

[54] **APPARATUS AND METHOD FOR
MANUFACTURING JET IMPINGEMENT
TYPE FILTERS FOR SMOKING ARTICLES**[75] Inventors: **Hoyt S. Beard; Leslie E. Payne;
Colin S. McArthur**, all of
Winston-Salem, N.C.[73] Assignee: **R. J. Reynolds Tobacco Company**,
Winston-Salem, N.C.[22] Filed: **June 26, 1973**[21] Appl. No.: **373,863****Related U.S. Application Data**[62] Division of Ser. No. 171,448, Aug. 13, 1971, Pat. No.
3,779,849.[52] U.S. Cl. **156/443, 156/475, 156/486**[51] Int. Cl. **B31f 1/00**[58] **Field of Search** 156/212-215,
156/443, 69, DIG. 20, DIG. 15, 320, 475,
486; 93/1 C, 77 FT; 53/32, 42, 341, 378;
131/10 A, 10.3, 10.5, 94, 261[56] **References Cited****UNITED STATES PATENTS**

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 Anderson & Olson

[57] **ABSTRACT**

This improved apparatus and process for manufacturing jet impingement type filters for smoking articles utilizes a normally substantially air impervious sheet material having a plurality of preformed smoke passing perforations therein and a rod of smoke pervious filter material. A tab of the perforated sheet material is positioned over the end of the rod of filter material by securing a peripheral portion of the perforated tab to the longitudinal surface of the filter rod adjacent an end whereby a major portion of the tab extends beyond the end and folding the major portion transverse the axis of the filter rod with peripheral areas extending radially outwardly from the longitudinal surface. These peripheral portions are further folded or draped over the longitudinal surface of the filter rod and secured thereto so as to form a cup-like enclosure or cap over the end.

The preferred apparatus for assembling the filter comprises a female die, means for successively tabbing filter rods with the perforated sheet material and aligning the tabbed filter rods adjacent the opening in the female die with the tabs folded therebetween and means for effecting relative reciprocal movement whereby the female die cups or caps the tabs over the ends of successive filter rods. The resulting cupped-tab filter plugs are then disposed in gaseous communication with a smokable material such as a cigarette rod by, for example, an overwrap of conventional tipping paper.

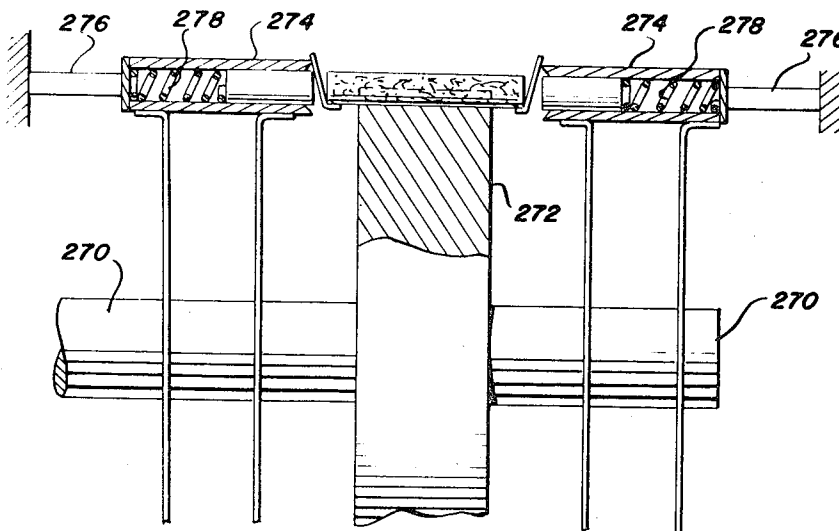
3 Claims, 24 Drawing Figures

FIG. 1

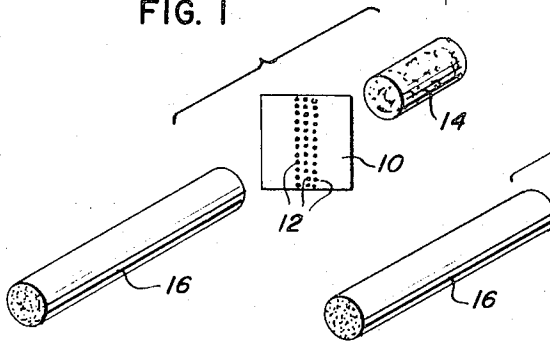


FIG. 2

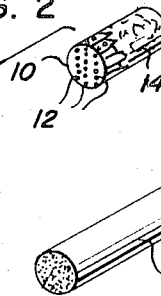


FIG. 3

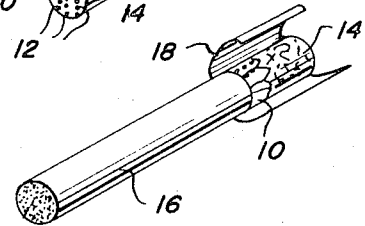


FIG. 4

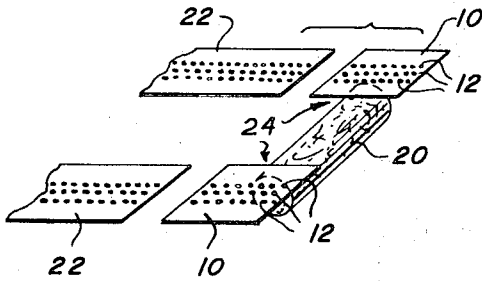


FIG. 5

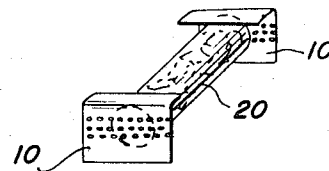


FIG. 6

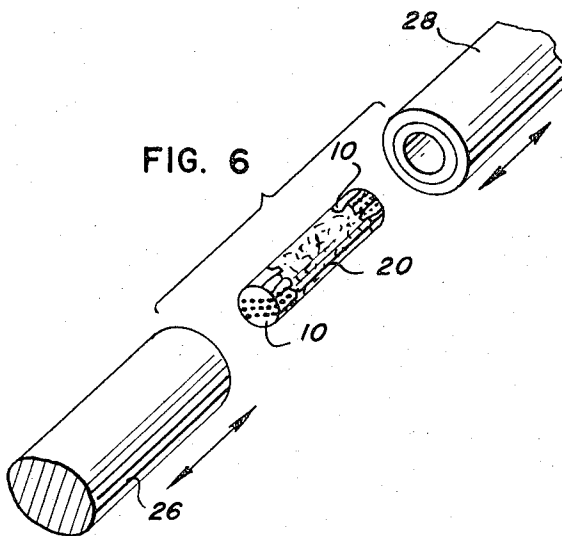


FIG. 7

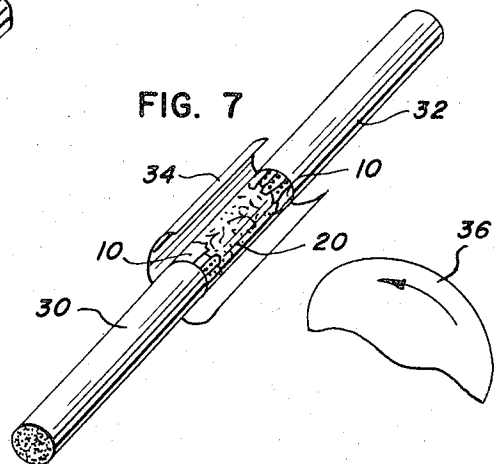


FIG. 8

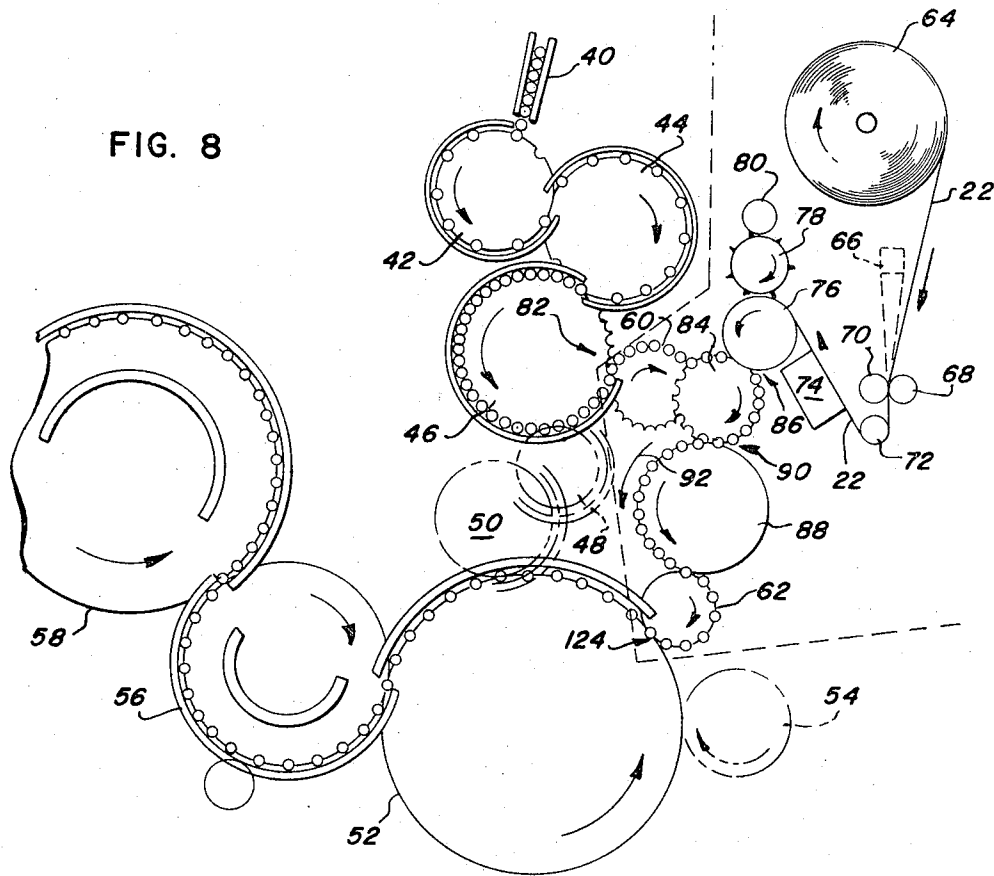
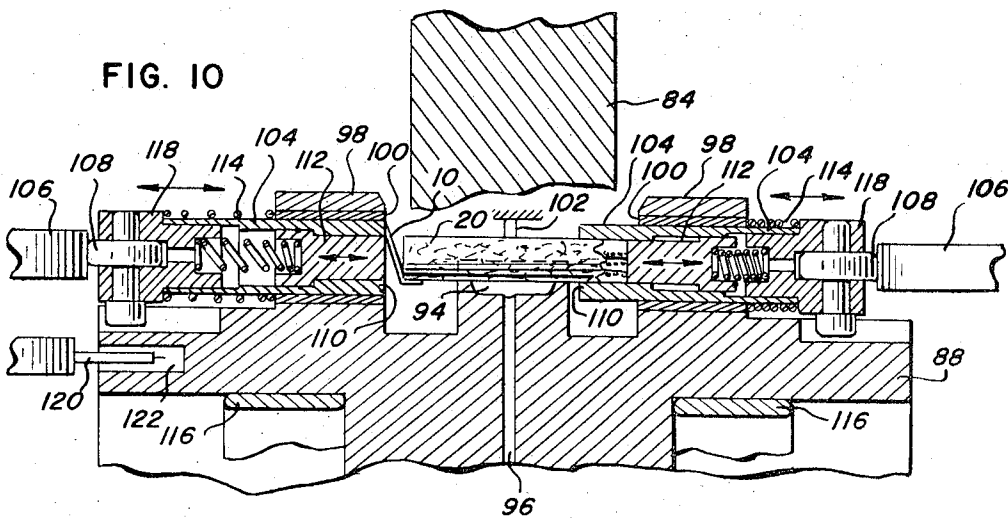


FIG. 10



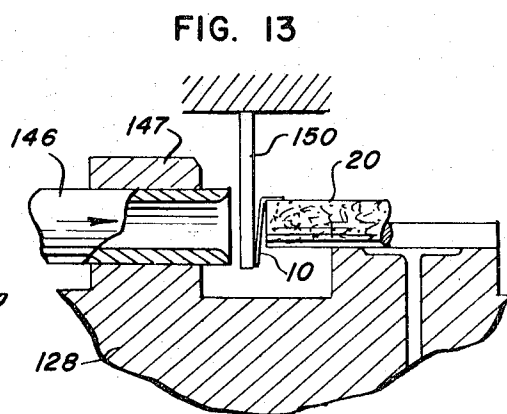
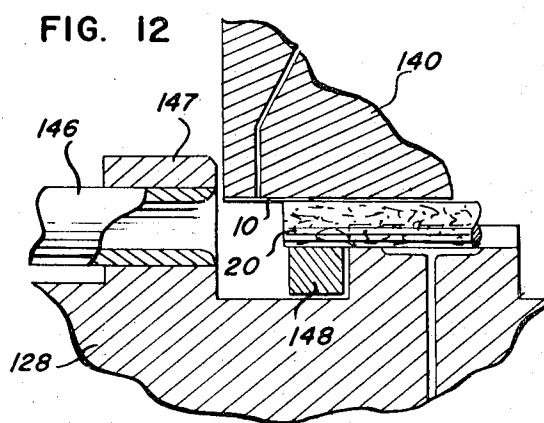
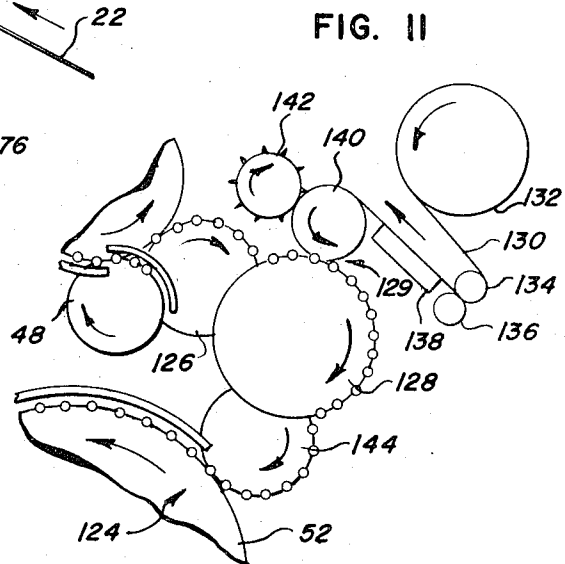
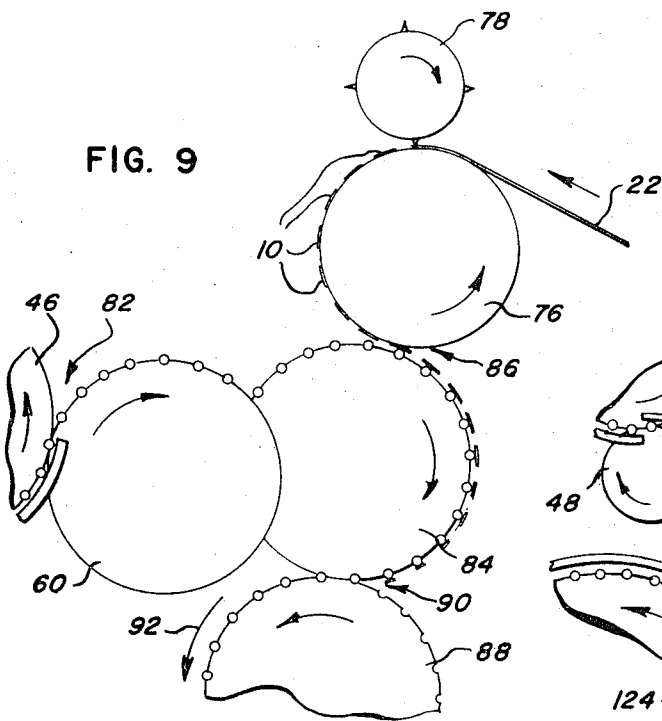


FIG. 14

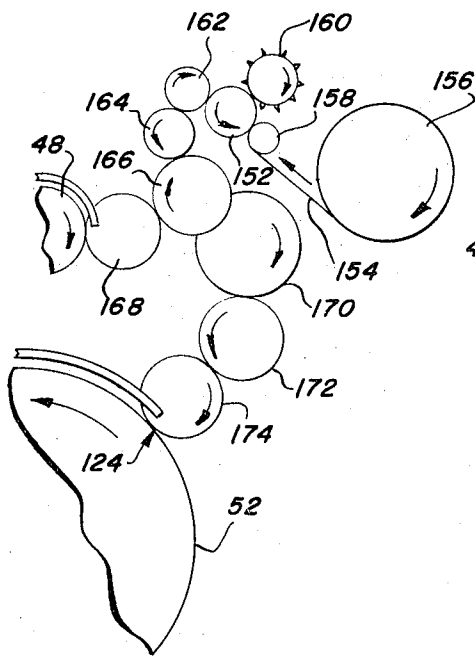


FIG. 15

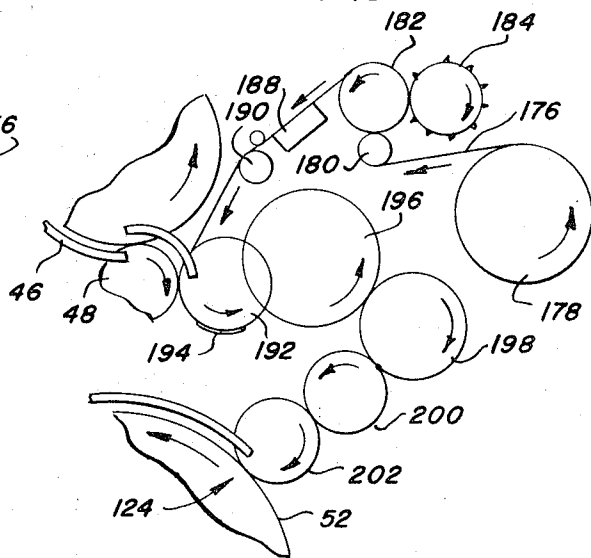


FIG. 16

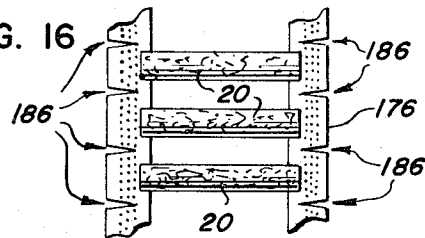


FIG. 17

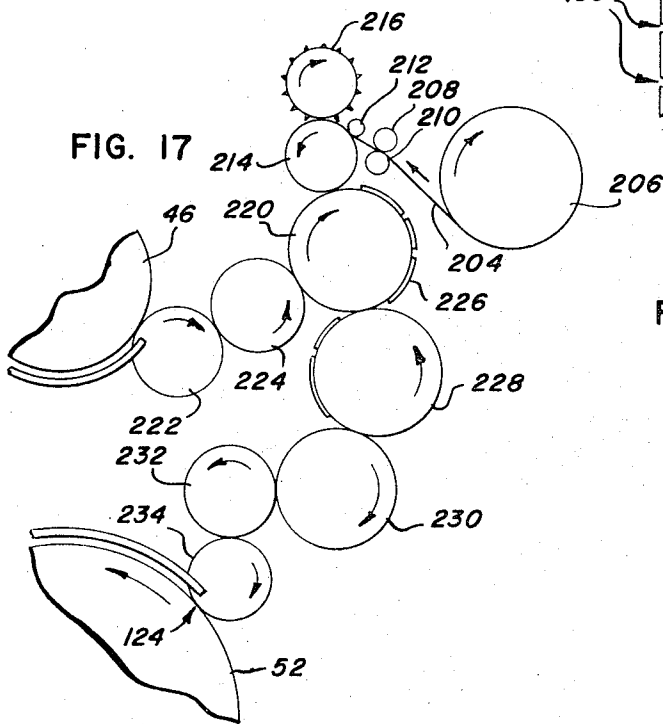


FIG. 18

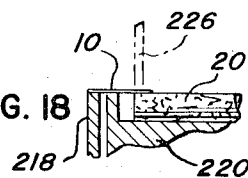


FIG. 19

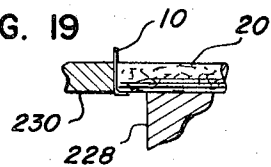


FIG. 20

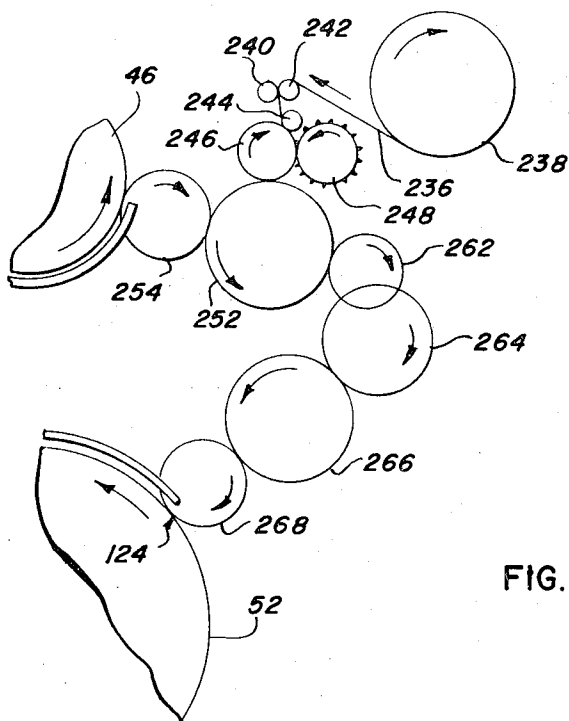


FIG. 21

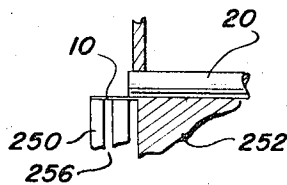


FIG. 22

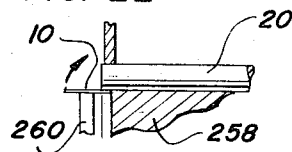


FIG. 24

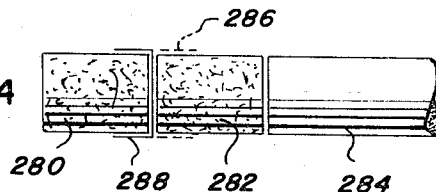
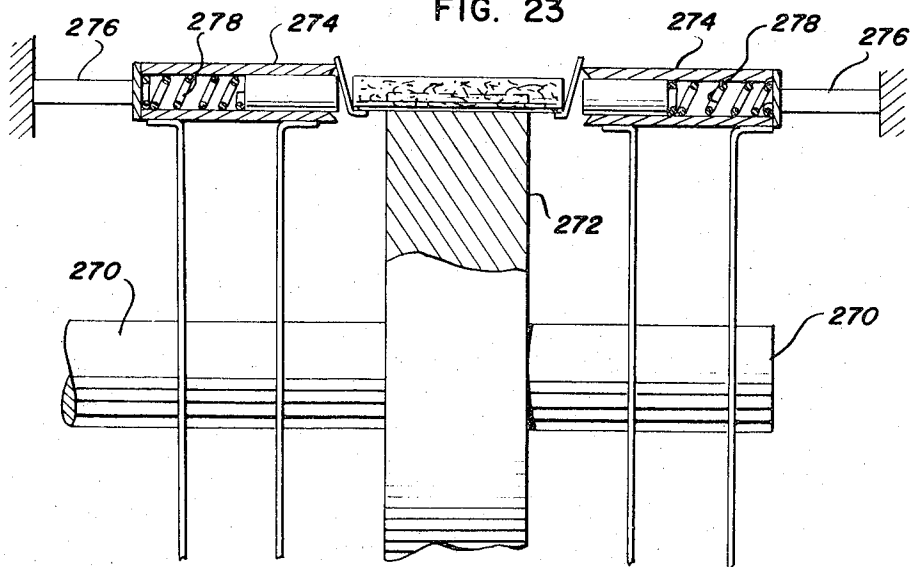


FIG. 23



APPARATUS AND METHOD FOR MANUFACTURING JET IMPINGEMENT TYPE FILTERS FOR SMOKING ARTICLES

This is a division of application Ser. No. 171,448 filed Aug. 13, 1971, now U.S. Pat. No. 3,779,849.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an improved apparatus and method for the continuous, high speed manufacture of jet impingement type filter plugs. More specifically, it relates to a low cost and reliable method and apparatus which makes it practical to provide highly efficient jet impingement type filters wherein the smoke passes through a plurality of accelerating jets in a sheet material and impacts directly upon the surfaces of a superjacent porous filter medium.

While the present invention is described herein with particular reference to impingement filters for cigarettes employing porous plugs of cellulose acetate fibers as the impaction surfaces, it should be understood that the invention is not necessarily limited thereto. The method and apparatus can also be employed for preparing filter plugs for various smoking articles other than cigarettes and may utilize various other conventional and non-conventional porous filter media, as those skilled in the art will recognize in the light of the present disclosure.

2. Description of the Prior Art

One effective technique in the continued drive to lower the total particulate matter in the smoke of smoking articles such as cigarettes is the use of jet impingement devices, alone or, preferably, in combination with a porous filter medium. Prior art jet impingement filters have, however, suffered from a number of shortcomings which tend to inhibit their widespread utilization. Certain prior art devices, for example, are relatively complicated structurally. They involve the assembly of hard-to-handle items such as discs, pills, capsules or other structural elements which must be carefully oriented.

Some of the more complicated jet impingement type filters also require the development of new manufacturing methods and machinery and do not lend themselves to production on existing filter tip cigarette manufacturing apparatuses. As a consequence, otherwise satisfactory machines would have to be discarded and new capital investment incurred. The departure from proven manufacturing techniques is also accompanied by transition and shakedown periods, often accompanied by excessive downtime, uneconomic production rates, employee training complications, unreliability and quality control difficulties.

In addition to the above factors which are ultimately reflected in higher costs, certain prior art impingement type filters add unduly to the length of the filter section. This requires some sacrifice in the length of the tobacco rod to maintain a standard overall size. Employing a porous filter medium as the compaction surfaces and eliminating any intervening void space between the accelerating jets and the porous filter medium minimizes the length problem and provides a desirable combination filter. But the demand for lower unit cost and the unsatisfactory solutions to manufacturing problems such as set forth above has continued to inhibit the widespread use of such combination impingement filters.

It is to the solution of these various problems that the method and apparatus of the present invention are addressed, as more fully set forth in the following objects.

OBJECTS OF THE INVENTION

It is therefore a general object of the present invention to provide an economically-feasible method and apparatus for producing smoking articles having jet impaction filters, which method and apparatus lend themselves to continuous, high speed production techniques. It is another general object to provide a low cost, reliable and simplified method and apparatus for producing jet impingement filters which employ a porous filter medium for the impaction surfaces as well as for conventional filtering. It is another general object to provide an improved method and apparatus for producing a combination jet impingement-porous medium filter which is free of longitudinal void spaces and requires substantially no more space than a simple porous medium filter plug.

It is a specific object to provide a highly efficient, simplified method and apparatus for producing combination impingement-porous medium filters, which involve no hard to handle components and utilize proven filter and cigarette making technology. It is another specific object to provide a high speed, continuous apparatus for producing such filters which can be a free-standing unit or which can be mounted or "grafted" onto conventional filter tip cigarette assembly machinery as an attachment without excessive capital investment.

It is another specific object to provide a method and apparatus for producing combination jet impingement-porous medium filter tip cigarettes without incurring the high investment associated with completely new machinery, and the time delays and other manufacturing problems associated with the design, construction, debugging and breaking-in thereof. It is still another specific object to provide a highly efficient, low cost and versatile method and apparatus for producing combination jet impingement-porous filter medium cigarette filters, which are competitive cost-wise with other methods and apparatuses.

These and other objects of the present invention will become apparent as the detailed description proceeds.

SUMMARY OF THE INVENTION

These objects are achieved in a particular embodiment by a simplified process and low-cost apparatus for assembling a normally substantially air impervious sheet material and a rod of smoke pervious filter material. The sheet material, preferably in tab form, is pre-punched or otherwise perforated with a plurality of smoke passing perforations to provide the desired accelerating jets or orifices. A tab of the sheet material is positioned over the end of the rod of smoke pervious filter material such as a conventional fibrous cellulose acetate filter rod by a two-step procedure. The first step is side tabbing, that is, a peripheral portion of the perforated tab is secured by spot adhesion to the longitudinal surface of the filter rod adjacent an end whereby a major portion extends beyond the end, preferably generally parallel to the axis of the cylindrical filter rod. The second step is folding the major portion transverse the axis with peripheral portions extending radially outwardly from the longitudinal surface.

The peripheral portions of the folded tab are then further folded or draped over the end of the rod so that with the central portion in direct contact with the end surface of the rod and the peripheral surface in contact with the side surface of the rod, a cup-like enclosure or cap on the end is formed. This cap is secured to the rod, preferably by means of a hot melt coating on one surface of the sheet material, i.e., a heat-activatable, pressure-sensitive adhesive coating. The resulting filter plug rod is then disposed in gaseous communication with a smokable material such as a cigarette rod. This is conveniently carried out by aligning the cigarette rod and filter plug rod end to end and securing and sealing the two together with conventional tipping paper.

A preferred apparatus for preparing the combination filter comprises means for successively side tabbing the ends of the elongated filter rods and folding the tabs transverse the ends thereof, female die means disposed to receive successively the tabbed ends of the rods aligned therewith and means for effecting relative reciprocal movement between the female die means and each successive filter rod with folded tab whereby the rod, in conjunction with the female die means, acts as a male die means to cup or cap the folded tabs over the end. In the embodiment wherein a heat-activatable, pressure-sensitive adhesive is employed to secure the tabs to the elongated rods, heating means, preferably in the form of electrical heaters, are provided to activate the adhesive.

In a preferred embodiment of the method and apparatus, a double size filter rod with jet impingement tabs cupped over each end is prepared, cigarette rods are secured to both ends, and the resulting dual cigarette transversely cut centrally to produce two substantially identical filter tip cigarettes. This preferred technique of initially producing a double cigarette filter permits the method and apparatus to be readily tied in with conventional filter tip manufacturing techniques and apparatuses which employ the dual or double cigarette approach.

As those skilled in the art will recognize, the filter, both before and after the double cupping operation, has substantially the same dimensions as an ordinary double porous filter rod without the impingement filtering feature. Thus the double filter rod can be detoured at an appropriate point from a conventional filter tip cigarette assembly machine into an attachment comprising the cupping or capping apparatus of the present invention and then returned to the conventional machine for completion of the assembly operation.

In the completion phase, the cigarette rods are aligned at each end of the double cupped filter, wrappers of tipping paper having a heat-activated adhesive thereon are applied so as to span abutting ends of the filter and cigarette rods and the resulting double cigarette sliced into two substantially identical filter-tipped cigarettes. Assembly machinery for such purposes is disclosed, for example, in McArthur U.S. Pat. Nos. 3,420,243, 3,470,884 and 3,484,582.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention and specific aspects thereof will be more clearly understood from the following detailed description of particular method and apparatus embodiments for producing filter tip cigarettes, which

should be read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a perspective view of the three unassembled components of a filter tip cigarette which are assembled by the method and apparatus of the present invention;

FIG. 2 is a perspective view of the impingement type filter prepared by the method and apparatus of the present invention prior to assembly with a cigarette rod;

FIG. 3 is a perspective view illustrating the final assembly of the impingement type filter and cigarette rod by means of an overwrap of tipping paper;

FIG. 4 is a diagrammatic perspective view of the side tabbing step as applied to a double filter rod;

FIG. 5 is a diagrammatic perspective view of the tab folding step as applied to a double filter rod;

FIG. 6 is a diagrammatic perspective view of the tab capping step as applied to a double filter rod;

FIG. 7 is a diagrammatic perspective view of the tipping paper overwrapping step as applied to a capped double filter rod;

FIG. 8 is a diagrammatic elevation view of a conventional filter tip cigarette assembly machine with one embodiment of the novel apparatus of the present invention mounted as an attachment thereon, the novel apparatus being disposed generally to the right of, and above, the dashed lines;

FIG. 9 is a diagrammatic elevation view on an enlarged scale of a portion of the novel apparatus of FIG. 8;

FIG. 10 is a section view of a portion of one embodiment of the capping apparatus of the present invention, the left and right sides portraying the apparatus in two different positions respectively;

FIG. 11 is a diagrammatic elevation view of an alternative apparatus for carrying out the process of the present invention;

FIGS. 12 and 13 are section views of a portion of the apparatus of FIG. 11;

FIG. 14 is a diagrammatic elevation view of a second alternative apparatus for carrying out the process of the present invention;

FIG. 15 is a diagrammatic elevation view of a third alternative apparatus for carrying out the process of the present invention;

FIG. 16 is a diagrammatic view of the partially cut tabs and double filter rods employed in the apparatus of FIG. 15;

FIG. 17 is a diagrammatic elevation view of a fourth alternative apparatus for carrying out the process of the present invention;

FIGS. 18 and 19 are section views of portions of the apparatus of FIG. 17;

FIG. 20 is a diagrammatic elevation view of a fifth alternative apparatus for carrying out the process of the present invention;

FIGS. 21 and 22 are section views of portions of the apparatus of FIG. 20;

FIG. 23 is a diagrammatic section view of an alternative apparatus to that of FIG. 10 for capping the double filter; and

FIG. 24 is a perspective view of alternative embodiments of a filter tip cigarette which may be manufactured by the method and apparatus of the present invention.

It should be understood that these drawings are not necessarily to scale and that graphic symbols and diagrammatic representations are employed in some instances. Moreover, details shown in some figures may be omitted in other figures to facilitate illustrations of still other details. Furthermore, in some figures, mechanical details which do not relate to the essence of the present invention have been omitted for simplicity and economy of drawings. Thus, the drawings may depart in certain respects from appearances of actual physical embodiments.

It should also be understood, of course, that the invention is not necessarily limited to the particular embodiments illustrated herein. Where feasible and convenient, the same reference numerals may be used in different embodiments to identify the same or similar elements or components.

DETAILED DESCRIPTION OF THE DRAWINGS INCLUDING PREFERRED EMBODIMENTS

FIGS. 1-3: Components of Filter

Referring to FIGS. 1, 2 and 3, the impingement filter prepared by the method and apparatus of the present invention comprises a tab 10 of normally substantially air impervious sheet material having a plurality of preformed smoke passing perforations 12 therein, the sheet material being positioned over the end of a rod 14 of smoke pervious filter material and folded to form a cup or cap thereover. It is then oriented and combined with cigarette rod 16 by means of conventional tipping paper 18 which spans the abutting ends to form a complete cigarette. The smoke passing perforations 12 in tab 10 act as accelerating jets or orifices for the cigarette smoke which passes therethrough and impacts on the porous filter material of rod 14.

In the illustrate exemplar of FIGS. 1, 2 and 3, perforated sheet material 10 has a square configuration, the side dimension of which is sufficient whereby peripheral portions extend beyond the outer surface of filter rod 14 by about 2-4 millimeters or more. These peripheral portions are draped or folded over the end of filter rod 14, as illustrated in FIG. 2, by a two step procedure described hereinafter to form the cup-like enclosure or cap. The cap is secured and sealed to the outer surface of filter rod 14, preferably by an adhesive, e.g., a heat-activatable, pressure-sensitive adhesive such as one of the vinyl acetate acrylic copolymers. Similarly, the inner central portion of the cap is adhered directly to the rod end.

Sheet material 10 is manifestly not limited to a square configuration. It may be otherwise configured or oriented relative to the end of the filter rod to meet the dictates of manufacturing convenience and cost considerations, so long as a central portion and peripheral area are provided to obtain the desired end cup or cap. Thus, for example, tab 10 may have a rectangular, circular, oblong or even an irregular configuration.

The composition of sheet material 10 is not critical so long as it meets accepted standards for such a cigarette component and is flexible enough to fold neatly around the end of the plug. It may, for example, comprise conventional cigarette tipping paper. It may also be prepared from laminated papers, plastic films, aluminum foil, composite laminates of these materials, or the like.

The sheet material may also comprise high porosity paper so long as the porosity is not so great as to pre-

clude sufficient pressure drop under normal smoking conditions to obtain the desired jet effect and impingement. It is in this sense that the term "normally substantially air impervious sheet material" is used herein to characterize the porosity exclusive of the preformed accelerating jets or perforations. In a preferred embodiment, a highly plasticized paper having a thickness in the range of about 0.001 to 0.003 inch, e.g., 0.002 inch, is employed.

The number of smoke passing perforations 12 in tab 10 which register with the end of the rod 14 after capping may typically range from about 10 to 30, preferably 15 to 25. The approximate diameter of the perforations or holes may range from about 0.005 to about 0.015 inch. e.g., about 0.010 inch, fewer perforations being required when a larger diameter is employed and a greater number of perforations when a smaller diameter is employed. Sufficient perforations of a given size must, of course, be present so that the draw or pressure drop across the sheet material is not excessive.

The perforations may be formed by conventional means, e.g., forcing the sheet material against a plurality of needles, employing a continuous punching wheel, flame burning, spark perforation, or the like. In a preferred embodiment the perforations are burned in the sheet by a pulsed laser.

The perforation pattern may vary, although it is preferred that the perforations be reasonably well distributed over a substantial portion of the center of the tab which registers and is in contact with the end of the filter rod. Thus, for example, the pattern may be circular or may be configured as concentric circles, a spiral, or any other well distributed pattern. For convenience of manufacture, the perforations in a preferred embodiment are patterned in a plurality of continuous parallel rows, as depicted in FIGS. 1, 2 and 3, e.g., three rows of perforations approximately 1 1/2 millimeters apart with approximately 1 millimeter between holes in a given row.

The porous filter rod 14 may be of conventional design, i.e., a low draft filter plug of fibrous material such as cellulose acetate yarn, a particular form being marketed under the trademark "Estron." Such filters have substantially the same diameter as the cigarette rod and conventionally have a length of approximately 20 millimeters.

The cigarette rod 16 may be of any conventional design, i.e., a cylindrical rod of tobacco encased in either standard porosity or high porosity cigarette paper which may optionally have a plurality of air dilution perforations therein. The particular cigarette rod per se and the particular filter rod per se are not essential parts of the invention other than being necessary components employed in the practice of the process and operation of the apparatus. Thus, since they are within the knowledge and skill of the art, they need not be described in further detail.

FIGS. 4-7: A Preferred Method

FIGS. 4 through 7 illustrate the principal steps in a preferred method as applied to a double length filter rod 20, which is typically about 40 mm. long. Tabs 10 are cut from perforated continuous "jet" strips 22, as illustrated in FIG. 4, and are tabbed to the side of the filter rod 20 by spot adhesion at contacting portions 24. After such side tabbing, tabs 10 are folded across the end faces of the rod 20 transverse to its axis with pe-

ripheral areas extending beyond the surface of the rod, as illustrated in FIG. 5.

Tabs 10 are then cupped or capped over the respective ends of filter rod 20 by forcing the folded tabs into cup-like restricted openings using filter rod 20 as a male die for such purposes, whereby the peripheral areas of the tabs are folded against the longitudinal surface of rod 20. This is illustrated in FIG. 6 wherein the restricted openings of female die means 26 and 28 reciprocate towards each other and move over each end of the folded-tabbed filter rod 20. Structural details of several embodiments of die means 26 and 28 are set forth hereinafter. After the return stroke of die means 26 and 28, the caps are held in place by an adhesive. If a hot melt is employed as the adhesive, the cups of die means 26 and 28 are preferably heated.

Filter tip cigarettes are then assembled from the capped double filter by securing a cigarette rod at each end thereof and transversely severing the double cigarette in half. This is diagrammatically illustrated in FIG. 7 wherein cigarette rods 30 and 32 are secured to abutting ends of capped filter rod 20 by an overwrap of tipping paper 34. The double assembly is severed into two completed cigarettes by knife blade or saw 36.

FIGS. 8-10: A Preferred Apparatus

A preferred embodiment of the apparatus of the present invention to carry out the process steps illustrated in FIGS. 4-7 is shown in FIG. 8. In FIG. 8 a front elevation view of conventional cigarette filter feed and tipping equipment is shown generally to the left and below the dashed lines, and the apparatus of the present invention is mounted thereon as an attachment shown generally to the right and above the dashed lines.

In the conventional cigarette filter tipping operation, a multiple length Estron filter rod having a length of about 120 mm. is fed from a hopper (not shown) via feed guides 40 successively through five "feed" drums 42, 44, 46, 48 and 50 to the cigarette drum 52. By the time the filter rods have reached drum 46, they have been cut into three double-length filters, e.g., 40 mm. double lengths; and the cut lengths have been aligned into a single row around the periphery of drum 46. When the double-length filters are transferred to cigarette drum 52, the two ends thereof are aligned with cigarette rods introduced to cigarette drum 52 from cigarette transfer drum 54. The aligned cigarettes and filters are then further processed on transfer drums 56 and 58 and subsequent drums (not shown) wherein the overwrap of tipping paper is applied and the double cigarette rods severed to form two identical cigarettes.

When the preferred apparatus of the present invention is attached to such conventional machine, drums 48 and 50 are omitted and the double filter rods are detoured to the new apparatus by transfer drum 60 for the capping operation, as hereinafter described. After capping, the capped filter rods are redeposited on cigarette drum 52 by transfer drum 62, following which the capped filter rods are assembled into completed cigarettes as above described.

Referring to the new equipment in FIG. 8, two reels 64 of preperforated sheet material or jet strip 22 having a width of $\frac{1}{2}$ inch and a hot melt coating on one side are mounted above the apparatus, only one of the two reels being visible in FIG. 8 because the other reel is mounted directly behind. The two reels are separated by a distance equal to the length of the double filter rod

20 less twice the tabbing overlap distance, that is, the distance tab 10 overlaps the filter rod. It should be understood that the two reels may be mounted in any other convenient orientation, e.g., 90° to the position shown, in which case the strips would be fed over rollers 66 shown in dashed lines. It should also be understood that in the following description the various operations are performed on both front and back jet strips simultaneously.

After leaving reels 64, jet strip 22 passes between metering rollers 68 and 70, which determine the rate of travel of the jet strip, and around idler roller 72. Jet strip 22 then passes against heater bar 74 which is maintained at a temperature sufficient to activate the hot melt coating on the opposite side of jet strip 22, e.g., a heater bar temperature of about 350°F . Bar 74 or idler roller 72 may be retracted upon stopping to prevent overheating of the jet strip.

Jet strip 22 then passes around vacuum ledger drum 76, where the strip is cut into a succession of $\frac{1}{2}$ -inch long tabs 10 by rotating knife drum 78, the blades of which come into interference contact with ledger drum 76. Rotating brush 80 helps to clean the blades of knife drum 78. As aforementioned, the tabs need not necessarily have the square configuration which results in this embodiment.

Referring to FIGS. 8 and 9 together, ledger drum 76 rotates at a surface speed slightly exceeding that of metering rollers 68. Thus the cut tabs 10 move ahead and away from the leading edge of the strip, which is vacuum-held and slides on the surface of ledger drum 76 with a sliding velocity equal to the difference between the surface speed of ledger drum 76 and metering rollers 68. A space is thereby created between the consecutively cut tabs 10, e.g., about $\frac{1}{4}$ inch.

Ledger drum 76 is slightly heated, e.g., a temperature of about $150^\circ\text{--}175^\circ\text{F}$., to keep the hot melt activated while strip 22 and tabs 10 are in contact with the drum. Alternatively, a hot rail (not shown) may heat the filter rod itself to activate the hot melt.

Referring to transfer point 82, the double length filter rods are transported from drum 46 by drum 60 to tabbing drum 84, to which they are transferred. The transferred filter rods are held in vacuum pockets on tabbing drum 84, which is timed so that the filter rods pass beneath the spaced tabs 10 on ledger drum 76. Ledger drum 76 is mounted and adjusted so that slight pressure exists between the contacting tabs and the filter rods.

At point 86 the vacuum which holds tabs 10 on ledger drum 76 is released such that the tab is then free to stick to the filter rod by adhesion of the activated hot melt. Thus tabs 10 are securely stuck to both ends of the respective filter rods and appear as indicated in FIG. 4. The tabbed filters now travel around the outside of drum 84 and are transferred to cupping drum 88 wherein the tabs are folded transverse to the filter axis and then capped over the end of the filter.

Details of a portion of cupping drum 88 are depicted in the section view of FIG. 10. While only one pair of cupping sleeves is shown in FIG. 10, there are a plurality of such pairs evenly spaced around the periphery of drum 88.

The left side of FIG. 10 depicts the female die means or cupping sleeve in the retracted position as it would appear at transfer point 90. The right side of FIG. 10 depicts the cupping sleeve fully extended so as to cup tab 10 over the end of the rod, this operation taking

place during the rotation of cupping drum 88 generally indicated by arrowhead 92. It should be understood, of course, that the extension and retraction or opposed reciprocal movement of both cupping sleeves occur simultaneously. The two different positions depicted in FIG. 10 are employed in the interest of drawing economy.

In FIG. 10 filter rod 20 is seated on drum 88 in vacuum seat 94 after transfer from tabbing drum 84. Vacuum is supplied through channel 96 by a rotary vacuum transfer (not shown). As the filter rod is seated, tabs 10 are folded transverse the axis of the rod as they rub against the chamfered ends of flanges 98 which house sleeve bearings 100. As filter rod 20 is rotated away from transfer point 90, it is held in place on vacuum seat 94 by rail 102.

Cupping sleeves 104, which serve as female die means, slide inside bearings 100 and are actuated by fixed cams 106 which bear against cam followers 108. As drum 88 continues to rotate, sleeves 104 are cammed forward such that the centers of tabs 10 are pressed flat against the end faces of rod 20 and folding of the peripheral portions is begun by the tapered portions 110 of the openings in sleeves 104. Spring loaded plungers 112 keep the tab centers flat against the end faces of rod 20. Cupping sleeves 104 continue towards one another until they are completely around the ends of the filter rod, folding the periphery of the tabs smoothly against the longitudinal surfaces thereof.

Spring loaded plungers 112 recede inside sleeve 104 until the filter rod is at full predetermined depth inside the sleeves. Plungers 112 are designed so that they do not "bottom out." This allows for slight differences in the lengths of the filter rods and slight misalignments of the rods on vacuum seat 94. After full depth has been reached, cam return springs 114 simultaneously retract the sleeve assemblies as the fixed cams 106 recede. After both sleeves are retracted, the double end-capped filter rod remains in vacuum seat 94 until transferred.

If a permanently tacky adhesive is coated on tab 10, sleeves 104 need not be heated. If a hot melt is used, however, the sleeves may be heated to a temperature of, for example, 225°F. by heating the body of drum 88 with electric heater bands 116. The heat so added is conducted through bearings 100 to sleeves 104 and thence to tabs 10 as they are cupped around filter rod 20. Plungers 112 are also heated by conduction and thus seal tabs 10 to the ends of rod 20.

In some cases it may be desirable to keep the plungers at a lower temperature of, for example, about 175°F., to prevent excessive sealing of tabs 10 to the rod ends. This may be accomplished by making plungers 112 from material which has a low thermal conductivity and capacity, e.g., a thermoplastic resin. Similarly, cam follower yokes 118 may be constructed of a material having low thermal conductivity to prevent heat deterioration of the grease in the bearings of cam followers 108.

The temperature of cupping drum 88 is sensed by a rigidly mounted thermocouple 120 which fits into annular slot 122 of drum 88. The signal from thermocouple 120 feeds controllers (not shown) which vary current input to heater bands 116. This method of sensing and controlling temperatures may be used on all heated rotating drums in the various embodiments of the apparatus of the present invention.

Referring back to FIG. 8, the double capped filter rod is now transported from cupping drum 88 via transfer drum 62 to the conventional cigarette drum 52 at transfer point 124. It then travels through the standard tipping equipment and is cut into two cigarettes, as previously described.

FIGS. 11-13: First Alternative Apparatus

An alternative apparatus for carrying out the present invention is shown in FIGS. 11, 12 and 13. In this alternative embodiment, the filter rod is detoured from the standard equipment at clutch drum 48, rather than drum 46, and is transferred via drum 126 to a combination tabbing and cupping drum 128. Jet strip 130 is supplied from reel 132, metered by rolls 134 and 136 and heated by heater bar 138. The jet strip passes around vacuum ledger drum 140 and is cut by rotating knife drum 142 into individual tabs which are then successively and continuously side tabbed to the filter rods on drum 128 at point 129. As drum 128 rotates, the tabs are folded transversely and cupped around the ends of the rods, as described below in connection with FIGS. 12 and 13. The resulting capped filters are then returned to cigarette drum 52 via transfer drum 144.

FIGS. 12 and 13 are partial section views along the periphery of tabbing and cupping drum 128. As depicted in FIG. 12, the cut and spaced tab 10 is transferred from heated vacuum drum 140 and is secured to the longitudinal surface of filter rod 20 adjacent the end by spot adhesion. The cupping sleeve 146 and its bearing housing 147 have been recessed to provide clearance for the tabbing operation. An externally mounted non-rotating backup reel 148 provides support adjacent the end of filter rod 20 during tabbing. Alternatively, a wobble ring (not shown) may be used to provide support and then retracted as the cupping sleeve 146 comes forward.

After the tabbed rod 20 is rotated away from the transfer point 129 where tabbing occurs, a folding rail 150 (FIG. 13) folds tab 10 transversely across the end of rod 20. Meanwhile, cupping sleeve 146 has been advancing, and after rail 150 terminates, the sleeve 146 immediately takes over, holding the tab in the folded position and continuing forward to perform the cupping operation, as previously described.

FIG. 14: Second Alternative Apparatus

In the second alternative embodiment of FIG. 14, a room temperature ledger drum 152 is employed rather than the heated ledger drums of the previously described embodiments. The temperatures of the ledger drum is kept as low as possible to avoid warping of the cutting surface which may cause incomplete cutting.

In this embodiment, jet strip 154 from reel 156 passes around roll 158 and is cut into tabs by cutting drum 160. The tabs are transferred to intermediate drum 162 and then to heated drum 164, which activates the hot melt and places the tab on the filter rods which are travelling on tabbing drum 166. Intermediate drum 162 isolates ledger drum 152 from heated drum 164.

The double filter rods are removed from drum 48 of the conventional tipping machine and transferred via drum 168 to tabbing drum 166, which may be similar to the tabbing drums already described. The operation is completed via speedup drum 170, cupping drum 172 and transfer drum 174, whereby the capped filter rods are fed to cigarette drum 52 at point 124.

FIGS. 15-16: Third Alternative Apparatus

A third alternative method is depicted in FIGS. 15 and 16. Jet strip 176 from reel 178 passes via roll 180 to ledger drum 182 where it is partially cut by cutting drum 184, the partial cuts in jet strip 176 being depicted by arrows 186 in FIG. 16. The partially cut strip 176 then passes over heater bar 188 and roll 190 to heated vacuum drum 192 where the filter rods 20 transferred from drum 48 of the conventional tipping machine are side tabbed to the jet strip, as shown in FIG. 16. A heated folder bar 194 folds the partially cut tabs transverse to the axes of the filter rods and seals them against the respective ends thereof.

The pitch of the vacuum pockets in drum 192 is the same as the pitch of the partially cut tabs. The pitch of the pockets on drum 196, however, is larger than the pitch of the cut tabs. Thus, a speedup transfer occurs between drum 192 and 196, separating the filters and tearing the tabs completely apart at the respective partial cuts. The cupping operation is then carried out on cupping drum 198, after which the cupped filters are transferred via transfer drums 200 and 202 to cigarette drum 52 at point 124, as previously described.

FIGS. 17-19: Fourth Alternative Apparatus

A fourth alternative embodiment is depicted in FIGS. 17, 18 and 19. Jet strip 204 from reel 206 passes via metering rolls 208 and 210 and roll 212 to vacuum ledger drum 214 whereon the jet strip is cut into individual tabs by knife drum 216. The individual tabs are then transferred onto vacuum shoulders 218 of drum 220, as illustrated in the partial section view of drum 220 shown in FIG. 18.

The filter rods 20 are transferred from drum 46 of the conventional tipping machine via transfer rolls 222 and 224 to drum 220. An edge adjacent portion of tab 10 contacts the longitudinal surface of filter rod 20 and sealer bar 226 secures the edge adjacent portion to the rod. The first portion of sealer bar 226 is heated to activate the hot melt coating on tab 10 and a trailing portion is cooled to seal the tab to the filter rod.

The tabbed filter is then transferred to drum 228, a section view of which is shown in FIG. 19. A folder bar 230, which has a first portion which is heated and a second portion which is cooled, folds and seals tab 10 over the end of rod 20. The subsequent operations on cupping drum 230 and transfer drum 232 and 234, whereby the cupped filter rod is transferred to cigarette drum 52 at point 124, are carried out as previously described.

FIGS. 20-22: Fifth Alternative Apparatus

A fifth alternative method is depicted in FIGS. 20, 21 and 22. Jet strip 236 from reel 238 passes via metering rolls 240 and 242 and roll 244 to vacuum ledger drum 246 where the strip is cut into individual tabs by knife drum 248, essentially as previously described. Tabs 10 are then deposited on vacuum seats 250 on drum 252, as depicted in the section view of FIG. 21. Delivery drum 254 simultaneously transfers the filter rods 20 from drum 46 of the conventional tipping machine to drum 252 and onto peripheral portions of tabs 10, also depicted in FIG. 21.

The peripheral portions of tabs 10 are hot melt sealed against the outer longitudinal surface of filter rods 20, the hot melt being activated by heat from heated drum 252. The tabs are then blown upward by a jet of air from port 256, previously used for vacuum. A hot rail (not shown) catches the blown tabs and seals them to the respective end faces of rods 20.

Alternatively, the tabbed filter rods may be transferred to a subsequent drum 258, as depicted in the section view of FIG. 22. The tabs may then be plowed up by a hot rail 260, which is shown in its down position, and sealed against the end faces of rods 20.

The filter rods with transversely folded tabs are then transferred via drums 262 and 264 to cupping drum 266, wherein the cupping operation may be carried out as previously described. The cupped filter rods are then transported via transfer drum 268 to cigarette drum 52 at point 124 for completion of the operation.

FIG. 23: Alternative Cupping Means

An alternative means for cupping the folded tabs which can be substituted in previous embodiments is depicted in FIG. 23. The mechanism shown depicts only one of many identical cupping mechanisms situated around shaft 270 on which filter support drum 272 is mounted.

In this embodiment cupping mechanisms 274 are pushed forward by cams 276, thus compressing springs 278. The cupping mechanisms 274 are returned parallel with the shaft by springs 278 after cams 276 recede.

FIG. 24: Alternative Filter Constructions

In the above described embodiments, the method and apparatus of the present invention are applied to the production of jet impingement filters using conventional cellulose acetate filter rods. The method and apparatus, however, can be applied to various other types of filter materials and combinations of materials such as dual element filters. The dual elements may be, for example, cellulose acetate, paper, charcoal or charcoal impregnated filter medium, other fibrous materials, molded elements of plastic having suitable smoke passages, or any other material suitable for use as a smoke filtering or conveying medium which also provides suitable impaction surfaces for the accelerated smoke.

For example, a dual element filter rod previously combined on known filter making equipment can be capped as described herein. Moreover, the procedure of the present invention may be applied to dual filter elements with the cap between the elements, as those skilled in the art will recognize in the light of this disclosure.

This latter embodiment is illustrated in FIG. 24 wherein dual elements 280 and 282 are secured to tobacco rod 284. The dashed lines 286 illustrate the cap on the downstream end of the element 282 which is adjacent the tobacco. Alternatively, the cap may be placed on the end of the second element 280, as shown in solid lines 288.

In the case of dual elements such as depicted in FIG. 24, the capping machinery may be free standing with the capped double length element then transported to dual element combining machinery. Alternatively, the capping machinery may be adapted to standard in-line or rotary combining machinery.

From the above description it is apparent that the objects of the present invention have been achieved. While only certain embodiments have been set forth, alternative embodiments and various modifications will be apparent from the above description to those skilled in the art. For example, the rotary mechanisms such as the drums herein described may also take the form of machine elements attached to link chains or belts. These and other alternatives are considered equivalents and within the spirit and scope of the present invention.

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Having described the invention, what is claimed is:

1. An apparatus for preparing a smoking article having a filter plug which comprises:

- a. female die means disposed to receive elongated rods of smoke pervious filter material having ends which are substantially perpendicular to the axis of the rod; 5
- b. means for successively feeding tabs of normally substantially air impervious sheet material having a plurality of smoke-passing perforations therein and successively adhesively securing a minor peripheral portion thereof to the longitudinal surface of elongated rods of smoke pervious filter material adjacent an end thereof with a major portion of the tab extending beyond said end and generally parallel to the axis of said rod; 10 15
- c. means for successively aligning the elongated rods of smoke pervious filter material with the opening of said female die means;
- d. folding means for folding said major portion athwart the end of said rod so as to be disposed substantially perpendicular to the axis of said rod with peripheral areas extending radially outwardly from the longitudinal surface; and 20
- e. means for effecting relative reciprocal movement 25

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between successive aligned elongated rods and said female die means after said major portion is folded athwart the end of the rod whereby successive elongated rods are inserted into and thereafter retracted from said female die means and thereby serve as male dies and cup the tab over the rod end.

2. The apparatus of claim 1 including at least a pair of said female die means in opposed spaced relationship, at least a pair of said means for successively feeding tabs of impervious sheet material and securing a peripheral portion to the longitudinal surface at each end of the rod; and means for effecting simultaneous opposed reciprocal relative movement between said pair of opposed female dies so that the ends of each successively aligned elongated rod of smoke pervious material are inserted into and thereafter retracted from the respective opposed female die means whereby the folded over tabs of sheet material are cupped over the respective ends of said elongated rods.

3. The apparatus of claim 1 including heaters disposed to heat said tabs whereby heat-activatable, pressure-sensitive adhesive on said tabs is rendered sufficiently tacky to secure the same to said rods.

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