March 3, 1970 KATSUNOSUKE MAEDA ET AL 3,497,910

APPARATUS FOR THE DRAWING OF SYNTHETIC FIBER TOWS

Filed Aug. 7, 1967 4 Sheets-Sheet 1

Fig. 1

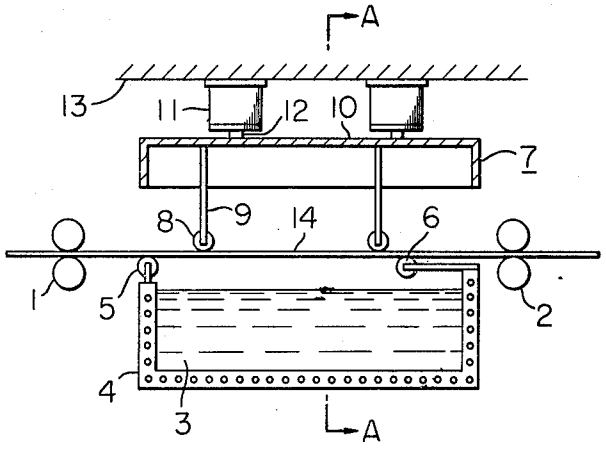


Fig. 2

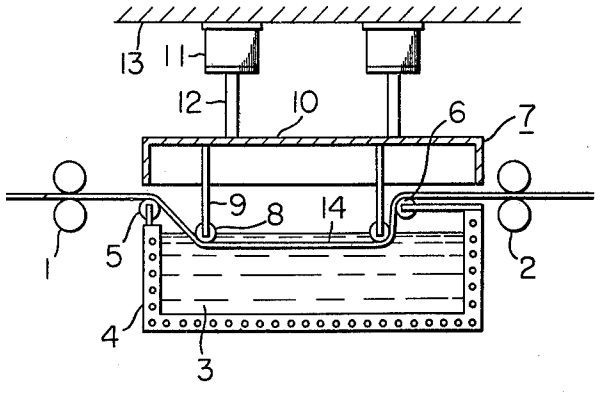


Fig. 3

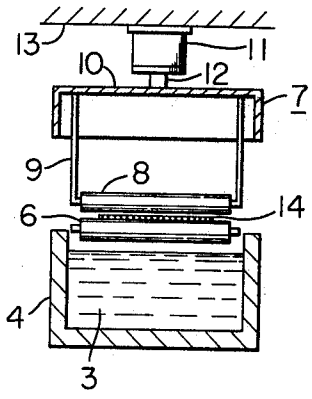


Fig. 4

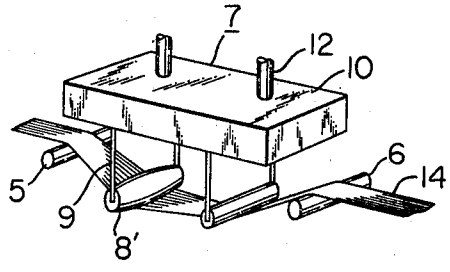


Fig. 5

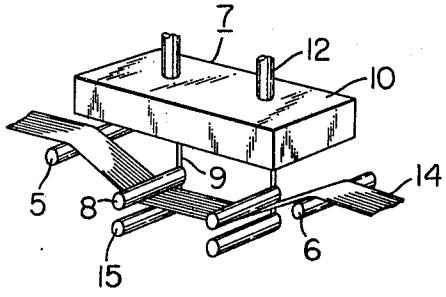


Fig. 6

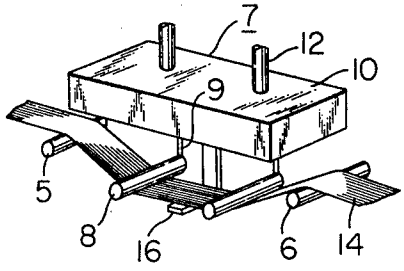


Fig. 7

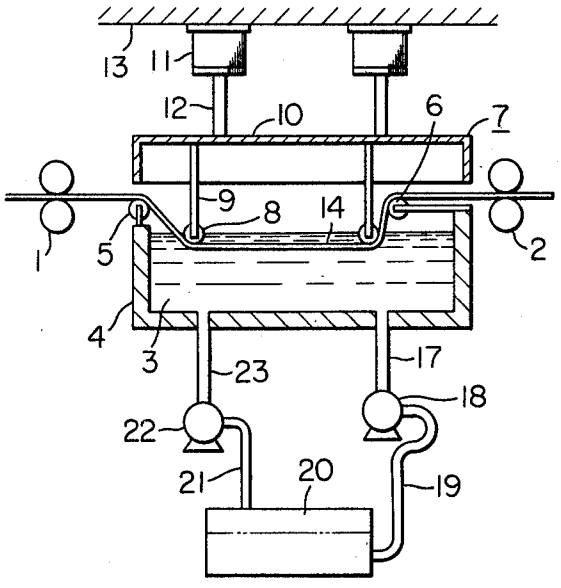


Fig. 8

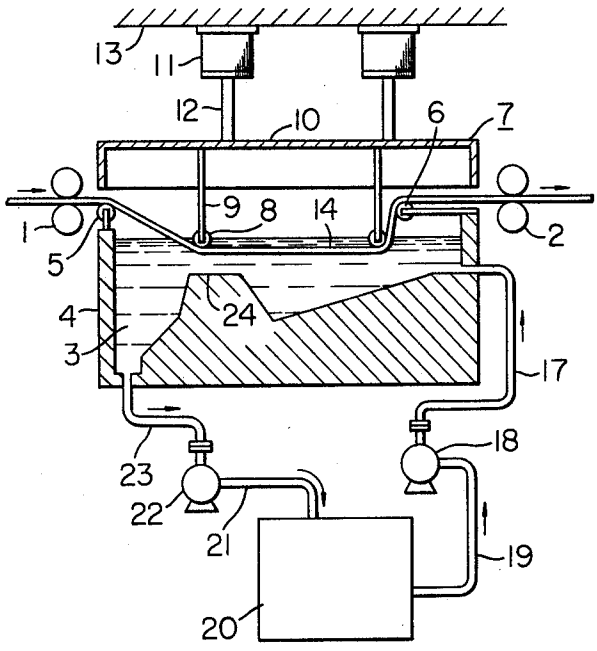
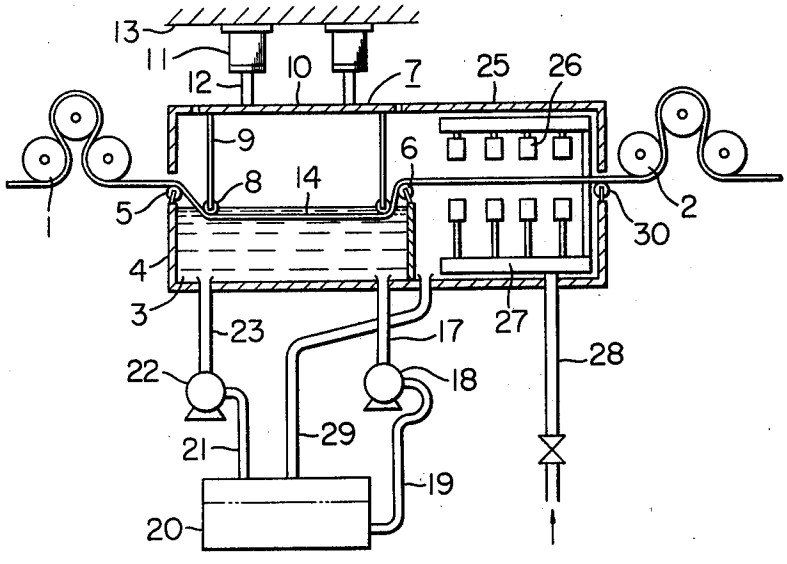

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Fig. 9


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APPARATUS FOR THE DRAWING OF SYNTHETIC FIBER TOWS

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Int. Cl. B29c 17/02
U.S. Cl. 18—1 7 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for drawing undrawn tows in which dipping pieces movable up and down to the surface of a liquid of a hot bath are provided to immerse the tow in the hot liquid during the drawing operation, and to position it above the hot liquid when the apparatus is inoperative.

This invention relates to a novel method and apparatus for the drawing of synthetic fiber tows.

In the manufacture of synthetic fibers, undrawn filaments are generally drawn to several times the original length, and then subjected to a treatment suitable for the respective use such as crimping, heat-setting and cutting. When an assembly of many monofilaments having a total denier of more than 1,000 and less than 5,000,000 is drawn, the so-called hot bath drawing method has widely been used by which an undrawn tow is immersed in a hot liquid and heated, and simultaneously drawn under tension.

An advantage of drawing a tow by the hot bath drawing method is that the individual monofilaments of the tow can be uniformly heated by the hot liquid. To utilise this advantage effectively, a tow has hitherto been immersed to a considerable depth in a hot liquid bath or has been advanced through a flowing hot liquid whereby each individual monofilament of the tow has been uniformly heated.

One known apparatus for drawing tow is the type wherein fixed guides are provided within a hot bath to facilitate the permeation of the hot liquid into a tow. The tow is set on these fixed guides and allowed to detour in the hot liquid whereby it is travelled from the inlet of the hot liquid bath to the outlet, and during this time, it is drawn under a predetermined tension. This type of apparatus is desirable in that it can heat each individual monofilament of the tow almost uniformly, but the operation by which a fresh tow is put from the inlet of the hot liquid bath, successively set on the fixed guides in the hot liquid, and withdrawn from the outlet, and then the tow is transferred, and begins to be drawn is troublesome. Furthermore, if it happens that in the afore-mentioned type of apparatus the advancement of the tow is stopped, the tow in the hot liquid also comes to a halt. The tow which is present in the hot liquid is compelled to be heated tension and heat. Consequently, a portion of the tow which is present in the hot liquid is compelled be heated at a high temperature for an abnormally long time.

Many publications relating to the drawing of filaments teach that heating for an abnormally long time at a high temperature is not at all desirable in the drawing of ordinary synthetic fibers, especially thermoplastic synthetic fibers. A portion exposed to such condition undergoes a considerable deterioration as compared with a portion continuously drawn in a good drawing condition. Hence, when the aforementioned accident occurs in the manufacture of long continuous synthetic filaments, it is necessary

to cut and remove the deteriorated portion. The operation for this purpose and waste yarns produced thereby greatly affect the cost of production of synthetic fibers.

We have endeavored to obviate adverse effects caused by such an accident and have come to provide the method and apparatus for the drawing of a tow of synthetic fibers which will be described in the following.

Accordingly, an object of this invention is to provide a method and apparatus for the drawing of tows by which the drawing of the tow is carried out by a simple operation and which produces hardly any waste yarns.

Briefly speaking, the method of this invention is a method of drawing an undrawn tow in a hot liquid bath between feed rolls and draw rolls, which comprises positioning a tow forcibly in a liquid of the hot bath at the start of drawing, drawing it, and in the event that the advancing of the tow is ceased, releasing the tow immediately from the hot bath.

One apparatus for practising the method of this invention is an apparatus for a hot bath drawing comprising a drawing mechanism consisting of a pair of feed rollers and draw rollers and a hot bath disposed between the said feed rollers and draw rollers, characterized in that a guide roller is provided respectively at the inlet and outlet of the hot bath, the said guide roller at the inlet and outlet being situated at positions above the surface of the hot liquid in the bath, and that a dipping means is provided above the surface of the hot liquid in the bath, the said dipping means consisting of a bracket supported by a lifting means, holders secured to the said bracket and dipping pieces fitted to the tips of said holders.

An apparatus for practising one embodiment of the invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a longitudinal sectional view of one embodiment of the apparatus of this invention which shows the state of the tow during stoppage;

FIG. 2 is a somewhat modified view of FIG. 1 showing the state of the tow at the start of drawing and during drawing;

FIG. 3 is a view taken on the line A—A of FIG. 1;

FIG. 4 is a perspective view showing another embodiment of the dipping means in FIG. 1;

FIG. 5 is a perspective view showing still another embodiment of the dipping means in FIG. 1;

FIG. 6 is a perspective view showing still another embodiment of the dipping means in FIG. 1;

FIG. 7 is a longitudinal sectional view of another embodiment of the apparatus of this invention showing the state of the tow at the start of drawing and during drawing;

FIG. 8 is a longiudinal sectional view of still another embodiment of the apparatus of this invention showing the state of the tow at the start of drawing and during drawing; and,

FIG. 9 is a longitudinal sectional view of still another embodiment of the apparatus of this invention constructed by providing a hot steam treating chamber in connection to the apparatus shown in FIG. 7 for the purpose of heat-treating the drawn tow.

The practice of one embodiment of the process of this invention will be described with reference to the drawings.

FIG. 1 shows the relation of a tow and a hot liquid when the advancing of the tow is ceased, and FIG. 2 shows the relation of a tow and a hot liquid when the tow is being drawn. The apparatus of the invention consists mainly of a pair of feed rolls **1**, a pair of draw rolls **2**, a hot bath **4** containing a hot liquid **3**, guide rollers **5** and **6**, and a dipping means **7**. In the dipping means **7**, holders **9** having dipping pieces **8** at their tips are secured to a bracket **10** which in turn is fitted to the end

of piston rods 12 driven by means of air cylinders 11. The air cylinders 11 are held to a supporting member 13. Between the feed rollers 1 and draw rollers 2 is disposed the hot bath 4, and the guide rollers 5 and 6 are provided respectively on the incoming side and outgoing side. A common tangential line of the guide rollers 5 and 6 is positioned above the surface of the hot liquid 3 of the hot bath 4. The dipping means 7 is situated above the hot bath 4. The tow 14 to be drawn is, as shown in FIG. 1, positioned such that it extends from the feed rollers 1, passes on the guide roller 5 and above the surface of the hot liquid of the hot bath 4, and via the guide roller 6, reaches the draw rollers 2.

At the start of drawing, the dipping pieces 8 are caused to fall by the action of the air cylinders 11 so as to urge the tow 14 against the surface of the hot liquid. When the tow 14 is completely immersed in the hot liquid at a position near the surface, the operation of the dipping means 7 comes to a halt. The instant the tow 14 is placed at the position shown in FIG. 2, the operation of the feed rollers 1 and draw rollers 2 begins and allows the tow to advance from left to right in FIG. 2. Thus, the tow is drawn by the tension and the hot liquid.

If an accident occurs to halt the continuous treatment of the tow in the drawing step or any subsequent step, the advancing of the tow 14 is stopped and simultaneously the dipping pieces 8 are transferred upwards. With the rising of the dipping pieces 8, the tensioned tow positioned in the vicinity of the liquid surface spontaneously comes out of the liquid, and is positioned almost as shown in FIG. 1. As, therefore, the tow 14 is released from the hot liquid during the stoppage of the drawing apparatus, the deterioration of the tow by the heat of the hot liquid is prevented and we no longer need a complicated operation of tow hooking as seen in the conventional apparatus in passing the tow through the hot bath prior to the start of drawing.

The liquid in the hot bath to be used according to the process of this invention is an aqueous medium such as water and an aqueous solution of a surface active agent.

As the means for heating the bath liquid, an electric heater fitted to the bath is usable, but preferably is a heating means by which the heated liquid is continuously circulated. One mode of the apparatus to effect this type of heating is shown in FIG. 7.

The apparatus shown in FIG. 7 is different from the apparatus shown in FIGS. 1 to 3 in the means for heating the bath liquid. The bath liquid 3 in FIG. 7 is heated by a boiler 20 provided outside the hot bath 4. A feed pipe 19 extends from boiler 20 and enters a feed pump 18. The feed pump 18 and the hot bath 4 are connected with each other by means of a feed pipe 17 which opens into the bottom of the hot bath 4. A return pipe 23 opening into the bottom of the hot bath 4 is provided to discharge the hot liquid from the hot bath 4. The return pipe 23 is connected to an outlet pump 22, and the outlet pump 22 and the boiler 20 are connected by a return pipe 21. Boiler 20 has a heating means (not shown). The liquid heated by this means is introduced into the hot bath 4 through feed pipe 19, feed pump 18 and feed pipe 17 to heat the tow 14, and then returns to the boiler 20 via return pipe 23, outlet pump 22 and return pipe 21. When the advancement of the tow 14 is stopped and the tow is placed in the hot liquid 3 in the circulating type hot bath, it is considerably deteriorated.Thus, the dipping means 7 provided above the hot bath 4, which is adapted to release the tow from the hot liquid, makes it possible to prevent the deterioration of the tow during stoppage, enhance the productivity, and to minimize the production of waste yarns.

In the apparatus of this invention, the feed rollers and draw rollers can concurrently serve as guide rollers at the inlet and guide rollers at the outlet, respectively.

As the dipping piece, a roller of an ordinary cylindrical shape is used, but as another type, a convex drum-like roller 8' as shown in FIG. 4 is also usable. This latter type of roller has an effect of separating individual filaments of the tow from each other.

It is possible to use as the dipping means the type shown in FIG. 5 wherein dipping pieces 8 and lifting pieces 15 provided under the dipping pieces 8 with a spacing for the passage of the tow are together secured to holders 9. Also usable is a dipping means of the type shown in FIG. 6 wherein an L-shaped hook 16, which pulls the tow upwards from the surface of the bath liquid with the rising of the bracket 10 is held to bracket 10 by another holder. If these types of dipping means are used, the releasing of the tow from the bath liquid at the time when the apparatus is inoperative is achieved by pushing the tow upwards by means of the lifting piece or hook, instead of the residual tension of the tow.

The dipping pieces may be rotatable, but it is preferred to use the fixed type.

Heretofore, it has been attempted to fix the drawing point of filaments in the hot bath liquid by the frictional action between the filaments and a fixed guide roller. To apply this method to this invention, it is sufficient to fix the said dipping pieces. To achieve the fixing of the drawing point more effectively, the fixed dipping pieces are subjected to mirror face finishing or ceramic coating finishing, or are made of titanium to increase their surface friction.

The fixing of the drawing point is the most important factor in the drawing of undrawn filaments.

We have found that by the use of a bath partly having a narrow portion and partly having an enlarged portion, the fixing of the drawing point is very conveniently accomplished in the drawing of undrawn filaments in a hot liquid. When the hot liquid is flowed in the direction opposite to that of the travel of the filaments, the speed of the liquid flow is larger at the narrow portion than at the enlarged portion. In the narrowest portion the relative velocity of the liquid with respect to the filaments reaches the maximum. As a result, the drawing point is fixed at this narrowest portion. An embodiment wherein this method is applied to this invention is shown in FIG. 8.

The apparatus shown in FIG. 8 consists of a means for forwarding a tow, a hot bath, a dipping means and a hot liquid circulating means. The means for forwarding the tow consists of feed rollers 1 and draw rollers 2.

The hot bath 4 is formed in convex and concave shapes at its bottom, and is narrowest in the neighborhood of a point where the dipping piece 8 is positioned to form a narrow portion 24. At the inlet and outlet of the hot bath 4, guide rollers 5 and 6 are respectively provided to position to tow 14 above the surface of the hot liquid when the travel of the tow is stopped. The construction of the dipping means 7 is almost the same as those shown in FIGS. 1 to 3. The dipping piece 8 closest to the inlet for the tow of the hot bath 4 is of the fixed type. For the operation of the dipping means 7, reference may be had to the above description. The hot liquid 3 is introduced by the hot liquid circulating means from the tow outlet side (the side where guide roller 6 is situated), and discharged from the tow inlet side (the side where roller 5 is situated), thus forming a current in the direction opposite to the travel of the tow. The hot liquid circulating means consists of a hot liquid passage formed by feed pipe 19 extending from boiler 20 and connected to feed pump 18, and feed pipe 17 extending from feed pump 18 and opening into the tow outlet side of the hot bath 4, and another hot liquid passage formed by return pipe 23 opening into the tow inlet side of the hot bath 4 and extending to the outlet pump 22 and return pipe 21 extending from the outlet pump 22 and connected to the boiler. The liquid heated by boiler 20 enters the hot bath 4 through feed pipe 19, feed pump 18 and feed pipe

17, and flows from the outlet to the inlet of the tow in the hot bath 4 having concave and convex portions at the bottom. The speed of the flow is largest at the narrow portion 24. Then, the flow returns to the boiler 20 through return pipe 23, outlet pump 22 and return pipe 21. The tow introduced via guide roller 5 slidably comes into contact with the fixed dipping piece 8. The point at which drawing occurs being fixed, it advances while being drawn, and is conducted out of the hot bath 4 via the guide roller 6. In the vicinity of dipping piece 8, the velocity of the hot liquid flow is larger than at other portions, which facilitates the action of the dipping piece 8 to fix the drawing point. Now let us suppose that the travel of the tow is stopped in the above described type of hot bath drawing apparatus. The tow, coming slidably into contact with the dipping piece 8, undergoes a very sharp increase in tension at this portion. Moreover, as the velocity of the flow of hot liquid 3 is largest here, the stoppage of the travel of the tow adversely affects the interior structure of the tow. That is to say, the physical properties of the tow are different from those of the tow drawn continuously in a good drawing condition, and such portion should naturally be removed to ensure a good quality of end products. If the tow 14, when coming to a stop during the travel, is released from the hot liquid by the action of the dipping means 7, is again immersed into the hot liquid by the dipping means 7 at the start of the next drawing, and then drawn, the difference of the physical properties as mentioned above does not occur. Thus, we need no extra operation of separating and removing the tow and the rise of the cost of production caused by the removal of waste yarns can be prevented. In addition, the setting of a tow on the apparatus is very simplified. One can simply set a tow between guide rollers 5 and 6, and cause it to fall by the dipping pieces 8 and be immersed in the hot liquid.

As an apparatus for drawing an undrawn tow in a hot bath, there is known the type wherein a hot liquid treating zone and a hot steam treating zone are present in a single chamber. This type of apparatus has an advantage in that the heat-setting of a tow can be efficiently practised and the thermal efficiency is high. The apparatus and process of this invention can also be very conveniently applied to this type of apparatus.

One embodiment of such apparatus is shown in FIG. 9.

The left half of this apparatus is similar to the apparatus shown in FIG. 7. Namely, this apparatus is constructed by providing a chamber for hot steam treatment in juxtaposition to the tow outlet side of the apparatus shown in FIG. 7. The apparatus shown in FIG. 9 is intended to subject to a tow drawn by means of a hot bath to hot stream treatment to complete the drawing more pneferably, or to stabilize the interior structure of the tow.

A hot steam treatment chamber 25 is juxtaposed to the hot bath 4, and is opened at one end into the upper portion of the hot bath 4. The other end acts as an outlet for the tow 14, and a guide roller 30 is located there. Inside the hot steam treatment chamber 25 are provided a plurality of steam ejecting nozzles 26 in opposing fashion with a passage of the tow in between. Each of the nozzles 26 is connected to a pipe 27, and a pipe 28 communicating with pipe 27 is connected to a steam supply source (not shown). The details of the hot bath 4, hot liquid circulating means, and dipping means 7 are apparent from the explanation already given with respect to FIG. 7. The point to be noted here is that the construction of the apparatus of FIG. 9 is such that drain occurring in the hot steam treatment chamber 25 is introduced into the boiler 20 through pipe 29.

The advantage of the provision of a dipping means 7 in the apparatus of FIG. 9 is as follows. The stoppage of a gas such as steam ejected into the hot steam treatment chamber 25 or the resumption of the ejection are easily and rapidly achieved by such means as valves. On the other hand, however, it is difficult to intercept the contact of the hot liquid with the tow rapidly. Accordingly, it is a very advantageous factor in an apparatus intended for the above-mentioned hot steam treatment that the contact of a tow with a hot liquid is easily intercepted by dipping means 7 in the left half portion of the apparatus of FIG. 9, that is, a portion where the tow is treated with hot liquid. Before the start of drawing, the tow 14 is hung between guide roller 5 and guide roller 6 without being immersed in the hot liquid 3, passed through a passage between the opposing nozzles 26, and is conducted out of the apparatus via guide roller 30. At the start of drawing, the tow 14 is immersed by the falling of dipping pieces 8 actuated by the action of dipping means 7, as shown in FIG. 9. The tension for the drawing is given by the difference in peripheral speed between the feed rollers 1 and draw rollers 2. In the apparatus of FIG. 9, the dipping means 7 may safely be changed to those shown in FIGS. 4 to 6, and by the change, favorable results are obtained according to the respective purpose.

The process of this invention will be better described by the following examples, by which the invention is in no way limited.

EXAMPLE 1

An undrawn tow of polyethylene terephthalate with an intrinsic viscosity of 0.61 having 2,700,000 denier composed of 600,000 monofilaments each having 4.5 denier was drawn by the apparatus illustrated in FIG. 1 at a mechanical draw ratio of 3.9, and a draw rate of 120 m./min. using a hot water at 90° C. The drawing apparatus was stopped halfways for 10 minutes, and then it was again operated. The tow is crimped by a customary method, and heat-treated for 30 minutes by hot air at 150° C. The obtained tow was dyed, and with respect to 50 cm. of the so treated tow, the deeply dyed portion, that is, undrawn portion, was examined by a magnifying glass. The result was that there were only 5 undrawn monofilaments, that is, deeply dyed monofilaments, among 600,000 monofilaments. The tow in that form could be treated as a product. The yield of the product was 99%.

EXAMPLE 2

The same undrawn tow as used in Example 1 was drawn under the same conditions as in Example 1. The drawing apparatus was stopped halfways for 10 minutes. During this time, the tow remained immersed in the hot liquid, and when the apparatus started again, the tow between the feed rollers and the draw rollers was broken and it was impossible to continue the drawing. Consequently, the yield of the product was reduced to 90%.

EXAMPLE 3

In the same manner as in Example 2, the tow was drawn and the apparatus was stopped for 3 minutes halfways during the drawing operation. During this time, the tow remained immersed in the hot liquid, and when the apparatus started again, the tow between the feed rollers and the draw rollers was not broken. The tow was dyed in the same manner as in Example 1, and examined by a magnifying glass. It was found that there were 1000 deeply dyed monofilaments in 600,000 monofilaments. The tow could not be treated as product, and the yield of the product was 92%.

We claim:

1. An apparatus for the drawing of an undrawn tow of synthetic fibers in a hot liquid, comprising a pair of feed rollers, a pair of draw rollers, said feed rollers and draw rollers being provided to advance the tow at different peripheral rates to draw said tow; a bath of hot liquid disposed between said feed rollers and draw rollers; guide rollers provided respectively at the inlet and outlet of said bath, said guide rollers being situated at positions above the surface of said hot liquid in said bath; a supporting member fixed above said bath; a lifting means held to the supporting member; a dipping means disposed above said bath and

consisting of a bracket, holders and dipping pieces, said bracket being fitted to the lifting means, said holders being secured to said bracket and each of said dipping pieces being secured to the corresponding tip of said holders, said dipping means being caused to fall by the action of the lifting means to urge the tow against the surface of said hot liquid at the start of drawing, the falling movement of said dipping means coming to a halt when the tow is completely immersed in said hot liquid at a position near the surface thereof and a hot steam treatment chamber juxtaposed to said bath on the tow outgoing side thereof, the said hot steam treatment chamber having an outlet for the tow at one end, a plurality of nozzles for ejecting steam disposed in opposing fashion to the passage of the tow, the said nozzles being connected to a steam supply source, a heating means located outside the bath, a drain in the hot steam treatment chamber, and a pipe connected to the heating means and the drain.

2. The apparatus according to claim **1** wherein the said feed rollers act in conjunction with the guide roller at the inlet, and the said draw rollers act in conjunction with the guide roller at the outlet of the bath.

3. The apparatus according to claim **1** wherein the said dipping pieces are of a convex drum shape.

4. The apparatus according to claim **1** wherein the said dipping pieces are of the fixed type.

5. The apparatus according to claim **4** wherein the surface of each of the fixed dipping pieces has a large frictional property.

6. The apparatus according to claim **4** including means for circulating the hot liquid of said bath.

7. The apparatus according to claim **1** including means for circulating the hot liquid of said bath.

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ROBERT R. MACKEY, Primary Examiner

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