May 15, 1956 E. R. FREDERICK 2,745,375

APPARATUS FOR COVERING CORE MATERIAL WITH FIBROUS MATERIAL

Filed Aug. 18, 1952 2 Sheets-Sheet 1

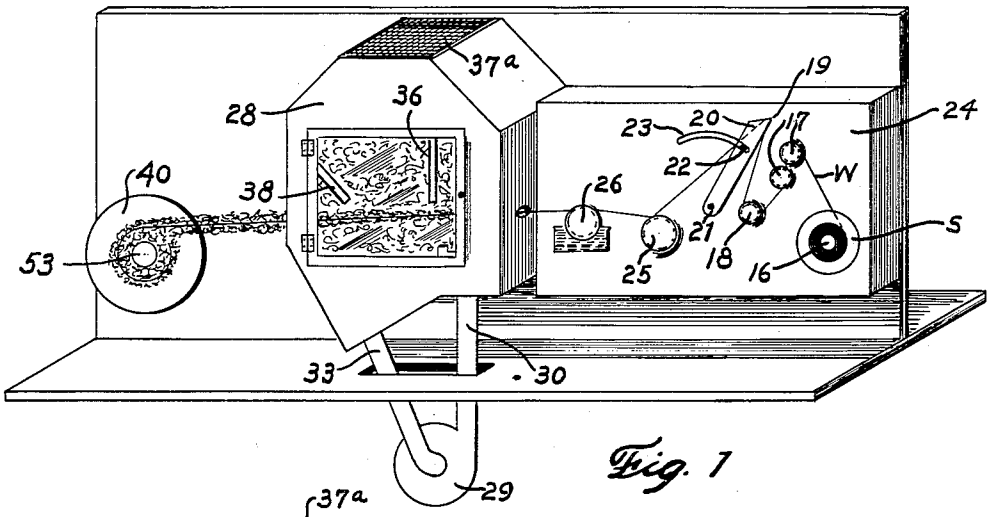


Fig. 1

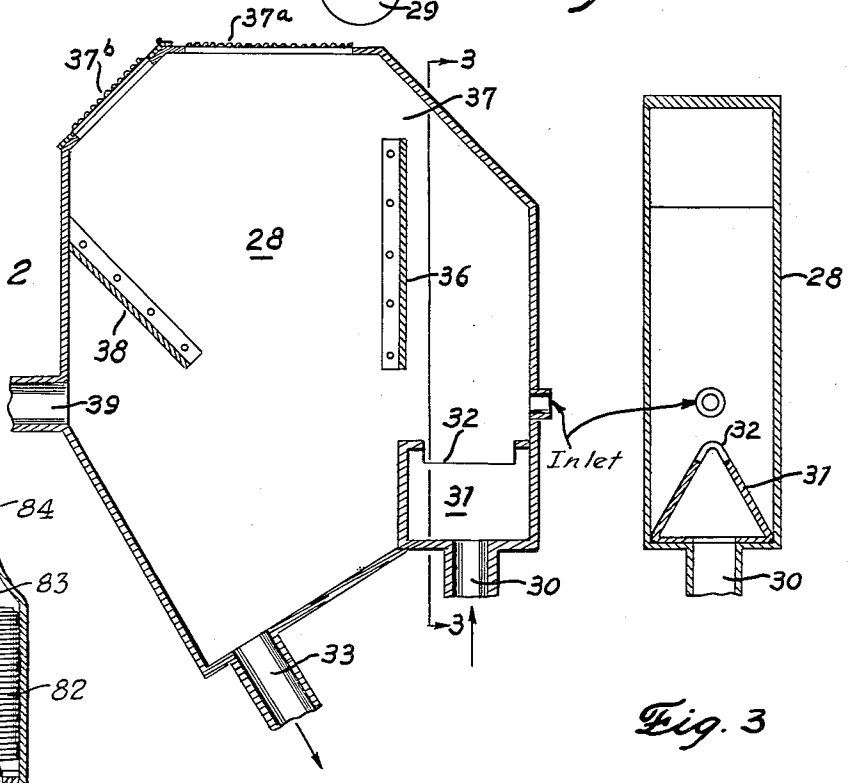


Fig. 2

Fig. 3

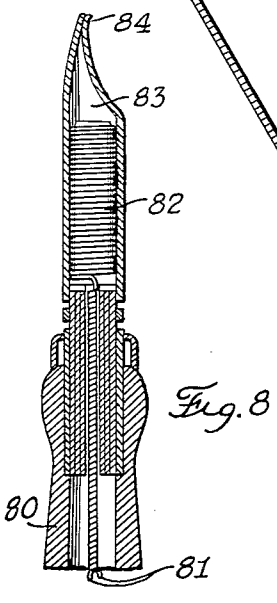


Fig. 8

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APPARATUS FOR COVERING CORE MATERIAL WITH FIBROUS MATERIAL

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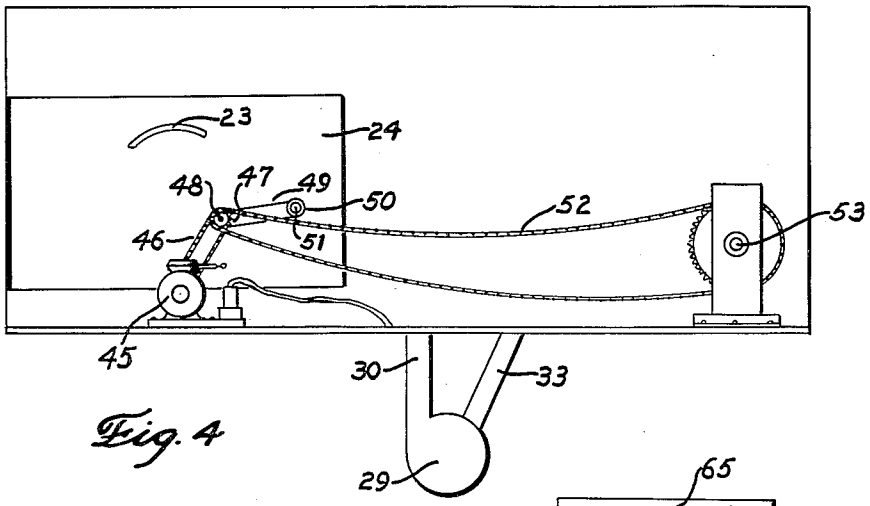


Fig. 4

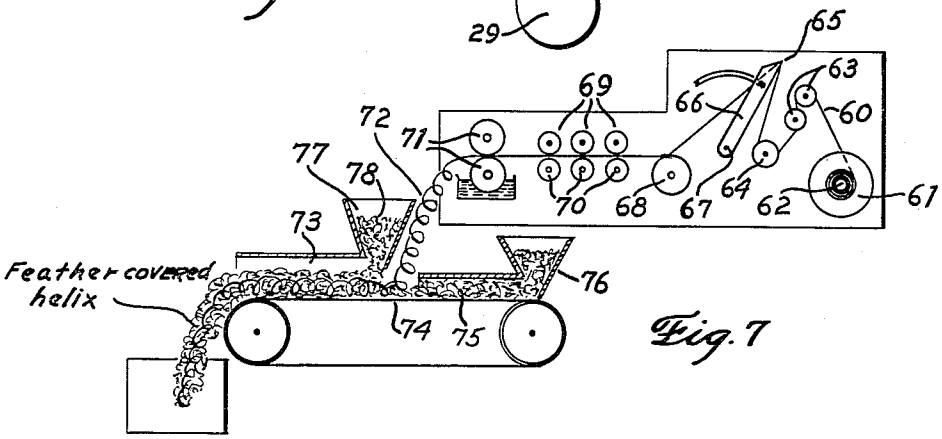


Fig. 7

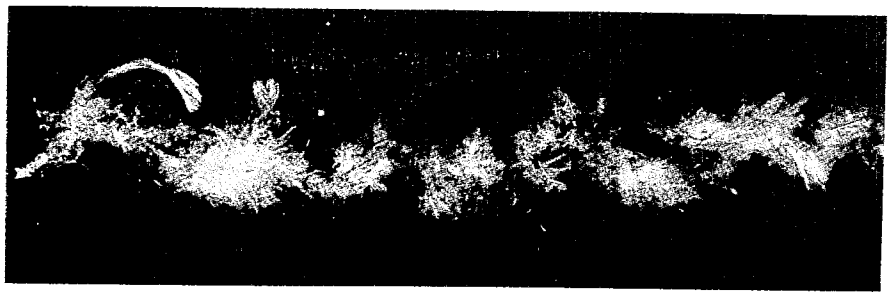


Fig. 6

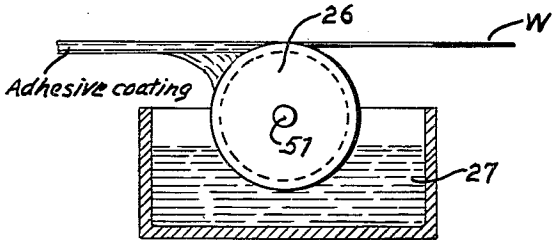


Fig. 5

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2,745,375

APPARATUS FOR COVERING CORE MATERIAL WITH FIBROUS MATERIAL

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Application August 18, 1952, Serial No. 304,875

8 Claims. (Cl. 118—33)

This invention relates to apparatus for covering core material, especially a resilient wire or monofilament, with fibrous material, preferably chicken feathers, to make high bulk filler elements useful for sleeping bags, mattresses, pillows, cushions, comforters, cold weather clothing and other articles requiring insulation, softness and drape properties. The apparatus herein shown and described is, except for a few minor details, disclosed in my pending application Ser. No. 276,985 filed March 17, 1952, now Patent No. 2,715,086 dated August 9, 1955, of which the present application is a continuation-in-part.

The general object of the invention is to provide apparatus to manufacture a filler element whose "filling power" will approach or equal that of waterfowl feathers and waterfowl feathers plus down mixtures, while having other properties making it superior to such feathers and mixtures.

In explanation of the term "filling power," reference may be made to the report entitled "A Proposed Method for Measuring the Flling Power of Down and Feathers" by Henry A. Sinski, publication No. TD 103037, The Office of Technical Services, U. S. Department of Commerce, and to the article by N. B. Edelman in Textile Research Journal, vol. 17, p. 199 (1947) entitled "Investigation of methods for determining the filling power of feathers." See the Sinski et al. Patent No. 2,706,910 dated April 26, 1955.

A more specific object of the invention is to provide apparatus which will produce continuously a low density, high bulk chicken feather or like filler which may therefore be of any desired length. Another specific object is to provide apparatus which is adjustable or automatically operable to vary the compression resistance of the filler at different points along its length to meet service requirements. Other objects will be apparent from the following description of two embodiments of the invention shown somewhat diagrammatically in the accompanying drawings forming a part of this specification.

In said drawings,

Fig. 1 is a somewhat diagrammatic perspective view of the apparatus;

Fig. 2 is a vertical section through the feather-applying chamber;

Fig. 3 is a cross section on line 3—3 of Fig. 2;

Fig. 4 is an elevation of the back side of the apparatus of Fig. 1, showing the drives;

Fig. 5 is a detail in sectional elevation showing the coating of the wire with an adhesive;

Fig. 6 is a reproduction of a photograph of a chicken feather filler element made by the apparatus of Figs. 1–5;

Fig. 7 is a diagrammatic elevation of a modified apparatus particularly useful for attaching two different fibrous products simultaneously to the core;

Fig. 8 is a longitudinal sectional view showing a prior art heated knife which may be used in "spiralizing" nylon and other monofilaments.

Before describing the machines, it should be explained that a careful study of the problem and available raw materials led to the conclusion that the filler should be of indefinite length, that it should employ feathers cemented to a helical wire or monofilament, and that the helix itself should be open and of relatively large dimensions. Because chicken feathers are available in huge quantities, are non-strategic, inexpensive, light in weight and can be processed to acquire a fairly high filling power, they are preferred to all other raw materials. However, turkey feathers with their quills removed, rabbit hair, other animal hair or wool, synthetic fibers such as chopped nylon monofilament, and even mixtures of feathers or feather fibers with natural or synthetic fibers, may be used as the fibrous material. If a mixture is used, the one presently preferred by me consists of "Dacron" (polyethylene terephthalate) 50%, commercial crushed chicken feathers 50%. This material is disclosed in my pending application Ser. No. 305,683 filed August 21, 1952, now Patent No. 2,684,337 dated July 20, 1954.

The following wires or monofilaments have made satisfactory cores for carrying the fibrous material: steel wire (piano wire) 000, 00, 0, 1, 2 and 3 gauge; nylon: 0.005, 0.006, 0.007, 0.008, 0.010, 0.015 and 0.020 in. diameter; "Dacron": 0.009 in. diameter; polyvinyl chloride: 0.010 and 0.020 in. diameter; polyethylene; 0.020 in. diameter; "Saran" (polyvinylidene chloride): 0.010, 0.015 and 0.020 in. diameter. The best known monofilament is "Dacron." For convenience, the term "wire" is frequently used herein to denote any suitably fine metallic wire or resinous monofilament having the necessary resilience and other qualities.

Referring first to Figs. 1 and 2 of the drawings, a spool S is shown supported on a spindle **16** so as to rotate freely and pay out a monofilament or wire W wound thereon. A friction device **17** of known construction grips the wire W frictionally, and as the end of the wire is being pulled by a power-driven reel to be described, the wire will be under constant tension. An idler pulley **18** guides the wire to a fixed knife edge **19** mounted on the upper end of an upwardly extending arm **20** pivoted at **21** whose angle may be adjusted by means of a bolt **22** which passes through an arcuate slot **23** in upright support **24**. As the tensioned wire passes at an acute angle over the knife edge, one side of the wire is stretched, which results in a permanent set, causing the wire to assume a permanent helical form when the tension is relaxed. For nylon monofilaments and the like, the described knife edge may be replaced by an electrically heated, thermostatically controlled curling edge, such as a soldering iron modified at its tip to provide a heated knife edge. Thus as shown in Fig. 8, arm **20** may be superseded by a hollow heat-insulating arm **80** carrying a pair of electrical conductors **81** leading to a resistance wire **82** housed in a hollow metal body **83** having a knife edge **84** at its upper end, the monofilament W being passed (while tensioned at a sharp angle) over the knife edge in the manner indicated in Figs. 1 and 7. The prior art contains numerous examples of electrically heated knife edges, for instance the Paolicelli et al. Patent No. 1,616,544 dated Feb. 8, 1927, from which Fig. 8 is copied.

When working with nylon and similar monofilaments, it is advantageous to set the helices with heat and/or humidity control. The desired high humidity may be attained by a fine water spray or a moistened wick (not shown) which the monofilament contacts before it passes over the knife or curling edge. The described treatment of a wire or filament to cause it to assume a helical form may be termed "spiralizing," and in some of the appended claims, for convenience, the wire or filament is said to be "spiralized," that is, treated in the manner described.

From the knife or curling edge the wire goes to a

power-driven roll 25 about which it is wrapped once, to effect drawing of the wire; then it passes to and around an adhesive-coating roll 26 dipping into an adhesive bath 27. See Fig. 5. For the adhesive I prefer to employ "Pliobond 20," which is understood to be a butadiene-acrylonitrile rubber type adhesive, made by the Goodyear Tire & Rubber Company. This adhesive forms a positive bond so strong that chicken feathers attached to the core by the adhesive may be pulled apart before their bonds will yield. "Pliobond 20" is extremely tacky, is vulcanizable, dries satisfactorily under the conditions obtaining, and is not brittle at low temperatures (—65° F.), nor does it disintegrate or flow at +120° F. Also it forms a protective coating for steel wire, minimizing rusting. While the adhesive has an objectionable odor, perhaps due to a volatile ketone, the odor disappears in time; if desired, deodorants or aeration may be used to shorten the period during which the odor is noticeable.

After passing around coating roll 26, the adhesive-coated wire extends in a horizontal line, due to its tension, and passes through a feather-applying chamber 28 to which a blower 29 (driven by a direct-connected electric motor, not shown) is coupled through a blower line or tube 30 discharging into the bottom of the chamber. A fixed nozzle 31 having a narrow elongated discharge opening 32 extends from the bottom of the chamber upwardly nearly to the horizontal wire or filament to direct the blast of air against it. Air is supplied to blower 29 principally from an exhaust or suction line 33 which sucks air and feathers out of the bottom of chamber 28. Feathers are supplied from a feed conveyor which may be connected with a hopper, not shown, or if preferred, the feathers may be blown into the chamber, with suitable precautions (such as baffles) to prevent interference with the air-borne feathers inside the chamber.

The stream of air from the blower 29 not only carries the feathers upwardly but orientates them, the quills of nearly all the feathers traveling through tube 30 being foremost or in advance the barbs. Thus, it is usually the quills which strike the wire and become attached thereto by the adhesive. When so attached the quills are generally at right angles to the wire. The air stream helps to dry the adhesive to make a reasonably firm bond between the feathers and the wire before the wire passes out of the machine. Those feathers which do not become immediately attached are blown upwardly to the top of the chamber, being confined in a definite stream of air by an upper vertical partition 36 which is located wholly above the wire and extends nearly to the top of the chamber but provides an opening or throat 37 for the air stream and unattached feathers to flow through, the movement being counterclockwise as the parts are viewed in Fig. 1. This counterclockwise flow is aided by the illustrated inclined or angular disposition of the top walls of the chamber; if preferred, a rounded top wall may be employed to make the flow more smooth. A baffle 38 fixed to the end wall of the chamber and extending downwardly at an angle of about 45° to the horizontal, but located wholly above the wire, diverts the unattached feathers moving down from the top of the chamber away from the discharge opening 39 and causes the unattached feathers, in many cases, to strike the portions of the coated wire not covered by feathers, thereby to complete the covering of the wire before the wire emerges from the chamber. The top walls of the chamber may have foraminous areas or screens 37*a*, 37*b* permitting escape of air blown into the chamber, which prevents loss of feathers through the discharge opening 39. One screen 37*b* may be hinged as shown to permit dumping of new batches of feathers into the chamber from time to time. Those feathers which are still unattached after going past the wire a second time are recirculated, that is, are returned to the blower by suction line 33 and are again blown into the chamber against the wire, and continue circulating indefinitely until they are finally adherent to the wire. The covered wire, still straight due to its tension, travels to a take-up reel 40, to which one end of the wire was initially attached so that it could be wound up. If desired, reel 40 may be of such diameter that a single rotation thereof will be sufficient to make a single filler element; in this case, after each reel rotation, the drive motors may be stopped by a simple limit switch (not shown) which could be controlled by a cam on reel 40, and the filler element may then be cut and removed from the reel for further processing, or else the filler element may be cut while the reel is still in rotation, provided the reel has appropriate means for gripping the severed end of the filler element. Obviously, many other forms of take-up means may be used in lieu of the described reel, or if preferred the filler element may be discharged by gravity into a receptacle or to a machine for further operations.

Power to drive the several elements of the machine (except the blower, which is independently driven and controlled) is derived from an electric motor 45 (Fig. 4) driving a sprocket pinion (not shown) through a reduction gear (not shown) direct-connected with the motor. A sprocket chain 46 is driven by the sprocket pinion and is trained around another sprocket pinion 47 fixed to a shaft 48 which drives the roll 25. A small pinion (not shown) fixed to shaft 48 drives a small sprocket chain 49 which is trained around a second small pinion 50 fixed to shaft 51 to which the adhesive-coating roll 26 is also secured. A sprocket chain 52 couples shaft 48 with shaft 53 of the take-up reel 40 to rotate the latter at the desired speed. Obviously, many other mechanisms may be employed in lieu of the described power drives.

Fig. 6 shows a chicken feather covered filament after it has been removed from the described apparatus. The individual feathers were nearly all attached by their quills to the spiral core, and extended outwardly therefrom in all directions. The spiral core was a nylon monofilament of 0.020 in. diameter, weighing 0.01335 oz. per linear foot, when tensioned. A sample of this product when permitted to assume its untensioned spiral form weighed between 1.5 and 1.6 gm. per foot. Naturally the weight will vary according to the core material and the fibers covering it. Although the monofilament of Fig. 6 when "spiralized" might have assumed a helix diameter of about one inch and a pitch of about one inch, the powerful adhesive used plus the tension imposed by the described apparatus act to extend or stretch the helix permanently (at least in the case of nylon), so that the helix has a smaller diameter and a greater pitch than it would have were the tension relaxed immediately after the spiralizing step. In one instance observed, a nylon monofilament 27 in. long after coating with the described adhesive formed a helix of about ⅞ in. diameter with a pitch of at least 2½ in. If such stretching or distortion is more than can be tolerated, the apparatus shown in Fig. 7 may be used to form the helix; or the original helix form (1 in. pitch, 1 in. diameter) may be substantially restored by axial compression of the stretched helix combined with heat treatment (assuming that the filament is a heat-deformable or thermoplastic material).

Referring to Fig. 7, a form of apparatus is there shown which will minimize deformation or stretching of the helix. Here the monofilament 60 is unwound from a spool 61 supported to rotate freely about a fixed pin 62; the monofilament passes through a frictional tension device 63, then around a grooved pulley 64, then up over a knife edge 65 fixed upon the upper end of a pivoted and adjustable arm 66 whose pivot is indicated at 67. The tensioned monofilament then runs down around a driving or drawing pulley 68, power-driven of course, and between three pairs of driving rolls, 69, 70, then between the power-driven adhesive coating rolls 71. Immediately after leaving the coating rolls the monofilament, which has been spiralized by contact under tension with the knife edge 65, is allowed to assume its inherent helical or

spiral form by relaxation of its tension; this is indicated at 72. This assumption of the inherent helical or spiral form takes place gradually as the molecular stresses in the monofilament are given time to react.

The relaxed helical core now enters a chamber 73 through which a horizontal belt conveyor 74 runs. Chamber 73 may be much longer than is suggested by the diagram, so as to give time for the molecular stresses to react further, and so as to insure a complete covering of the coated helical core. The upper run of the belt conveyor receives continuously a supply of feathers 75 by gravity from a hopper 76 or from a pneumatic conveyor (not shown) whose delivery end may be greatly enlarged to deposit the feathers gently upon the upper run of the conveyor. In this case the conveyor may be foraminous to permit the feather-discharging air currents to pass through it while leaving the feathers behind. As the coated helical core enters chamber 73, it falls down on top of the layer of feathers 75 and immediately many of the feathers attach themselves at various angles to the loops of the helix on the outside, some of the feathers extending longitudinally of the helix on the outside to form bridging elements attached to and extending between two adjacent loops. Additional feathers are blown into the top of the chamber through a pneumatic conveyor having a discharge end 77 to insure attachment of some feathers to the inside of the helix, as well as to a multitude of points on the outside. An exhaust pipe (not shown) may be coupled to the chamber 73 at the delivery end to carry away by suction any loose feathers or fibers, and these loose particles may be again introduced into the apparatus. If necessary, an air jet (not shown) may be used to blow off unattached feathers remaining on the upper run of the conveyor so that they will be caught up by the aforesaid suction and carried away, or an electrostatic field may aid in dislodging the feathers from the conveyor.

If desired, different types of feathers may be simultaneously applied to the helical core by the apparatus described above in connection with Fig. 7. For example, straight chicken feathers, which are stronger than crushed feathers, may be discharged on the conveyor to form a layer 75, while crushed feathers and/or feather fibers 78 may be introduced into the chamber through conveyor outlet 77. The straight feathers supported on the conveyor will become attached almost wholly to the outside of the helix and in many instances will extend longitudinally, adhering to two adjacent coils thereof, while the crushed feathers etc. will be bonded both inside and outside the helix. The described form of filler element employing in part straight feathers has exceptional resistance to compression stresses primarily because the straight feathers form bridging elements tying together adjacent coils. However, because of this resistance, it will lack the softness and draping quality of the filler element made by the method of Figs. 1 and 2.

The dimensions of the helices, that is, their diameters and pitch, are subject to variation by (1) changing the tension of the wire when it passes over the knife or curling edge, or (2) changing the angle of the wire relative to said knife edge. Greater tension causes the wire to form a helix of smaller diameter, and a more obtuse angle between the wire and the edge makes for larger diameters. A variation in the tension may be effected by increasing the frictional resistance of the tension device, and such increase may be temporary or recurrent, in the latter case being effected by a power-driven cam (not shown) or a similar mechanism. A variation in the angle may be effected by manual adjustment of the angle of the arm carrying the edge by a power-driven cam (not shown) arranged to swing the arm to effect a change in the angle. In the case of steel wire, a spring coiling machine of a well known type may be used to turn out helices of the desired pitch and diameter.

Several alternations of close and open coils may be provided in each helix length so that the resistance to lateral compression may be proportioned to the load likely to be imposed. Thus, a human body inside a sleeping bag lying flat on the back presses heaviest below the shoulder blades, under the buttocks and thighs, and under the heels. The feather-covered helices provided by the apparatuses of the invention may be made and assembled to withstand the variable and unequal loads imposed by the weight of the human body, which sometimes equal 4 p. s. i. This aspect of the invention is disclosed more fully in my Patent No. 2,715,086.

The filler elements, being of indefinite or unlimited lengths, may be woven to form high bulk layers and lofty fabrics useful for heat insulation. Such bulky fabrics will be characterized by their outstanding stability due to the anchoring of the individual feathers and the core material; there will be no voids due to piling up or bunching of loose material in pockets such as occurs with many quilted fabrics of the prior art. Therefore, loss of body heat (which often results in severe frostbite) is unlikely to occur when using bulky fabrics made possible by the invention.

I am aware that it has been proposed to apply flock to straight wires and other resilient cores for the purpose of electrically insulating such cores; also, that rayon flock has been attached to automobile seat cushion springs by an adhesive to deaden the sound emitted by such springs under shifting loads. Flock is usually 1 mm. or less in length and is too fine to provide the substantial, bulky heat-insulating layer which feathers, feather fibers or the like, will provide when processed as described herein and in Patent No. 2,715,086. For convenience in the following claims I employ the term "bulky soft fibrous product" to denote all soft feather or feather-like products, including bulky synthetic downs and fibers, which are capable of being blown by an air current against a "spiralized" adhesive-coated core element, either tensioned as in Fig. 1 or relaxed as in Fig. 7, thereby to form a high bulk, low weight filler whose overall diameter is about one hundred or more times the cross sectional diameter of the core element.

What I claim is:

1. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; means over which the tensioned core material travels for changing the molecular structure of the core material by an unbalanced stretching so that the core material, when tension is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means to coat the treated core material with a tacky adhesive; means for applying a bulky soft fibrous product to said core material and in sufficient quantity to cover said core material with a high bulk bonded covering; and means to carry away the covered core.

2. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; a knife edge over which the core material passes under tension and at an acute angle so as to change the molecular structure of the core material by an unbalanced stretching so that the core material, when tensioned is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means to apply a coating of a tacky adhesive to the traveling tensioned core material; power-driven means to convey forcefully a bulky soft fibrous product to and against the tensioned coated core material in sufficient quantity

to cover it; and means to carry the covered core material away.

3. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; a heated knife edge over which the tensioned core material travels at an acute angle so as to change the molecular structure of the core material by an unbalanced stretching so that the core material, when tension is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means to apply to the traveling tensioned and treated core material a coating of tacky adhesive; means to apply a bulky soft fibrous product to the coated core material in sufficient quantity to cover it; and means to convey the covered core material away.

4. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; a knife edge over which the tensioned core material travels at an acute angle so as to change the molecular structure of the core material by an unbalanced stretching so that the core material, when tension is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means to apply a tacky adhesive to the traveling tensioned and treated core material to coat the same, pneumatic conveyor means; a substantially closed chamber into which the pneumatic conveyor means discharges; said pneumatic conveyor means and said chamber effecting a circulation of a bulky soft fibrous product to blow the fibrous product repeatedly against the coated core material to cover the latter; and power-driven means to convey the covered core material away.

5. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; means over which the tensioned core material travels for changing the molecular structure of the core material by an unbalanced stretching so that the core material, when tension is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means to coat the traveling treated and tensioned core material with a tacky adhesive; means for circulating a mass of bulky soft fibrous product and blowing it repeatedly against the coated core material, said last-named means including a partly closed chamber having an inlet for receiving the core material, a blower, and pipes connecting the intake and discharge sides of the blower with said chamber; said chamber having an outlet for the covered core material and another outlet for air; and means to conduct the covered core material away from the chamber.

6. The invention defined in claim 5, wherein a discharge nozzle is connected with the discharge side of the blower and is located within said chamber adjacent the core material inlet but below the tensioned core material traveling between the inlet and the outlet, said discharge nozzle discharging the fibrous material upwardly only.

7. The invention defined in claim 5, wherein the blower has a discharge nozzle located in the chamber adjacent but below the inlet, the chamber has its bottom below the nozzle, the intake pipe of the blower being connected to said bottom, a vertical baffle being arranged in the chamber above the nozzle and to one side thereof to direct the fibrous material in a straight path up to the top of the chamber, there being a throat for passage of the fibrous material between the upper edge of the vertical baffle and the top wall of the chamber, a foraminous area located in the top walls of the chamber above and beyond said throat and constructed to permit air to escape but to hold the fibrous material within the chamber, and a downwardly inclined baffle fixed within the chamber above the outlet and the tensioned core material and acting to divert the fibrous material, moving down from the top of the chamber, against the core member and away from said outlet.

8. Apparatus for producing continuously a low density, high bulk filler suitable for sleeping bags comprising means for moving a continuous fine resilient core material in its own length; means for imposing tension on said core material as it travels; means over which the tensioned core material travels for changing the molecular structure of the core material by an unbalanced stretching so that the core material, when tensioned is released, will automatically assume a generally helical form, the diameter of the helix so formed being many times the diameter of the cross section of the core material; means for applying a coating of a tacky adhesive to the tensioned core material; chamber means for receiving and enclosing the coated core material in a relaxed condition, so that the core material is generally helical; means for conveying a bulky soft fibrous product into said chamber means and against said relaxed core material; and conveyor means for conveying the core material away after it has been covered in said chamber means by said fibrous product.

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