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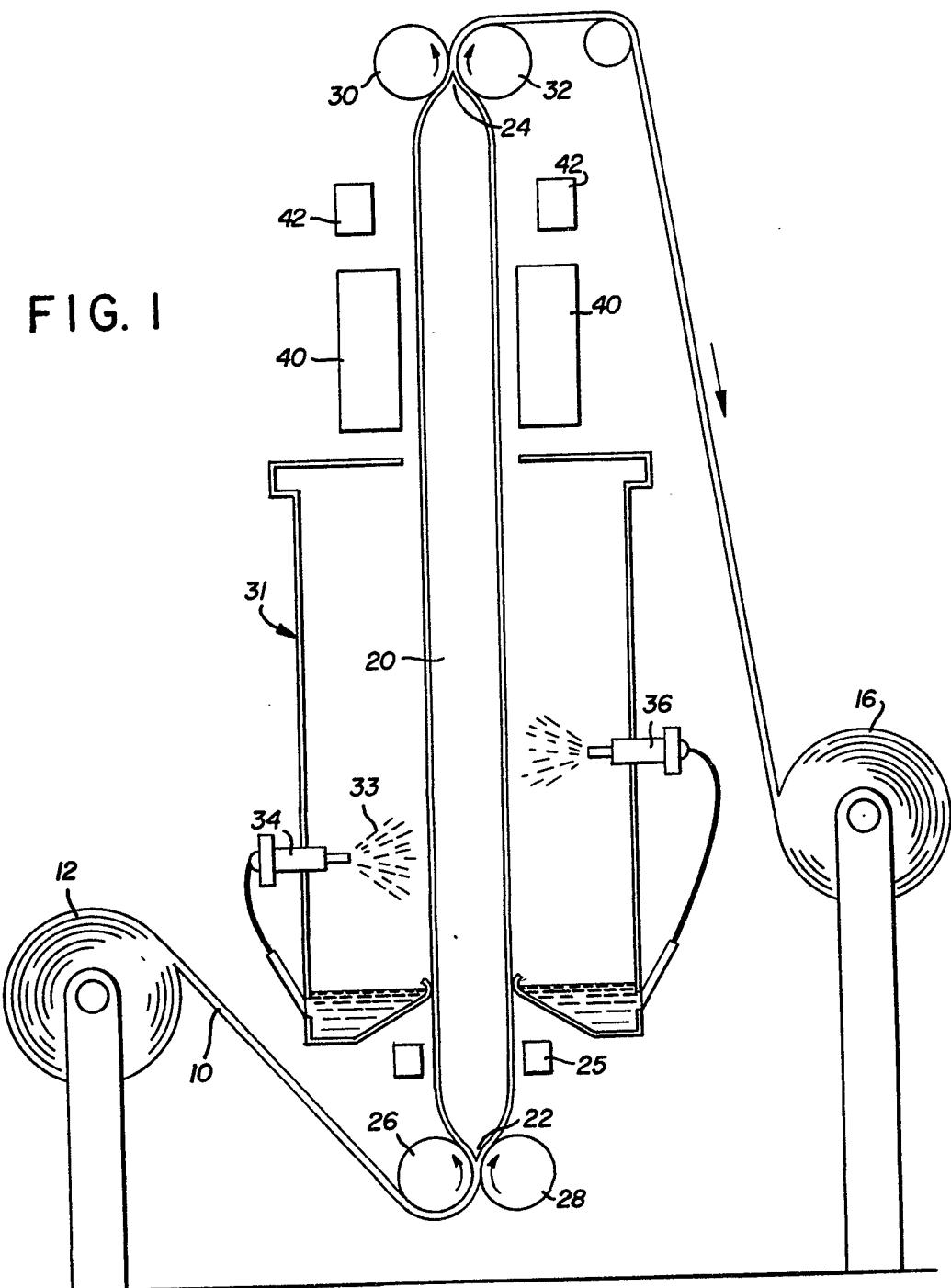
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(54) **Method for coating a tubular food casing**

(57) A method for coating a tubular food casing includes electrostatically coating an inflated section (interior or exterior) of the food casing and sintering the coated food casing. The process provides a pin-hole free coating and permits a continuous operation.

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FIG. 2

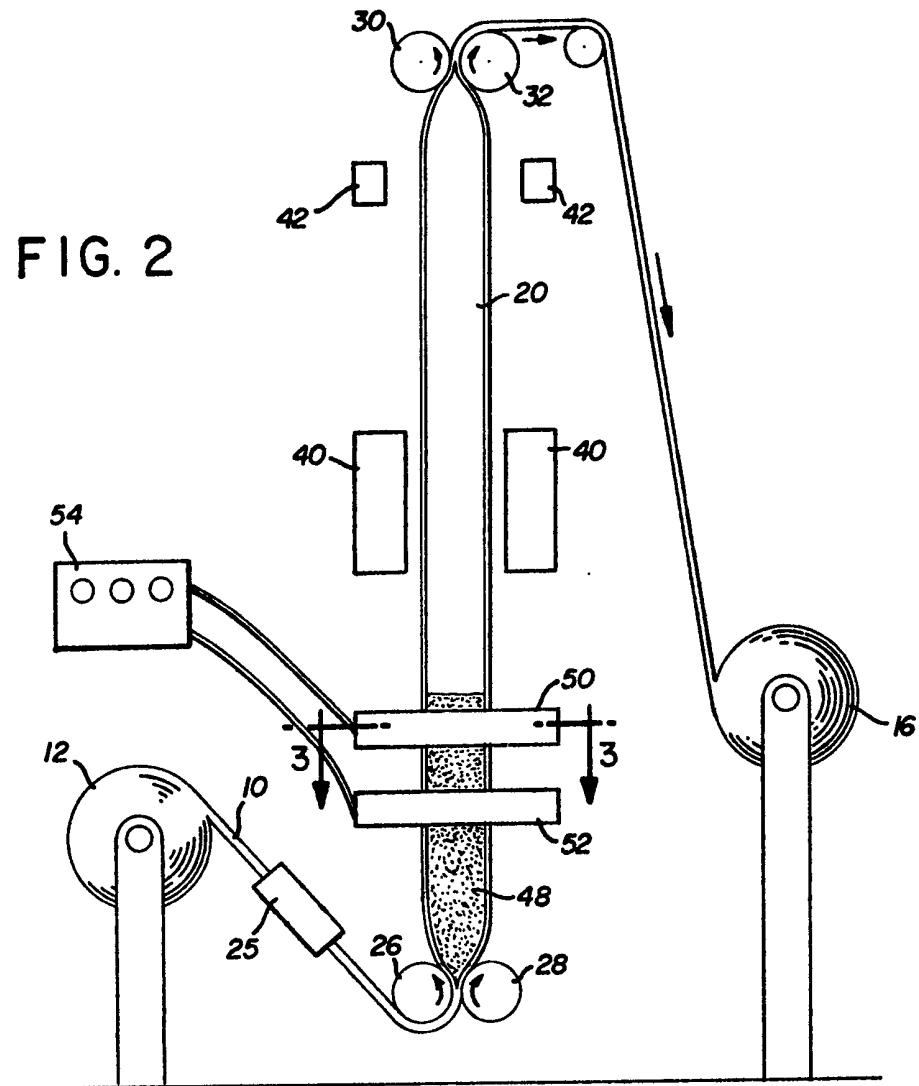
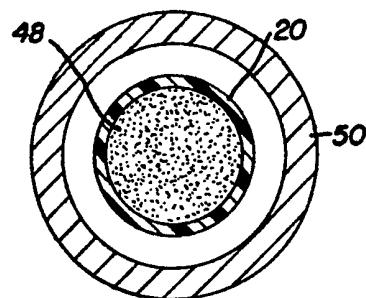


FIG. 3



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SPECIFICATION

Method for coating a tubular food casing

This invention relates to composite casings and more particularly to a method of forming a pin-hole free coating of resinous polymer upon a tubular cellulosic casing.

5 Tubular regenerated cellulose and fibrous casings are used in the food industry for processing food products such as meats, sausage, turkey, etc. A fibrous casing is composed of regenerated cellulose reinforced with a cellulosic fiber in the form of a paper preferably a long fiber hemp paper. The food product is stuffed into the casing and processed in situ. The casing serves as a container during processing of the food product and as a protective wrapping for the finished product. Since there are so 10 many differences in recipes for making processed food products, such as sausages and so many different modes of processing the different products, it is difficult to provide a casing which is acceptable for all uses. There are also several casing applications where low moisture vapor transmission with or without low oxygen transmission are extremely important. Accordingly, it is desirable to coat fibrous and cellulose casings with a polymer resin particularly to satisfy gas and vapor 15 permeability requirements.

15 Heretofore composite casings have been formed by covering a conventionally extruded tubular cellulose or fibrous casing with a coating of a preferred resin composition prepared from a solution or dispersion. The resin composition is applied by a procedure of dipping, spraying, slugging, gravure coating, or doctoring the solution or dispersion directly onto a surface of the tubular cellulose or fibrous 20 casing.

20 In the conventional solution and emulsion coating processes, heat must be applied gradually to the coated casing to vaporize the solvent and at an adequate temperature to effect sintering. Rapid drying of the casing may result in entrapment of solvent or water between the casing and the coating leading to "pin-holes" and/or blisters in the coating. A "pin-hole" free coating is defined for purposes of 25 the present invention as a continuous film essentially free from voids. The drying rate is therefore a limiting factor controlling the length of time required to sinter the coating i.e., flow and coalesce to form a continuous, tenaciously adherent coating on the casing surface. In addition, the sintering temperature cannot be too high as this could cause desiccation. Accordingly, the drying operation must be carefully controlled and monitored, since it is a principal factor in establishing the operating speed and it plays an 30 important role in applying a uniform and continuous coating thickness.

30 Applicant has discovered, in accordance with the present invention, a new method of forming a relatively thick pin-hole free coating of a polymer resin upon a tubular cellulose or fibrous casing which eliminates the drying step in conventional solution and emulsion coating processes, thereby providing increased flexibility over the time of exposure to heat, operating speed and sintering temperature. In 35 particular, the sintering time may be substantially reduced relative to the time required in conventional processes.

35 The present process also provides control over the uniformity in coating thickness. Thickness variations of less than about \pm 30% from the measured average thickness have been readily attained with the process of the present invention whereas prior art variations extend to about 80—100% from 40 average.

40 The process of applicant's invention for coating the exterior surface of a casing comprises: inflating the tubular cellulose or fibrous casing; securing the inflated casing from opposite ends thereof such that the inflated casing is held in a state of tension; exposing the casing to a cloud of electrostatically charged particles of a resinous polymer material having an average particle size less 45 than 125 microns for a period of time sufficient to form a surface deposit of such polymer material around the casing periphery; subjecting the coated casing to a temperature sufficient to sinter said coating in a time period of less than about 5 minutes; and cooling the sintered coating.

45 The process of applicant's invention for coating the interior surface of an inflated tubular cellulose or fibrous casing comprises: securing the inflated casing from opposite ends thereof such that the 50 inflated casing is held in a state of tension; introducing a slug of micronized resin powder into the interior of such inflated casing; generating an electrostatic field external of said casing and adjacent said slug of resin powder so as to form a deposit of said powder on the inside surface of the casing; advancing the casing at a predetermined rate past a sintering station; subjecting the coated casing within said sintering station to a temperature sufficient to sinter said coating about the interior of said 55 casing; and cooling the sintered coating.

55 The invention will now be further described by way of Example by reference to the accompanying drawings in which:-

55 Figure 1 is a schematic representation of an exemplary system for carrying out the method of the invention for coating the exterior surface of a casing;

60 Figure 2 is a schematic representation of the system of the present invention for coating the interior of a casing; and

60 Figure 3 is a cross section of the casing taken along line 3.3 of Figure 2.

65 The cellulose or fibrous casing 10, as identified in Figure 1 of the drawing, is a conventional casing of tubular geometry made by any conventional extrusion process upon which a primer operating as a

suitable adhesion promoter has been applied.

Primer materials which have been found compatible with the process of the present invention include the following compositions; polyhydroxylated alkoxy alkyl melamine complexes, triazine amine formaldehyde complexes, ethylene imine type compound, and the condensation product of a polyamide 5 with epichlorohydrin or a polyamine-polyamide with epichlorohydrin or a polyamine with epichlorohydrin. 5

The extruded tubular casing 10, preferably with a primed surface, is thereafter flattened and wound onto a feed roll 12 whereupon, if desired, it may be stored before initiating the coating method of the present invention. Coating of the tubular casing 10 is accomplished by passing the casing 10 10 from the feed roll 12 through a coating and sintering operation at a controlled speed to a pick up roll 16 as hereinafter described. A section 20, representing a predetermined length of tubular casing 10, is controllably inflated to a predetermined pressure by introducing air into the casing and trapping the air between the two ends 22 and 24 of the section 20. The end 22 is squeezed between a pair of nip rolls 26 and 28 whereas the end 24 of the section 20 is squeezed between a pair of nip rolls 30 and 32 15 respectively. 15

Although the casing may be held in either a horizontal or a vertical plane during the coating operation it is preferred to have the casing aligned in a vertical plane. If the coating is applied to a casing aligned in a horizontal plane, the casing may sag since the casing can not be supported until the resinous powder is anchored permanently from the sintering process. When the casing is permitted to 20 sag it becomes more difficult to apply a uniform coating and/or to assure uniform sintering. This problem of sagging is further aggravated at increased coating speed since the sintering time must remain constant, thereby increasing the length of unsupported casing. This length of unsupported casing is avoided or minimized by passing the casing 10 through a preheater 25 before exposing the section 20 to the electrostatic cloud 33. The preheater 25 should be located upstream of the coating 25 chamber 31 either preceding or following the inflated end 22 of section 20 of the casing 10. Preheating the casing increases the degree of adherence between the electrostatically coated powder particle and the casing surface as will become more evident hereafter in connection with the discussion of the coating operation. 25

The pair of nip rolls 30 and 32 is spaced at a predetermined distance above the pair of nip rolls 26 30 and 28 in a common substantially vertical plane so that section 20 is held in the preferred substantially vertical position during the sequence of operations for coating and sintering the section 20. It is also preferred to maintain the section 20 under at least some tension during treatment by a differential nip roll operating speed. 30

The inflated and preferably preheated section 20 is advanced at the controlled speed through a 35 coating chamber 31 in which the exposed section is subjected to a cloud 33 of electrostatically charged resinous polymeric particles for forming a coating of such particles about the periphery of the section 20. Preheating of the section 20 enhances adhesion of the coated particles by initiating sintering within the chamber 31. 35

The cloud 33 of electrostatically charged particles may be established by use of an electrostatic 40 spray gun 34 as exemplified in the drawing or by means of an electrostatic fluidized bed. In each case an electrostatic field is established in which the resin particles are charged and propelled to form the 40 electrostatic cloud. Upon dispersement, the electrostatic cloud is attracted to the tubular casing 10 which is maintained at ground potential. 40

In utilizing the electrostatic spray technique, it is preferred that at least two conventional 45 electrostatic spray guns 34, 36 be employed on opposite sides of the tubular section 20 during the coating operation with one of the guns preferably elevated relative to the other. The guns are used to charge and propel the powdered resin particles which form the electrostatic cloud 33. 45

The particle size of the polymeric material has been found to be a critical parameter in the spray 50 coating process. A particle size range of less than 125 microns but preferably between 20—80 microns was found necessary to form a uniform relatively thick deposit of particles. 50

In addition, it was found that certain electrostatic spray parameters such as spraying distance, powder flow rate and spray time must be maintained within predetermined ranges to achieve a relatively thick and evenly distributed deposit around the tubular section 20. The spraying distance or distance between the outlet nozzle of each of the spray guns 34 and 36 respectively should be 55 maintained between about 6—9 inches from the tubular section 20. The powder flow rate should be held preferably between 2—5 grams per second from each spray gun 34 and 36 respectively. The spray time is determined by the rate of travel of the section through the electrostatic spray chamber. The rate of travel may then be varied to establish the desired thickness of deposit. When the coating thickness was under about .5 mils, pin-holes were observed in the finished coating. 55

60 In addition to the preferred vertical disposition of the casing 20 in the electrostatic chamber, and the selection of spray parameters and particle size range, it is necessary that the section 20 of tubular casing be inflated to a pressure which maintains the casing fully inflated, and preferably between 10—50 inches of water, during both the coating and sintering sequence. The inflation of the tubing, particularly within the preferred range, not only assists in assuring an even distribution of particles but 65 prevents shriveling of the casing due to loss of moisture during the relatively fast sintering operation. 65

The preheating of the casing is also important in that sintering may actually be initiated for promoting adhesion between the electrostatic particles and the casing within the coating chamber.

Sintering of the electrostatically coated casing occurs upon passage of the casing through a stack of radiant heaters 40 for a period of less than 5 minutes and preferably less than 3 minutes at a suitable 5 temperature of, for example, 400°F to effect sintering. The sintering period can be reduced to under thirty seconds at a higher sintering temperature of about 510°F.

Cooling of the sintered coated section of the tubular casing is preferred before passage through the nip rolls 30 and 32. A preferred method of cooling is to use an air ring 42 for passing ambient air at 10 a controlled flow rate about the sintered coating. The section 20 is progressively being renewed with the coated casing at the end 24 being reflattened and wound up on the take-up roll 16 while the uncoated casing upstream of end 22 is being advanced through nip rolls 26 and 28 until the entire 15 tubing is coated with a continuous pin-hole free coating about its exterior surface.

Resinous polymers suitable for use in coating the casing of the present invention include "polyolefins" ionomers, polyamides, polyesters, polyacrylonitriles, "vinyl polymers" and epoxy resins. By 20 polyolefins we mean polymers such as polyethylene, ethylene acrylic acid and ethylene vinyl acetate. By 15 vinyl polymers we mean polyvinyl chloride, polyvinylidene chloride and the copolymers of vinylidene chloride. As used herein the term polymer includes homopolymers, copolymers, terpolymers, block copolymers and the like. Examples of polyvinylidene chloride copolymers include vinylidene chloride polymerized with such materials as vinyl acetate; vinyl chloride; alkyl acrylate or methacrylate such as 25 methyl, ethyl, propyl, butyl, isobutyl; acrylonitrile; methacrylonitrile; styrene; and the like or mixture of two or more of these compounds.

The resins used as coatings may include suitable plasticizers, stabilizers, slip and anti-blocking agents, pigments and other additives which are well known in the art.

The polyvinylidene chloride resin (PVDC) composition includes more than 50% vinylidene chloride 25 and preferably between 70—95% vinylidene chloride. The following Table shows the spraying conditions for pin-hole free coatings with a PVDC resin coating composition and a polyethylene coating composition.

**OPERATING CONDITIONS FOR PINHOLE FREE COATING USING
ELECTROSTATIC SPRAY GUN**

Sample	Resin	Particle Size	Spraying Time (sec)	Powder Output gm/sec	Spraying Distance (inch)	Average Coating Thickness (mils)
1	PVDC	* 40 microns	3.0	2.0	10	1.2
2	"	* " "	3.0	3.0	8	2.2
3	"	* " "	2.0	2.3	8	1.5
4	"	* " "	2.5	2.2	9	1.0
5	"	* " "	6.0	2.0	8	3.5
6	Polyethylene	20 microns	2.0	2.8	8	2.6
7	"	" "	2.5	3.0	9	2.2

* Vinylidene chloride 89—92% and Vinyl chloride 8—11%

Figure 2 is an illustration of the preferred procedure for establishing the coating on the interior side of the inflated section 20 of casing 10. For simplicity of explanation the same reference numbers have been used to identify corresponding elements between Figure 1 and Figure 2.

5 The flat casing 10, internally coated with a primer, is held in tension between the two sets of nip rolls 26, 28 and 30 and 32 respectively in the same manner as explained heretofore with respect to Figure 1. A slug of micronized resin powder 48 is introduced into the casing 10 within the inflated section 20. The powder coating composition is equivalent to that taught earlier for coating the exterior of the casing 10. An electrostatic field can be established by several methods using for example a high voltage AC or DC source or by means of a corona discharge. Figures 2 and 3 show one technique for 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 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2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 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6. A process as claimed in claim 5, wherein said polymeric material is a vinyl polymer and comprises a composition containing at least 50% vinylidene chloride.

7. A process as claimed in any one of the preceding claims, wherein said polymeric material is bonded to said food casing through a primer material selected from the class consisting of 5 polyhydroxylated alkoxy alkyl melamine complexes, triazine amine formaldehyde complexes, ethylene imine type compound, and the condensation product of a polyamide with epichlorohydrin or a polyamine-polyamide with epichlorohydrin or a polyamine with epichlorohydrin.

8. A process as claimed in any one of the preceding claims, wherein said sets of pinch rollers are aligned in a substantially vertical plane.

10 9. A process as claimed in any one of the preceding claims, wherein the electrostatic coating is carried out to produce a layer thickness having a surface uniformity which varies about \pm 30% from its average thickness.

15 10. A continuous process for forming a pin-hole free layer on the exterior surface of a flexible tubular cellulosic food casing substantially as hereinbefore described with reference to and as illustrated in Figure 1 of the accompanying drawings.

11. A food casing whenever treated by a process as claimed in any one of the preceding claims.

12. A continuous process for forming a pin-hole free layer on the interior surface of a flexible tubular cellulosic food casing, comprising the steps of; establishing a path for processing said food 20 casing; providing two sets of pinch rollers at spaced apart locations along said path so that said food casing can move through said sets of pinch rollers continuously while being maintained in a pinched state; maintaining an inflated section of said food casing in tension between said sets of pinch rollers; providing within the interior inflated section of said food casing a predetermined amount of dry particles of a resinous polymeric material having an average particle size of less than 125 microns; electrostatically coating a portion of the interior of said food casing section; moving said food casing 25 along said path so that the coated portion of said food casing moves to a location for sintering between said sets of pinch rollers; and sintering said coated portion to form said layer.

13. A process as claimed in claim 12, further comprising the step of preheating said food casing prior to the coating step.

14. A process as claimed in claims 12 or 13, wherein said polymeric material is selected from the 30 group consisting of polyolefins, ionomers, polyamides, polyesters, polyacrylonitriles, vinyl polymers and epoxy resins.

15. A process as claimed in claim 14, wherein said polymeric material is a vinyl polymer and comprises a composition containing at least 50% vinylidene chloride.

16. A process as claimed in any one of claims 12 to 15, wherein said sets of pinch rollers are 35 aligned in a substantially vertical plane.

17. A process as claimed in any one of claims 12 to 16, wherein said polymeric material is bonded to said casing through a primer material selected from the class consisting of; polyhydroxylated alkoxy alkyl melamine complexes, triazine amine formaldehyde complexes, ethylene imine type compound, and the condensation product of a polyamide with epichlorohydrin or a polyamine-polyamide with 40 epichlorohydrin or a polyamine with epichlorohydrin.

18. A continuous process for forming a pin-hole free layer on the interior surface of an flexible tubular cellulosic food casing substantially as hereinbefore described with reference to and as illustrated in Figures 2 and 3 of the accompanying drawings.

19. A food casing whenever treated by a process as claimed in any one of claims 12 to 18.