locations of the lands **6**, the streams preferably issuing in a direction parallel to extrusion axis. The effect of the cooling jets of air striking said surfaces is to chill them and initiate a certain degree of set or hardening of these surfaces. The degree of set initiated is such that when the workpiece is thereafter pulled down as it advances toward and through the closing aperture, the sheath will pull down differentially, that is, to a lesser extent longitudinally along the surfaces defining the lands **6** than at the surfaces intervening said lands. Thus the sheath will pull down disproportionately along the adjacent longitudinal bands defining the lands and grooves, the greater pull down at said intervening surfaces forming the grooves **5**. The overall pull down of the inner wall surfaces which form the grooves is shown in dashed lines in FIG. **2**. As the sheath is pulled down in size the tow at the surface of the mass thereof becomes clenched in the grooves **5** providing an anchoring of the mass. Moreover, the tow becomes adhered to the tacky surfaces in the grooves to secure the mass within the sheath. Since the grooves provide an increased surface area at which such adhesion can occur, they enhance the total character of the tow anchorage. The tow also adheres to the surfaces of the lands **6** since while the setting of these surfaces has been initiated by spraying them with cooling fluid, they retain sufficient tackiness to effect this additional adhesion.

Cooling of the composite article occurs as it enters the cooling chamber **40** through portal gland **42**, with the plastic

sheath being drawn down sufficiently and uniformly tightly against the tow and to about the optimum final dimension it is intended to have on entry to the gland. In pulling the sheath down, the tow mass of filler **14** is subjected to a further and final radial compression. As was indicated earlier, the portal gland serves as a closing aperture having substantially the same diameter and shape as the final external diameter of the sheath. Thus in the finished article, the sheath **12** will enclose the tow mass with a positive constraint of the latter and the tow will invest fully the anchorages provided by the grooves **5**.

In its passage through the cooling chamber, the composite article is submerged in the bath of cooling water **46** and passes through a series of apertured sizing plates in the manner taught in the earlier mentioned Gatto patent application to control accurately the circumferential dimension of the sheath **12**, one such plate **120** being shown. In effecting the sizing of the sheath which is done in the same manner as described in the prior mentioned Gatto application, the sleeve can be subjected to an internal pressure that tends to expand it radially to thus hold same tightly in sizing relationship with the sizing plates. The force of expansion is provided by maintaining the cooling chamber **40** and the fluid **46** therein under a condition of vacuum whereas the space enclosed by the sheath can be communicated with atmospheric pressure, in addition to having the presence of pressurized air therein introduced as the cooling streams to set the workpiece inner surface as earlier described.

On leaving the cooling chamber **40**, the sheathed article passes between the puller device wheels **64** which feed the article through a cutting unit (not shown) wherein the continuous length article can be cut into short lengths as shown in FIG. **2** and adaptable for use in further processing such as utilization in cigarette-making machines.

The tubular article produced according to the present invention is advantageously employed as the mouthpiece component of a ventilated cigarette. It is also suited for use as a filter for other purposes including in hydraulic systems wherein relatively high fluid pressure is to be encountered. A 10 mm. long cigarette filter plug made from rod produced by the present invention was subjected to both a negative pressure of almost absolute vacuum and a positive pressure of 25 p.s.i.g. without noticeable pullout of tow from the sheath. The tow of filters preferably is comprised of a plurality of filaments of cellulose acetate extending longitudinally and coextensively of the tow mass. When used in conjunction with a polyethylene mouthpiece for a ventilated cigarette of the type previously described the cellulose acetate preferably should have a total denier of 25,000 to 75,000 but more preferably in the range of 30,000 to 50,000 the foregoing being based on a fiber denier of about 1 to 16 and preferably 3 to 6 denier. Other materials are suitable for use as filler and can include polyalkenes, polyethylene, and paper tows. The sheath **12** can be formed from various types of thermoplastic materials including polyolefins, polypropylene, cellulose acetate and polyethylene, and can have various external and internal dimensions as well as external surface configuration depending on the use.

It will be seen from the foregoing then that the present invention is particularly suited for forming a fibrous filled thermoplastic rod wherein the filler is anchored in the workpiece in longitudinally extending grooves formed in the workpiece. This is accomplished very effectively by the present invention by directing the cooling streams of air at ambient temperature against the inner surfaces of the tubular extrudate as it leaves the annular extrusion aperture. The degree of securement of the filler within the workpiece is believed to be better with respect to rod produced according to the present invention than with rod which is formed by extruding thermoplastic material through an extrusion aperture having teethlike projections therein corresponding to the grooves to be formed. A greater degree of clenching is believed to be achieved because a more pronounced pull down of the extrudate along the groove surfaces is possible when pulling down the workpiece structure along bands located between already set surfaces. A further advantage of the present invention is that it allows for production of either plastic rod with a serrated inner configuration such as shown in FIG. **4** or of a smooth inner surface rod without the need for changing adapter pieces on the extrusion die. To produce smooth inner surface rod, all that need be done is to shut down the air supply.

It will thus be seen that the objects set forth above among those made apparent from the foregoing description, are efficiently attained and, since certain changes in carrying out the above method and in the construction set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense. For example, the pressure at which the cooling streams of air are supplied to the manifold **112** can vary depending on the type of material being extruded as long as the pressure is not above one which would cause a rupture of the workpiece **12** issuing from the die. Furthermore, the range of diameters of the passages **110** will vary depending upon specific requirements. For example for a sheath **12** of dimensions early discussed, the passages may have a diameter of one sixty-fourth inch–one thirty-second inch.

What is claimed is:

1. A method for forming an article comprising a mass of fibrous material enclosed in a tubular sheath, said tubular sheath having an inner wall surface provided with grooves extending longitudinally of said sheath with lands intervening adjacent grooves, said method comprising

extruding a thermoplastic material through an extrusion aperture to form a continuous tubular workpiece having a generally smooth inner wall surface and cross-sectional dimensions substantially larger than the intended final cross-sectional dimensions of said sheath,

conveying said tubular workpiece away from said aperture,

simultaneously advancing a cohesive tow of plural filaments of said fibrous material into and codirectionally with said continuous tubular workpiece,

spraying streams of cooling fluid against said inner wall surface of said workpiece at a circle of spaced locations thereon as it leaves said extrusion aperture to thereby chill said inner surface at said locations, and

pulling down said tubular workpiece against said continuous tow to form a sheath therearound and to an extent sufficiently tightly to radially compress said tow by advancing said tubular workpiece through a closing aperture of substantially the same dimension as the intended final external dimension of said sheath, the inner surface of said tubular workpiece being chilled sufficiently to initiate setting thereof whereby said tubular workpiece in its passage to and through said closing aperture pulls down to a lesser extent at said locations than at the surfaces intervening said locations thereby forming grooves in said wall surface at said intervening surfaces, the tow of filler material becoming clenched in said grooves during the pull down of said tubular workpiece.

2. The method of claim **1** wherein the thermoplastic material is polyethylene and the fibrous filler material is cellulose acetate.