# United States Patent [19]

**Lewis, Jr.**

[11] **3,798,699**

[45] **Mar. 26, 1974**


[54] **SYNTHETIC TUFTED CONSTRUCTIONS**


[75] Inventor: **John C. Lewis, Jr.**, Middlebury, Vt.

[73] Assignee: **Tucel Industries, Inc.**, Middlebury, Vt.



[22] Filed: **June 17, 1971**

[21] Appl. No.: **154,055**

**Related U.S. Application Data**

[62] Division of Ser. No. 20,624, March 18, 1970, Pat. No. 3,633,974.

[52] **U.S. Cl.** ..... **15/179,** 15/182, 15/201, 15/217

[51] **Int. Cl.** ..... **A46b 1/00**

[58] **Field of Search** ..... 15/179, 180, 181, 182, 15/161, 159, 202, 215, 216, 217, 201, 203; 300/21



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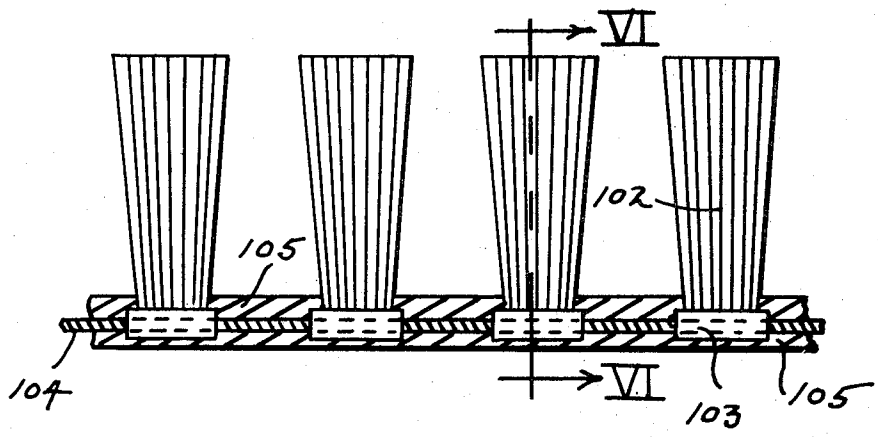
*Primary Examiner*—Peter Feldman
*Attorney, Agent, or Firm*—LeBlanc and Shur



[57] **ABSTRACT**

Tufted brush construction comprising pretrimmed synthetic filament tufts fused at one end and attached to adjacent tufts by a connector means. The base of each tuft and the connector means are embedded into a foam composition to support the tufted mat construction.


**8 Claims, 22 Drawing Figures**



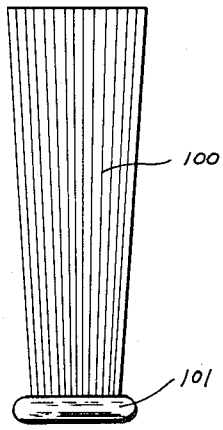



FIG-1

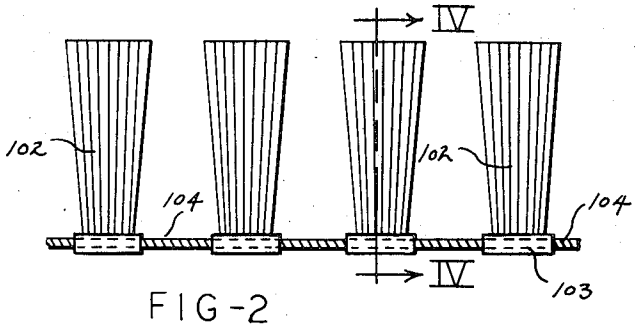



FIG-2

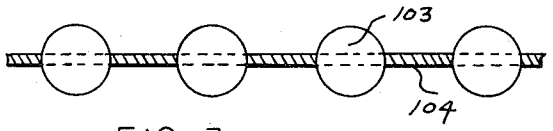



FIG-3

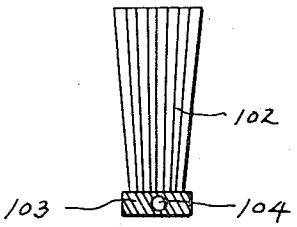



FIG-4

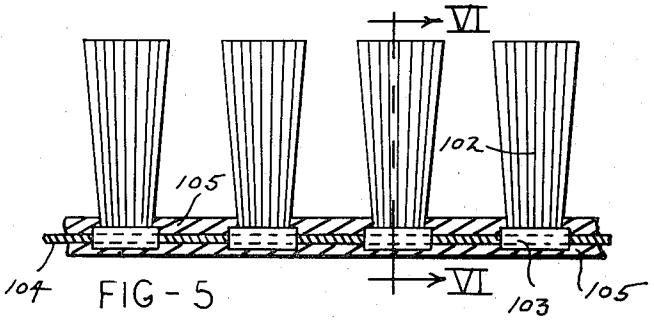



FIG-5

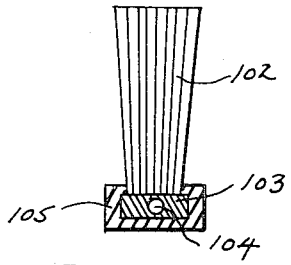



FIG-6

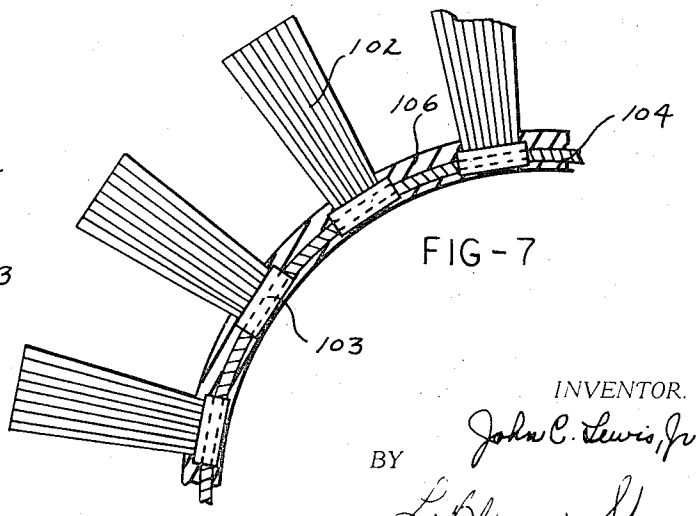



FIG-7

INVENTOR.
John C. Lewis, Jr.
BY
LeBlanc & Shur

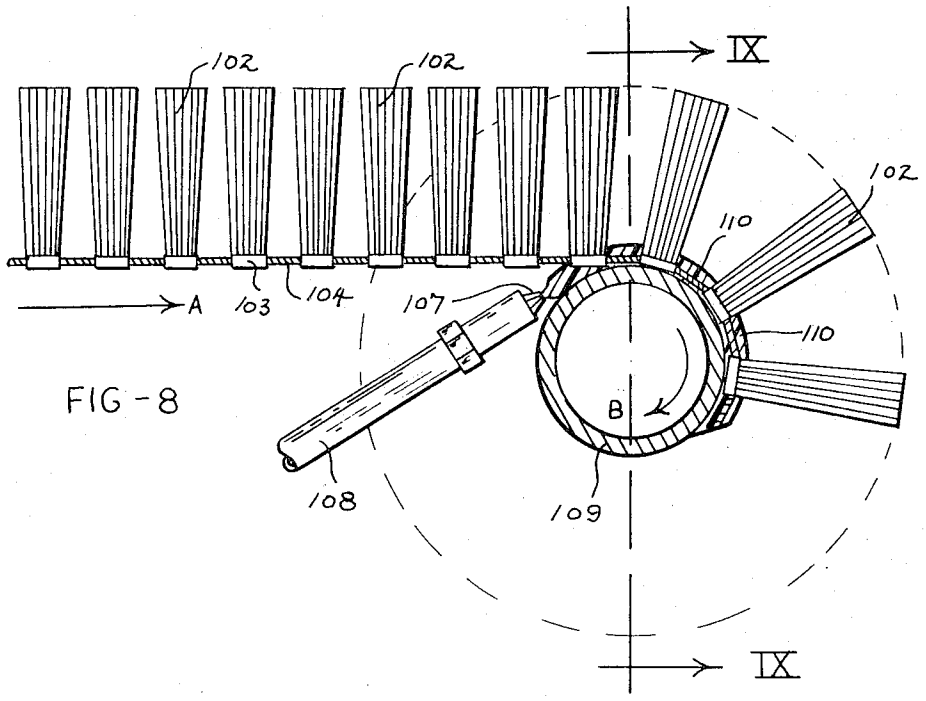



FIG - 8

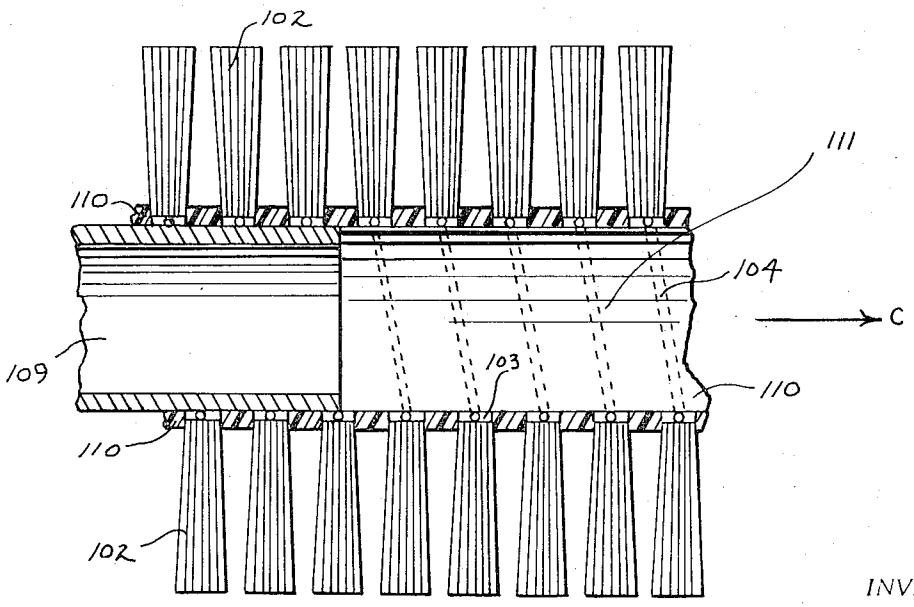



FIG - 9

INVENTOR.

BY John C. Lewis, Jr.

LeBlanc & Shur




FIG - 16

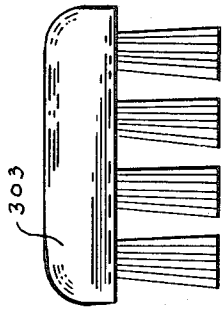



FIG - 17

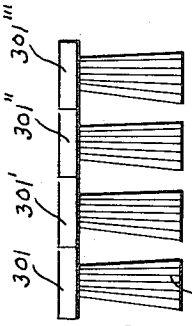



FIG - 15

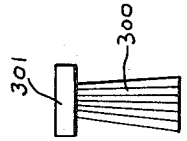



FIG - 14

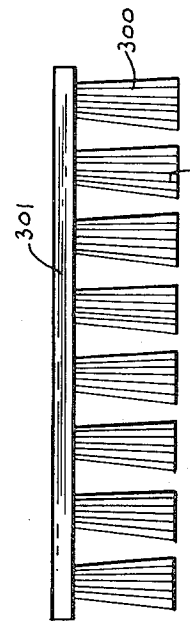



FIG - 13

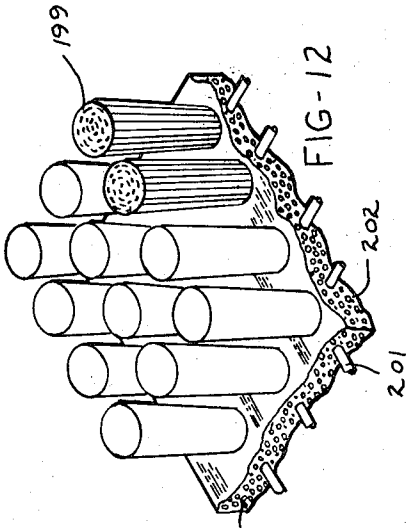



FIG - 12

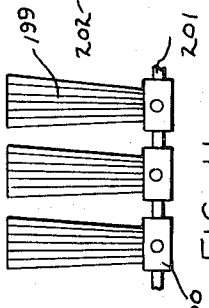



FIG - 11

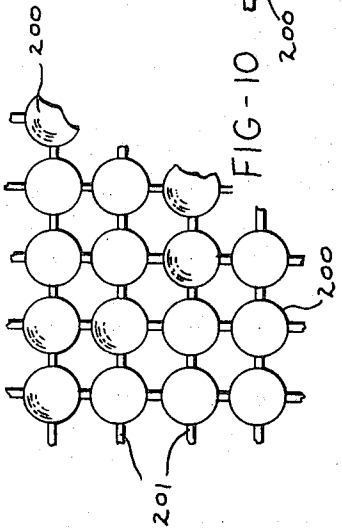



FIG - 10

INVENTOR.

BY John C. Lewis, Jr.

LeBlanc & Shur

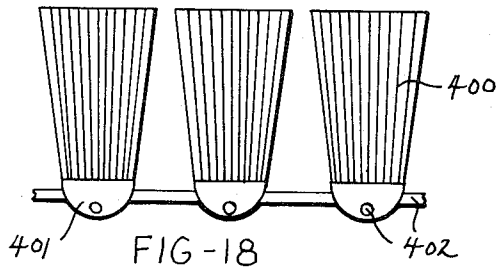



FIG-18

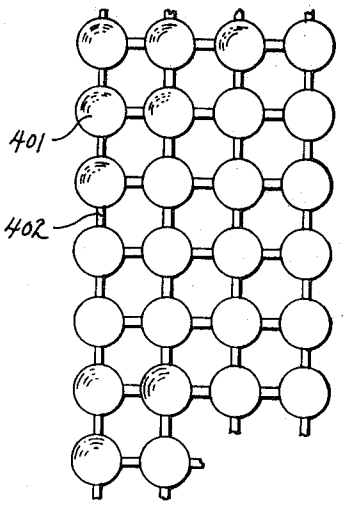



FIG-19

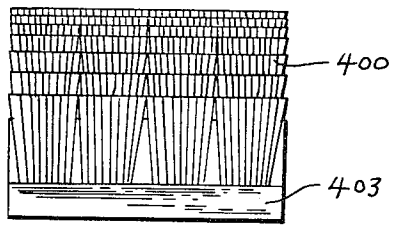



FIG-21

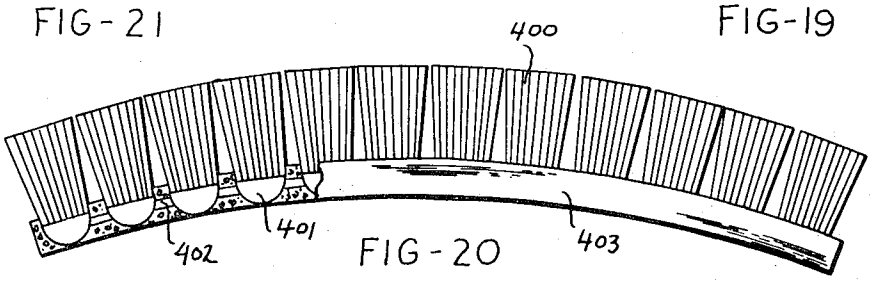



FIG-20

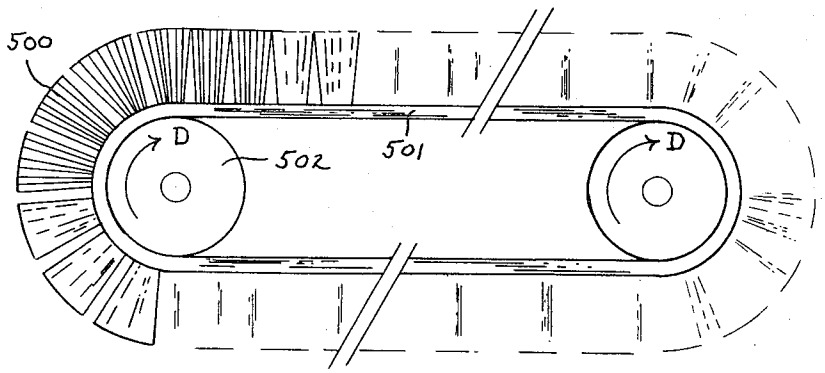



FIG-22

INVENTOR.

BY John C. Lewis, Jr.

LaBlanc & Shur

# SYNTHETIC TUFTED CONSTRUCTIONS

This application is a division of my patent application Ser. No. 20,624, filed Mar. 18, 1970, now U.S. Pat. No. 3,633,974, and a continuation-in-part of my copending patent application Ser. No. 841,160, now U.S. Pat. No. 3,596,999, a divisional application of parent application Ser. No. 578,840, now U.S. Pat. No. 3,471,202; and a continuation-in-part of my copending application Ser. No. 800,330, now U.S. Pat. No. 3,604,043 a divisional application of parent application Ser. No. 578,840, now U.S. Pat. No. 3,471,202.

This invention relates to new and useful brush-type articles. More specifically, it is concerned with fabrication of tufted synthetic filament whereby said filament is supported by foamed substrates.

The brush and carpet industry for many years have been limited in design due to the conventional substrates and methods employed for joining tufts of filaments to the substrates. In most instances, the filaments forming the tuft are doubled over in a U-shape and held to a somewhat thick substrate by means of a staple in the case of a brush and a cord-like rope in the case of a carpet. In both cases, the tufts are held fast by the anchoring means. Also, the method of making tufts and joining them to the substrate does not allow for multiple tuft formation.

The picking and formation of multiple tufts from synthetic filament have been described in U.S. Pat. No. 3,471,202 by Lewis, and allow pre-trimmed synthetic filament tufts to be assembled from filament having a length nearly the same as the finished desired tuft. By employing the method of forming tufts in accordance with the Lewis patent, it becomes possible to construct tufted articles having thin foamed substrates, i.e., 1 inch tufts supported by poly-urethane foam having a thickness of ⅛ inch.

It will be apparent in the discussion which follows wherein the novel constructions of this invention differ from conventional constructions and it should be apparent also that there are many economical factors to be gained by such methods of construction.

Objects and advantages of this invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the steps, methods, combinations and improvements pointed out in the appended claims.

The objects of this invention will now be described. While this invention is primarily concerned with new and novel brush constructions and tufted modular components, it should be realized that the principles of this invention are attained only through the novel combination of retaining cut-to-length parallel synthetic filament and dispensing those filaments in situations wherein (1) single filament tufts are formed, (2) multiple filament tufts are formed, (3) complete tufted brush-type constructions are simultaneously formed, and (4) continuous modular tufted strip-type constructions are formed. Any of these described situations can be supported by foamed substrate.

An object of this invention is to provide a tufted brush-type construction comprising pre-trimmed synthetic filament tufts arranged in a tuft pattern and self-supported by a thin foamed substrate. Another object of this invention is to provide a tufted construction comprising synthetic filament tufts supported by lightweight flexible foam.



Further objects of this invention are to provide novel methods for the production of tufted constructions employing the features set forth in the foregoing objects. These objects are attained by the procedure particularly described hereinafter, as well as in my hereinabove-mentioned U.S. Pat. No. 3,471,202, which procedure comprises, in its broader aspects, joining filament tufts at their fused base by employing a substrate or connector, said substrate employed for aligning tuft formations prior to supporting said tufts in foam. The more usually preferred connectors are those of extruded thermoplastic monofilament whereby the unset fused tuft end is brought into contact with said connector prior to cooling and then allowed to cool, providing a tuft base secured by the monofilament. This construction is then subsequently set in foam in one of the ways designated hereinafter.

Brushes have been prepared as described in U.S. Pat. No. 2,576,546 wherein plastic filaments, i.e., Nylon, have fused ends. The fused ends are set in rubber and cured until the filaments are held securely. Unlike the instant invention, tufts are not held together at their bases prior to insertion into rubber, nor are the tufts capable of being arranged in tuft formations, i.e., 48 tufted scrub brush. It should be noted that the prior constructions could not be supported prior to being secured in the rubber. The rubber had to be supported on a core, thus not allowing for self-supporting tuft formations.

In the discussion which follows, for convenience sake, the term "synthetic" filament applies to those synthetic monofilaments which are formed from linear thermoplastic polymers from the group consisting of polystyrene and polystyrene copolymers, polyvinyl chloride and polyvinyl chloride acetate copolymers, polyfluorides, polyethylene, polypropylene, polyethylene-polypropylene copolymers, polyamides, polyimides, polyesters and polyurethane. Both oriented and unoriented monofilaments may be employed. Also, various cross-sectional shapes may be imparted to the monofilaments, such as for instances, i.e., circular, lobular, trifoil, "X" and "Y" cross-sections, triangular, polygonal, star, etc. Mixtures of synthetic monofilaments may be employed in cases where the compositions of the filaments are compatible during any fusing operations, i.e., heat-sealing. Such filaments may have suitable crimp imparted to all or some portion of their length.

The term "picking" as used in the specification refers to the formation of a filament tuft wherein the tuft is formed by engaging more than one cut-to-length filament by its end and removing same from a parallel disposed bundle of filaments. The picking device employed is of the type disclosed in the aforementioned U.S. Pat. No. 3,471,202.

The term "substrate" refers to the foamed composition surrounding the filament tufts and can be either flexible or rigid. The foam acts as the handle or back in conventional brush constructions.

As indicated above, the foam substrate of this invention is made from a polyurethane foam. The term "polyurethane foam" as used herein includes both polyester-based polyurethane foam and polyether based-polyurethane foam. Any conventional polyester based-polyurethane foam or polyether based-

polyurethane foam may be employed for the substrate. As is well known, polyester based-polyurethane foams are conventionally made by reacting an organic polyisocyanate, i.e., toluene diisocyanate, with a polyester containing free hydroxyl and/or carboxyl groups, i.e., the polyester resin reacting product of ethylene glycol and adipic acid. When reacting a polyisocyanate with a hydroxy-polyester, a small amount of water is added to bring about carbon dioxide formation with polyisocyanate and the reaction is accelerated in known manner by the addition of catalysts, i.e., a tertiary amine catalyst such as triethylamine and N-methylmorphaline.

Polyether based-polyurethane foams are conventionally made in a manner similar to that described above except that in place of a polyester, polyether is employed for the reaction with polyisocyanate. U.S. Pat. Nos. 2,727,219, 2,814,606 and 3,029,209 disclose polyurethane foam compositions that may be used as the substrate in accordance with this invention. Specific foam examples will be set forth hereinafter.

The term "connector" refers to any material, for example, a monofilament, which is employed for attaching tufts thereon in order to arrange and support tufts prior to foaming. The connector can be in the form of a screen knit or other similar constructions.

In the drawings:

FIG. **1** is a front view of a fibre tuft of this invention;

FIG. **2** is a front view of the tufts of this invention attached to another at their base by a connecting means;

FIG. **3** is a bottom view of the tufts of FIG. **2**;

FIG. **4** is a side cross-sectional view taken along line IV—IV of FIG. **2**;

FIG. **5** is a front view in cross section of the tufts of FIG. **2** supported in rigid foam;

FIG. **6** is a side cross-sectional view along line VI—VI of FIG. **5**;

FIG. **7** is a front view in cross section of the tufts of FIG. **2** supported in flexible foam;

FIG. **8** is a sectional view in cross section of the tufts of FIG. **2** being set in foam to form a foam-supported tuft construction;

FIG. **9** is a longitudinal sectional view of the foam-supported tufts as formed in FIG. **8**;

FIG. **10** is a fragmentary bottom view of a group of tufts held together by a web-like means;

FIG. **11** is a side cross-sectional view of the tufts of FIG. **10**;

FIG. **12** is a detailed fragmentary view of a mat in perspective and partly in section showing one arrangement of the tufts from FIGS. **10** and **11** supported in foam;

FIGS. **13–17** illustrate a method of assembling a brush employing the sections of FIG. **5**. FIG. **13** is a front view of a section comprising a multiplicity of filament tufts joined together and supported by rigid foam. FIG. **14** is an end view of FIG. **13**. FIG. **15** is an end view of four sections aligned side by side. FIG. **16** is an end view of a cap adapted to be placed over the aligned segments of FIG. **15** in the manner shown in end view FIG. **17** which shows a finished brush construction with the sections held by the cap;

FIG. **18** is a front view of the tufts of this invention attached to each other by polypropylene monofilament;

FIG. **19** is a fragmentary view of a group of tufts as shown in FIG. **18**;

FIG. **20** is a side view, partially in cross section, of a shoe brush from the tuft formation of FIG. **19**;

FIG. **21** is an end view of the shoe brush of FIG. **20**; and

FIG. **22** is a fragmentary side view of a flexible continuous belt-of-tufts supported in flexible foam.

In order to describe the invention more fully, reference is now made to specific embodiments illustrated in the drawings. The invention is directed to brush making wherein tufted brushes and tufted constructions result by first forming modular tufted arrangements, said tufted arrangements comprising cut-to-length synthetic filament fused at one end and attached to adjacent tufts by means of a connector, then setting the arrangement in a foamed substrate whereby the resultant construction is self-supporting and said tufts are held securely within the foam support. Such a tuft employed for these constructions is shown in FIG. **1**. The tuft of FIG. **1** is formed from cut-to-length filament **100** by picking said filament from one end and heating to fuse the opposite end portion **101** to a temperature of approximately that of the melting point of the particular type of synthetic filament employed. Most thermoplastic filaments have softening points which make them pliable and capable of fusing together under slight pressure. Consequently, as the heated ends of the filaments soften, they are brought into contact with a connecting material, i.e., polypropylene monofilament, and subsequently pressed around the connectors thus resulting in the filament tuft being supported in a web-like structure whereby the fused base end **104** of FIG. **2** of each tuft is attached to an adjacent tuft. The tufts in FIG. **2** show one such tuft construction where the base **103** is attached to an adjacent tuft **102** by means of connector **104**. This construction can be likened to a "string-of-pearls." The fused base **103** for purposes of illustration is shown much larger than necessary, and does not have to extend beyond the filament in the tuft. The base **401** of FIG. **18** shows another embodiment of the fused section where the base does not extend beyond the width of the filament diameter.

In order to form a single length of self-supporting tufts as illustrated in FIGS. **5** and **6**, it is necessary to first prepare a continuous length of attached synthetic tufts as shown in FIG. **2**. The tufts are then brought into contact with a polyurethane foam-producing mix which, within seconds, begins to react and a foam structure results. Within a relatively short period of time, i.e., 90 seconds, the foaming action will reach a peak or rise point, and then gel. Within another few minutes, i.e., 120 seconds, the foam substrate will be tack free and for all practical purposes will be considered set. The tufts are, at this point, securely held and of a self-supporting nature.

To illustrate the aforedescribed procedure more specifically, the following specific example is now given:

## EXAMPLE I

A batch of 9 pounds per cubic foot rigid polyurethane foam was made by the following recipe (all reactants were at room temperature):

100 grams of Mistafoam 850-S urethane foam base (material manufactured by M-R Plastics and Coatings, Inc.) was blended with 100 grams of Mistafoam 801-H urethane foam prepolymer in an electric mixer for 60 seconds (cream time) and then poured to a depth of 1/16 inch onto a metal tray measuring ⅜ inch wide, 36

inches long and 3/16 inch deep. Immediately, a "string-of-tufts" was placed into the foam composition and within 30 seconds the foaming reaction started. At the end of 120 seconds, the tufts were held fast within the foam substrate. A strip of self-supporting tufts as shown in FIG. **5** resulted wherein the foam substrate **105** supports tufts **102**, the thickness of the substrate being on the order of ⅛ inch.

The invention in its broader aspects is not limited to rigid foam compositions. In order to fully describe the flexible strip of tufts shown in FIG. **7**, reference is now made to the flexible substrate **106** in FIG. **7**.

## EXAMPLE II

A batch of 2 pounds per cubic foot polyurethane foam was made by the following recipe (all reactants were at room temperature):

50 grams of Formez-50 (a polyester-resin) was blended with 2 grams of N-ethyl morpholine in an electric mixer for 45 seconds and then 3.6 grams of distilled water added and the mixture allowed to mix for another 30 seconds. To this resin pre-mix, 105 grams of Nacconate 80 (80:20 mixture of 2,4 and 2,6-toluene diisocyanate) was added and mixed for approximately 10 seconds, then poured onto the same metal tray as cited in Example I. Immediately after, a "string-of-tufts" was immersed in the pre-mix and foaming allowed to continue. Soon after, 5–10 seconds, the foaming action started and the cell structure formed. Within 240 seconds, the tufts were self-supported in the substrate and a strip of tufts as shown in FIG. **7** resulted. The substrate portion **106** was approximately 3/16 inch in thickness.

While the invention is susceptible of embodiment in many different forms, there is shown now in FIGS. **8** and **9** specific embodiments with the understanding that the present disclosure is to be considered as an exemplification of the principle of the invention and is not intended in any way to limit the invention to the embodiment illustrated.

Particular attention is now given to the cylindrical brush construction and method of forming as shown in FIGS. **8** and **9**. The method consists of wrapping a "string-of-tufts" **102** around a rigid supporting means **109** while simultaneously applying a foamed polyurethane pre-mix from supply **108** through nozzle **107** in order that the fused ends **103** of tufts **102**, said tufts attached by connector **104**, can become securely held in the substrate **110**. The foaming support means **109** is rotated in direction B while the tufts **102** come from direction A. As the foaming begins and cell structure takes place, substrate **110** is formed. After the foam composition is set, it is removed from support means **109** in direction C, thereby resulting in a tufted cylindrical brush **111**. The method can be carried out whereby the brush **111** is simultaneously removed during the foaming operation by allowing enough time between removal and curing of the foam. This only requires a sufficient distance between the wrapping and foaming section and the cured section of the brush. Although not shown, it is possible to form an inverted cylindrical tufted unit wherein the tufts project inward.

## EXAMPLE III

A tufted cylindrical brush (polypropylene tufts) having a 1 inch diameter and a 3 inch brush face comprising 108 synthetic tufts having a trim length of 1 inch and a tuft diameter of 3/16 inch, supported in rigid polyurethane foam, was constructed in the following manner:

A batch of 9 pounds per cubic foot rigid polyurethane foam was made according to the same procedures as cited in Example I. The pre-mix was then applied in liquid form to a paper mandrel (5 inches long and having a diameter of 1 inch, the thickness being 0.050 inch) and a continuous "string-of-tufts" was wrapped around, taking care to embed to base of the filament tufts in the foam pre-mix. When the tufts had been wrapped, foaming started and within 120 seconds, the whole mass had set. A few more minutes and the mass was tack free. The paper core was twisted from the brush unit leaving a completely self-supporting tufted polypropylene cylindrical brush having a substrate of rigid polyurethane foam. The substrate had an average thickness of 3/16 inch. The excess foam was removed at each end leaving a 3 inch brush face.

It is apparent that the tufted mat construction illustrated in FIG. **12** is a complicated construction, and could not be produced by any technique other than by practicing the method disclosed in the instant invention. In addition, the invention in its broader aspect is not limited to individual tufts having a base area greater than the area of the filament comprising the tuft whereby a bead is employed to anchor the tuft. Tufts so formed in accordance with this invention can have fused base portions wherein there is no significant portion of fused area, but more important is the fact that the fused portion is held to and attached thereto an adjacent fused portion by means of a finite substance. This connector acts as an alignment means for tufts, and arrangement control and a reinforcing medium for the foam composition, and contributes to the stability of the tuft with the foam support.

More specifically, referring now to the ski mat construction of FIG. **12**, the tufts **199** are supported in flexible foam **202**. The tuft bases **200** are attached to each other by means of connectors **201** as shown in FIGS. **10** and **11**. The connector is formed from an oriented polypropylene monofilament whose diameter is in the order of 0.025 inch.

A ski mat in FIG. **12** is made by the following example:

## EXAMPLE IV

A tufted arrangement consisting of polyamide synthetic filaments was produced by first picking filament at its non-working end to form tufts, and subsequently, adfixing the heated ends to a network of polypropylene monofilament in order to produce the construction shown in FIG. **10**. A pre-mix of flexible foam was prepared according to the method cited in Example II and poured onto a flat sheet of wax paper. Immediately afterwards, foaming started and continued for approximately 240 seconds. At that time the foam set and there resulted a flexible tufted mat comprising polyamide filament tufts. This tufted mat can be employed as artificial snow for skiing.

FIGS. **13–17** show how foam segments with synthetic tufts illustrated in FIG. **5** may be assembled into a finished brush. More particularly, as shown in FIGS. **13** and **14**, filament tufts **300** of this invention protrude from a common foam segment **301**. The common segment **301** can contain holes or other means for attaching it to another similar segment, but in the instant in-

vention reference is made to the use of an adhesive. An end view of this segment is shown in FIG. **14.** In FIG. **15,** four similar segments **301, 301', 301''** and **301'''** are placed so that they are aligned with each other. As shown in FIG. **16,** there is provided a molded cap **302.** When cap **302** is placed over segments **301, 301', 301''** and **301'''** as shown in FIG. **17,** with adhesive, a finished brush emerges as shown in FIG. **17.**

By employing synthetic filament tufts attached through their base **401** with connector **402** as shown in FIGS. **18** and **19,** a rigid or semi-rigid foam supported shoe brush may be constructed. The shoe brush shown in FIGS. **20** and **21** clearly demonstrates the simplicity in forming brushes. Employing tuft picking machinery as disclosed in U.S. Pat. No. 3,471,202, it is possible to form continuous modular strips of thermoplastic pretrimmed brush constructions as shown in FIG. **19.** By simply cutting the construction every 12 tufts, 48 tufted shoe brushes can be formed. The interconnected tufts can be supported in either rigid or semi-rigid oam substrates, depending upon the physical shape and flexibility desired.

As shown in FIG. **22,** a belt of tufts **501** may be made from the flexible strip construction shown in FIG. **7.** By placing a continuously connected flexible foam supported belt of tufts **501** onto a shaft **502** and rotating in direction D, a tufted brushing tool **500** is formed.

The filament tufts of this invention may best be tufted by use of heat-sealing technique and preferably by bringing the heated non-working ends of the synthetic filament tuft into contact with a suitable source of heated air and subsequently pressing the heated mass into a connector means. An inert atmosphere, such as nitrogen, carbon dioxide, or vacuum, can be employed when discoloration and degradation through oxidation of the thermoplastic filament is critical.

There is no restriction on the trim length, tuft diameter and tuft arrangement when manufacturing such foam-supported brush-type constructions.

The foregoing considerations conclusively demonstrate the advantages to be gained by providing self-supporting tufted arrangements of the type hereinbefore described. When such constructions are incorporated into brushes, mats and the like, there is attained new and novel constructions heretofore not known.

The invention in its broader aspects is not limited to the specific steps, methods, compositions, combinations and improvements described but departures may be made therefrom in the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What is claimed and desired to be secured by United States letters Patent is:

**1.** A tufted modular brush construction comprising: a plurality of mutually spaced, synthetic filament tufts, each tuft comprising a plurality of synthetic filaments extending from a prefused homogeneous mass of said filamentary material;

a flexible filamentary connector embedded in and extending laterally through said prefused masses to interconnect said mutually spaced tufts;

a cured synthetic foam base surrounding said connector and at least a portion of said prefused masses, said base supporting said tufts in a preselected configuration.

**2.** The tufted modular brush construction of claim **1** wherein said connector is a synthetic filament web.

**3.** The brush construction of claim **2** wherein said web filaments are polypropylene.

**4.** The tufted modular brush construction of claim **1** wherein the base is a material selected from the group consisting of polyester-based polyurethane foam and polyether-based polyurethane foam.

**5.** The brush construction of claim **1** wherein the cured foam base is flexible.

**6.** The tufted brush construction of claim **1** wherein the cured foam base is rigid.

**7.** The tufted brush construction of claim **1** wherein the foam base is cured in a contoured configuration to support said tufts in a circular brush construction.

**8.** The tufted modular brush construction of claim **1** wherein the foam base is cured to support said tufts in a flat brush mat configuration.

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