Dec. 27, 1960 O. DIETZSCH, SR 2,965,925

ARTIFICIAL HOLLOW THREAD AND DEVICE FOR MAKING SAME

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Fig. 1

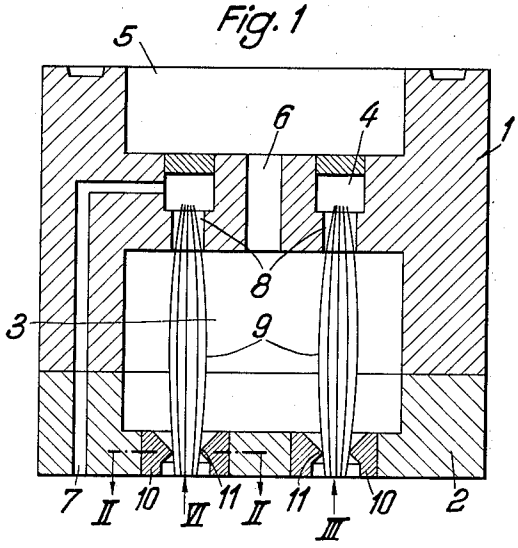


Fig. 4

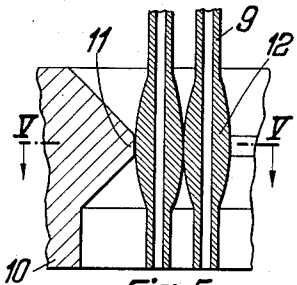


Fig. 5

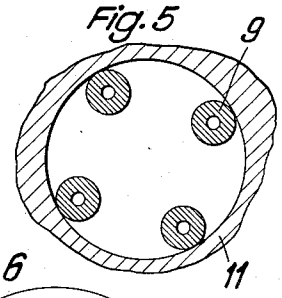


Fig. 2

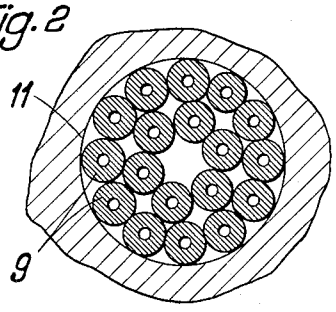


Fig. 6

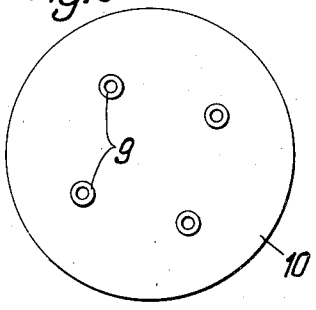


Fig. 3

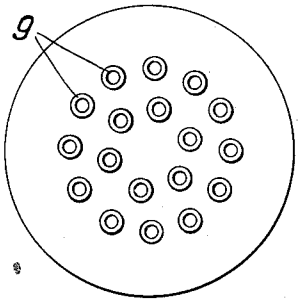
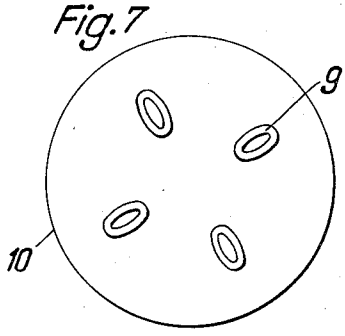


Fig. 7



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Fig. 8

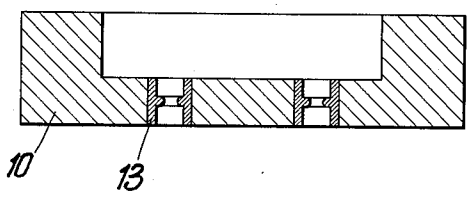


Fig. 9

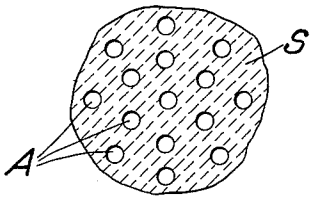


Fig. 10

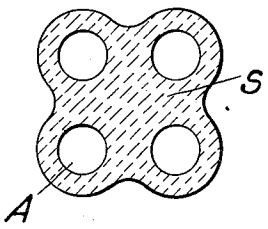
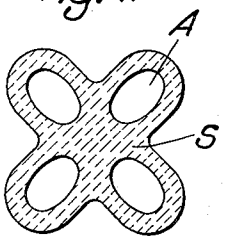


Fig. 11



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2,965,925

ARTIFICIAL HOLLOW THREAD AND DEVICE FOR MAKING SAME

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6 Claims. (Cl. 18—8)

The invention proceeds from an artificial hollow thread; it is the main object of the invention to impart to the hollow thread preferred textile qualities by appropriate shaping of its cross section. Such properties are, above all, soft touch, dull appearance and cohesion at comparatively low titer by weight.

In order to produce a low titer by weight in previously known artificial hollow threads, the cross section of the hollow space must be large in relation to the thickness of the wall of the tube of solid material. However, this causes the thread to lose its cross stiffness and to become deformed especially under the mechanical stress when processed, in the textile industry, to a band-shaped body of approximately elliptical cross section, and the finished textile structure (pattern) has irregularly distributed, unattractive glossy areas.

The present invention overcomes this disadvantage of previously known artificial hollow threads in that it comprises a plurality of hollow channels (ducts) distributed over the cross section. Such a many-veined hollow thread possesses the basic excellent qualities of a conventional hollow thread having only one hollow vein, namely, good heat insulation and low weight titer, and, in addition, at equal ratio of mass to hollow space in the cross section, a substantially greater cross stiffness than a single-veined hollow thread owing to the inner walls. Moreover, owing to the strong diffusion of light on its inner walls, the many-veined hollow thread has a natural, dull appearance. This is further increased by the fact that the thread has an outside cross section which is not round, i.e., a longitudinal profile, especially if the hollow veins are arranged close to the periphery. The shape of the surface and the properties of the thread depending thereon can be influenced within wide limits by the size and distribution of the hollow veins.

Suitable materials are those which can be deformed from the viscous phase, i.e., solution or melt. The deforming processes to which this invention relates are not only spinning processes in the narrow sense of the term, but also rope pressing, rope drawing, etc. The material may be of organic or inorganic nature. Glass may, for inst., be used as inorganic material. A preferred field in which the invention may be used comprises materials of organic nature, such as cellulose, cellulose compounds, aldehyde condensation products, albumin and other nitrogen containing substances, such as casein, gelatin, also synthetic resins on vinyl, acryl or styryl base, especially modern linear polymer resins. According to their nature, these spinning solutions are developed to form shape-retaining thread structures by suitable solidifying media, for inst., precipitating liquids, cooling gas, etc.

The cross section of the threads may or may not be round and may especially in one coordinate substantially more extended than perpendicular thereto causing the threads to be of band-like shape.

The material may contain coloring or other additives

for the purpose of producing certain optical effects, such as iridescence, luster, shot effect or the like.

It also lies within the scope of the invention to arrange on the inner walls of at least one hollow vein of the many-veined hollow thread substances which have a therapeutical or hygienic or generally pharmaceutical effect and to use hollow threads thus impregnated for purposes of clothing or dressing wounds. It is equally possible to prevent or at least to reduce an undesirable absorption of moisture, body fat etc. by introducing a substance of, for inst., fatty character which is substantially not diffused by the material of the thread.

It is further possible to make the gas or air content of the threads incompressible by microporous, solid substances, such as aluminum hydroxide or silica gel.

As a further development of the invention, the hollow spaces of the hollow threads may be provided with a loose filling of a solid substance which renders the threads particularly suitable for certain technical purposes, especially with respect to flavor.

It is apparent that dyes or pigments with fluorescent, phosphorescent or other special properties, if required, can be introduced into the hollow spaces of the hollow threads, in order to produce special optical effects. Such introduction of dyes, etc. into fibers has, of course, long been known in the art. It also lies within the scope of the invention to produce a special glazing effect by metalizing the inner walls. Such inner mirror coatings can be produced according to the known processes of the so-called wet metalizing.

Another possibility consists in covering the inner walls of the hollow spaces with a substance sensitive to light, in order to produce patterns (images) on the fiber or the textile structure formed by the fiber by means of photographic processes known per se. By optically sensitive substances we mean, for inst., diazo compounds which have the advantage that their maximum of sensitivity is located in the short-wave portion of the spectrum, and that it is, therefore, not necessary to protect them rigorously against light as is the case for highly sensitive silver salts. In addition, they may act as dye coupling components as such and thereby produce color patterns, for which printing stencils are otherwise required.

The invention further relates to the production of such many-veined, artificial hollow threads and shows methods for the appropriate construction of spinning heads. Spinning of many-veined hollow threads of viscous, for inst., molten material is substantially more difficult, for many reasons, than spinning of a single-vein hollow thread of the conventional type. Owing to the very large free wall areas, the forces of surface tension act very strongly in the liquid material [of which the thread is made]; for the purpose of maintaining the spaces (in the veins), these forces must be compensated by correspondingly strong counterforces, i.e., high gas pressure, in the spaces and must be limited to only brief action in that the material is caused to solidify quickly. Another production difficulty resides in the fact that the liquid material leaving the nozzle opening must have uniform energy of flow and uniform energy of surface tension at all points of the space of the subsequent partitions, in order that the distribution of hollow veins in the cross section of the thread remains as predetermined. The supply of material must, therefore, be regulated with great precision.

The spinning head for producing the above-characterized, many-veined artificial hollow threads fulfills these operational requirements in that it comprises, for each thread-forming place, a number of small capillary tubes of elastic material corersponding to the number of veins of the thread to be formed, said capillary tubes being anchored in the wall of a common feed chamber at one

end and opening convergently into the nozzle opening at the other end, where they are bundled to spatial contact against their inner elastic tension. All these different features of the new type of nozzle serve the same purpose discussed above: The capillary form ensures a high drop of pressure within the tube and hence a high velocity of discharge of the vein-filling gas at the nozzle opening, which serves to overcome the forces of surface tension of the material which is still in its liquid state. The convergent arrangement of the small capillary tubes with respect to the nozzle opening produces a certain funnel effect, which ensures that the material uniformly penetrates into the intermediate spaces between the small tubes and permeates them. The elastic bundling of the small tubes in the nozzle opening forces the tubes into a reciprocally correlated position and maintains them in same, said correlated position being dependent on the external shape of the tube in the contricting area and hence being predeterminable. Preferably, the small tubes are given a non-round cross section at least in said constricting area, in that they are, for inst., provided with axially running lay-on ribs which, in addition to the foregoing, will influence, for inst., equalize the conditions of flow in the intermediate spaces.

It also lies within the scope of the invention to enlarge the nozzle opening in the manner of a funnel and to have it project beyond the closing plane of the small capillary tubes. This will make the spinning process less sensitive to disturbance (disorder), since the front edges of the tubes are constantly washed with fresh spinning solution and since there is always sufficient spinning solution to form an outer skin of the thread of the prescribed wall thickness.

Several embodiments of the invention are described below by way of the accompanying drawing, in which:

Fig. 1 shows a diagrammatic longitudinal section through a spinning head for producing a many-veined hollow thread according to the invention,

Fig. 2 shows a cross section taken on the line II—II of Fig. 1,

Fig. 3 is a top view of the nozzle opening in the direction of the arrow III of Fig. 1,

Fig. 4 is a partial longitudinal section through a spinning head according to Fig. 1,

Fig. 5 is a cross section taken on the line V—V of Fig. 4,

Fig. 6 is a top view of the nozzle opening (orifice) in the direction of the arrow VI of Fig. 1,

Fig. 7 is a top view of the nozzle orifice of another embodiment of a spinning head, similar to Fig. 6,

Fig. 8 is a partial longitudinal section through the front plate of still another embodiment of a spinning head, approximately on the scale of Fig. 1, and

Figs. 9 to 11 are cross sections of different embodiments of many-veined hollow threads according to the present invention on a very much enlarged scale.

Fig. 1 illustrates a spinning head having only two spinning nozzles—to give a clearer overall picture. The housing comprises two portions **1** and **2** screwed together, which enclose the feed chamber **3** for the material to be spun into a thread and the annular feed chamber **4** for the vein-filling gas. The feed chamber **3** is supplied by way of the center passage **6**, and the feed chamber **4**, by way of the lateral boring **7**. Two plugs **8** corresponding to the number of spinning nozzles—formed by soldering together a plurality of small capillary tubes **9** are soldered into the partition between the two feed chambers. The tubes **9**, which are only shown by lines in Fig. 1 and about the production of which more will be said later, project into the feed chamber **4** with their short ends, while their full length projects through the feed chamber **3** into two nozzle mouthpieces **10**, which have been worked or inserted into the head portion **2** of the housing. The center portion of the nozzle mouthpieces **10** comprises a preferably annular constriction; they open conically mainly toward the feed chamber **3**. The small capillary tubes **9** are of somewhat elastic construction and are secured in the plugs **8** in such a manner that they strive somewhat apart. However, when the spinning head is assembled, their free ends are brought (forced) together in the constrictions **11** in the nozzle mouthpieces **10**, where they thus converge against their internal elastic tension and crowd together outwardly in the constricting area according to Fig. 2. This increases the funnel effect within the conically opening nozzle mouthpiece **10** on the spinning solution penetrating from the feed chamber. Within the area of the constriction **11** the tubes **9** have, preferably on both sides, a conical wall thickening **12**, as is shown in Fig. 4 by a considerably enlarged partial section. The projections causing the constriction **11** and the convex widenings **12** of the capillary tubes may be interrupted in perpiheral direction. This may serve further to influence the shape of the ducts of flow for the spinning solution in the area of constriction. This will further improve the above-mentioned funnel effect and will produce the additional result of spacing the ends of the tubes projecting beyond the constriction **11** in the outlet plane of the spinning head, as can be seen from Fig. 3.

Experience has shown that all nozzle members determining the cross-sectional shape of the spun thread must be dimensioned with great precision. For this purpose, the process used is preferably the method of producing a molded body for the controlled mixing or delivering at least two fluids with one main and at least one secondary duct, each of which is connected to a source where fluid is stored, and which have a predetermined form with respect to their cross section and their reciprocally correlated position, by using an auxiliary material which temporarily fills the cross section of the duct, wherein the material of the body and the auxiliary material are alternately super-imposed in layers in controlled, especially symmetrical correlation to the axis of the main duct and wherein the materials, prior to applying another layer of the one material to the outer surface of the layer of the other material last applied, are brought into predetermined dependence, for inst., into identical shape with same by tools aligned to the axis of the main duct, especially concentrically operating tools, whereby receiving areas are produced for the holder on the respective intermediate structure, preferably on its front end, by the removal by regions of the auxiliary material, said holder aligning, for inst., centering the intermediate structure with respect to the axis of the main duct.

In order to produce an extremely precise predetermined outer shape of a layer, its outer surface is preferably first treated with tools in such a manner that its measurements fall below the predetermined form, the resulting deficiency is measured and another covering layer of the material which is to fill up the deficiency to the predetermined form is applied to the deficient outer surface by means of a process of application, wherein the deficiency measured serves as regulating factor for the thickness of the layer to be applied. This very precise predetermined outer form of a layer may also be produced by a multi-stage deficiency correction of several partial layers applied successively.

Said processes are used in the present case for producing the small capillary tubes **9** and the nozzle mouthpieces **10**.

As has already been mentioned at the beginning, it is of decisive importance for the production of the many-veined hollow thread that the vein-filling gas is injected into the spinning solution at very high speed, in order constantly to overcome the forces of surface tension acting in the spinning solution. The high velocity of the gas in the capillary duct has the additional advantage of self-purification. As is known, modern polymeric plastic products (synthetic products) are not chemically uniform substances, but contain, in addition to com-

pounds of higher molecular weight, compounds with lower molecular weight and correspondingly higher vapor pressure. These volatile components not only enter the surrounding atmosphere at the nozzle orifice, where they form the known white smoke streamers, but also diffuse, as experience has shown, into the filling gas and hence into the capillaries, where they may condense to form a coating which constricts the cross section. Experience has shown the threatened obstruction can be prevented by a very high velocity of the gas in the capillaries.

Another advantage of the narrow capillaries consists in that it acts as reducing valve and hence self-regulating (self-dosing) on the throughput of gas.

The high velocity of the gas is produced by a corresponding fall in pressure in the small tubes, which may amount to several atmospheres. When using suitable filling gases, the thermal expansion effect (due to release from tension) may be utilized automatically to supercool the gas that enters the spinning solution and thereby to accelerate the solidification of the thread from the inside. As is known, such a gas is carbon dioxide.

The term "small capillary tubes" is not to be limited to tubes with hollow cylindrical cross section. In the contrary, the invention comprises every profile, for inst., an elliptical profile, as diagrammatically shown in Fig. 7.

Nor is the invention limited to the fact that the cross section of the nozzle is very largely filled by small tubes in the area of constriction **11**. Suitable hollow threads are also produced in that only very few small tubes are used, which, owing to their (springy) elasticity, form a single layer joining the inner periphery of the constriction, as is shown in Fig. 5. The tubes then occupy the position shown in Fig. 6 at the nozzle orifice. In this case, the tubes **9** need not be puffed up convexly in the area of constriction **11**.

It is also within the scope of the invention to arrange, instead of a single constriction **11** in the nozzle mouthpiece **10**, several such constructions in succession in the direction of flow, in order thereby to influence the conditions of flow within the spinning solution if required. The constriction **11** may also be produced by a special, annular insert body **13**, see Fig. 8, which is produced separately and inserted into the housing portion **10**.

Another advantage of the new type of spinning head consists in that it is largely self-centering, so that it may unhesitatingly be taken apart for cleaning and then be reassembled.

Figs. 9 to 11 show several forms (phases) of the new, many-veined hollow thread with considerably enlarged cross section.

In the embodiment according to Fig. 9, the spinning solution S is permeated with a plurality of veins A, for inst., **15**. Such a thread has an excellent dull effect.

Figs. 10 and 11 show hollow threads which can be produced by means of a spinning nozzle according to Figs. 5 and 6. The different cross-sectional shape was produced in that the thread according to Fig. 10 was spun with less filling gas per unit of quantity of spinning solution than the thread according to Fig. 11.

In many respects the new thread material has properties which could be produced in the past only by combining, for inst., twisting, a plurality of single-vein hollow threads. The (essential)) advantage of the new fiber consists in that it is practically draw-resistant, i.e., that separate threads cannot be pulled out, as is the case in a multi-thread structure. It is, of course, possible to combine the new many-veined hollow threads to thread bundles prior to further textile treatment.

The invention is obviously not limited to hollow threads, the solid body of which consists of a uniform material. The same is true of the construction of the spinning head, which may be equipped with muti-stage nozzles. Such multi-stage nozzles make it possible to produce hollow threads which have around each hollow vein an annular region of special material differing from the actual material of the thread. This annular region may impart to the hollow thread special properties, especially of a physical kind, for inst., increased ability to absorb water or other optical refractive powers.

What is claimed is:

1. Spinning head for producing many-veined hollow threads comprising a body forming a feed chamber for the substance to be spun and provided with a plurality of nozzle orifices, a plurality of capillary tubes corresponding to the number of veins of the thread to be formed, said tubes being secured at one end in the wall of a common feed chamber for the gas filling said thread veins, passing across said feed chamber for said substance to be spun and passing groupwise through each of said nozzle orifices, each of said capillary tubes being provided with a convex widening arranged at the location of said orifices so that a funnel effect is exerted on the spinning substance flowing through the nozzles.

2. Spinning head according to claim 1 wherein the body forming a feed chamber has at the location of each nozzle orifice at least one conical constriction.

3. Spinning head according to claim 1 characterized in that the inside diameter of the capillary tubes is so proportioned that the stream of gas permeating same is given a velocity which overcomes the surface tension of the spinning substance passing said nozzle orifice and prevents the diffusion of volatile components of said spinning substance into said capillary tubes.

4. Spinning head according to claim 2 characterized in that the inside diameter of the capillary tubes is so proportioned that the stream of gas permeating same is given a velocity which overcomes the surface tension of the spinning substance passing said nozzle orifice and prevents the diffusion of volatile components of said spinning substance into said capillary tubes.

5. Spinning head for producing many-veined hollow threads comprising a body forming a feed chamber for the substance to be spun and provided with a plurality of nozzle orifices each provided with at least one projection defining a constriction converging conically from said feed chamber, a plurality of capillary tubes corresponding to the number of veins of the thread to be formed, said tubes being secured at one end in the wall of a common feed chamber for the gas filling said thread veins, passing across said feed chamber for said substance to be spun and passing groupwise through each of said nozzle orifices, each of said capillary tubes being provided with a convex widening arranged at the location of said nozzle orifices so that a funnnel effect is exerted on the spinning substance flowing through the nozzles.

6. Spinning head according to claim 5 characterized in that the inside diameter of the capillary tubes is so proportioned that the stream of gas permeating same is given a velocity which overcomes the surface tension of the spinning substance passing said nozzle orifice and prevents the diffusion of volatile components of said spinning substance into said capillary tubes.

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