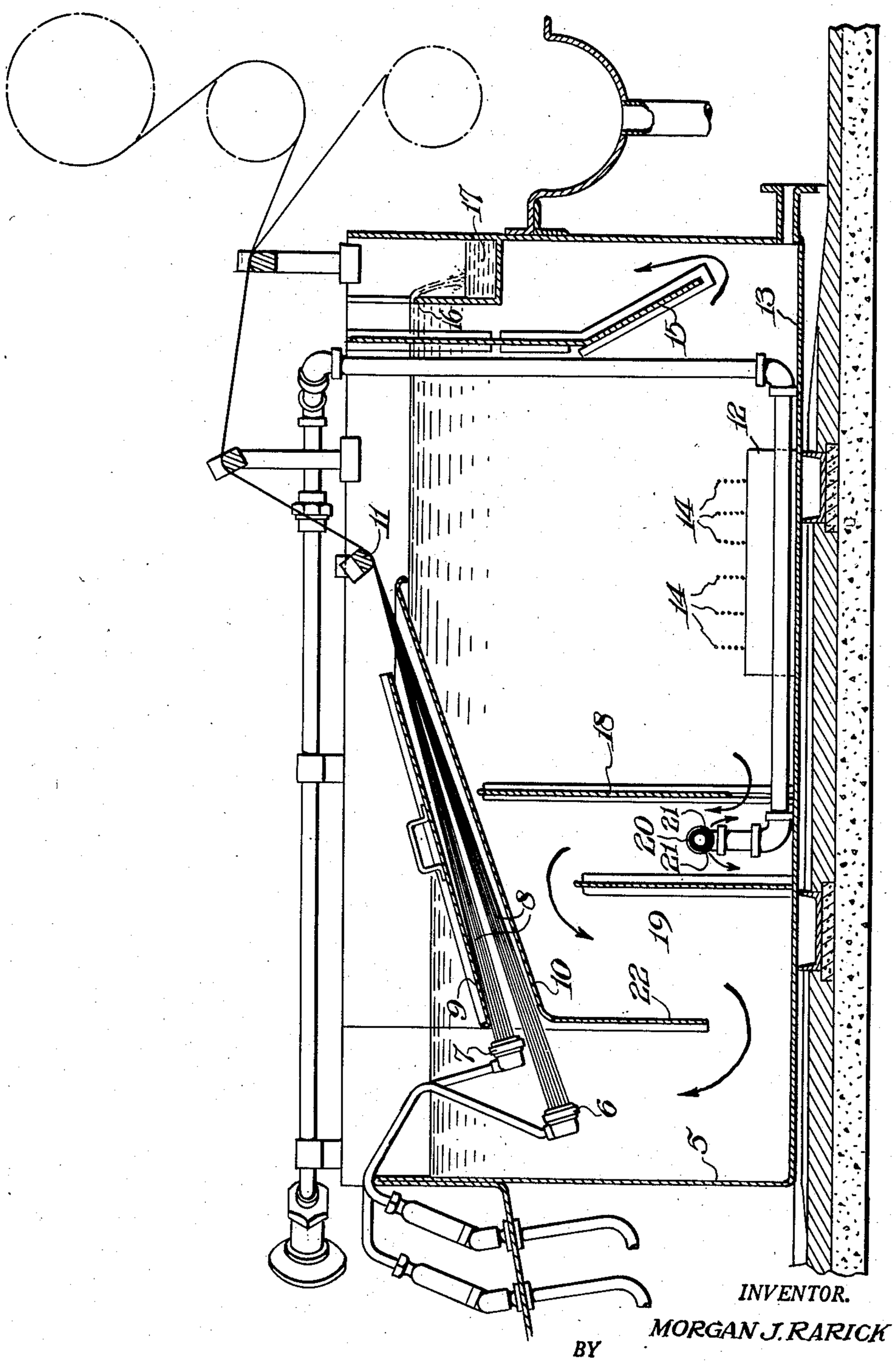
Nov. 17, 1953

M. J. RARICK

2,659,102

SPINNING VISCOSE RAYON

Filed March 14, 1951



INVENTOR.

MORGAN J. RARICK

BY

Morris E. Packman

ATTORNEY.

Patented Nov. 17, 1953

2,659,102

UNITED STATES PATENT OFFICE

2,659,102

SPINNING VISCOSE RAYON

Morgan J. Rarick, Madison, Tenn., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Application March 14, 1951, Serial No. 215,451

4 Claims. (Cl. 18—8)

1

This invention relates to a process and apparatus for spinning very heavy denier yarns or tows, comprising a very large number of filaments, by extruding viscose into an acid coagulating bath.

Bundles or tows of viscose rayon filaments intended for ultimate conversion into staple fibers are commonly spun by extruding viscose through large spinnerets containing several thousand holes, for instance of the order of from 5,000 holes per spinneret, depending on the filament size, method of processing, etc. The total denier of this filament bundle, based on the air dry weight, will be of the order of 15,000 denier. The spinning of such a bundle requires the extrusion of 3 to 5 pounds of viscose per minute per spinneret, and proper coagulation and regeneration of this large amount of material necessitates an extremely large amount of treating bath. Also, control of circulation, aeration, revivification and flow relative to the travel of the filaments are all quite important to obtain a completely satisfactory and uniformly coagulated and regenerated tow of filaments.

Attempts to comply with the essential requirements for good spinning of these very heavy denier tows while maintaining compactness, to permit the use of a number of spinning positions side by side in a single coagulating bath trough, have presented problems which the industry has tried for many years to solve. An entirely satisfactory solution to the problems should provide a large flow of non-turbulent bath to each spinneret; to provide a concurrent bath flow while maintaining the tension on individual filaments at a very low order while the filaments are still in an unregenerated and plastic state; provide a bath of uniform composition relatively free from decomposition or sludge-forming products at the spinneret; control recirculation of the bath and introduction of fresh bath so as to provide an intimate mixture of the desired bath composition at the spinneret at all times; and, at the same time, provide a long bath travel for the thousands of filaments before the filament bundle is converged and brought together at the first spinning guide.

Attempts have been made previously to provide concurrent and non-turbulent bath flow, so that the flow can be increased without increasing the tension on filaments during coagulation and regeneration. Such attempts have been concerned with passing the bath and bundles of filaments through confining tubes. In actual operation on a commercial basis, initially stringup of a tube is so difficult as to be impractical. It is necessary to pull the thread through the tube initially with a positive force such as a string or wire, or by forcing the bath positively through the tube by exterior means and letting the flow carry the thread with it through the tube. It is essential that such stringup difficulties be avoided. Moreover, provision should be made for aeration of the bath and for intimately mixing fresh bath with recirculated bath and converting turbulent flow into stream-line flow by the time the recirculated and reconditioned bath reaches the vicinity of the spinneret.

2

Accordingly, it is an object of this invention to provide an improvement in the spinning of very heavy denier viscose rayon filament bundles, suitable for conversion into staple, which will enable all the filaments of the bundle to be substantially uniformly coagulated, regenerated and tensioned at relatively high speed while maintaining good continuity of spinning over long periods of time. A further object of the invention is to provide readily operable means for accomplishing the above objectives which provides for aeration of the used bath, intimate mixing with fresh bath, and return of uniformly reconditioned bath to the vicinity of the spinneret with streamline flow. Other objects of the invention will become apparent from the following description and claims.

The invention can best be understood with reference to the drawing which is a side elevation, partially in section, of one embodiment of the apparatus of the invention.

The coagulating bath is contained in a large tank 5 which is about 5½ feet long and 3 feet deep. The width of the tank will depend on the number of spinnerets 6, 7 used. For example, 20 spinnerets may be used, spaced about 1.8 inches from center to center in a horizontal plan and arranged in a double row as indicated. The spinnerets are submerged in the bath near one end of the tank to a depth of about 5 to 10 inches, and the viscose is extruded into filaments 8 toward and into the space between two inclined plates 9, 10 which form a duct for concurrent spinning. The filaments travel a relatively long distance through the duct (e. g., 40 inches) and then pass out of the bath to a convergence guide 11. The guide may be inverted as shown or be of the more conventional hook design similar to an inverted J. The discharge end of the duct is about 2–4 inches above the bath level in the region of the spinneret, and bath is pumped through this duct in an uphill manner solely as a result

of the frictional drag of the filaments. In spite of the very large flow of bath through the duct, about 20–25 gallons per minute per spinning position the tension or work imposed on individual filaments has been found to be of an extremely low order.

The bath discharged from the duct falls into an aeration zone, the level of the bath in this region being about 1.5–3 inches above the level of the bath in the region of the spinneret. The air diffuser **12** is a flat, porous plate unit, resting on the tank bottom **13**, to which is piped air under a low pressure sufficient to overcome the hydrostatic head of the bath. The air, bubbling from the plate in fine bubbles **14**, rises through the bath carrying with it gaseous by-products formed in the act of spinning. Many of the bubbles creep along the lower plate **10** of the duct and, due to its upward inclination, move along this surface and discharge into the atmosphere. In view of the size of the bath tank, the recirculated bath remains for a considerable time in the aeration zone. Aerated bath for return to the plant system for reconditioning passes beneath the inclined baffle **15** at the extreme right of the tank and overflows over weir **16** into trough **17**, leading to the plant reconditioning system, in an amount of about 75 gallons per minute for a 20 position bath trough.

The major portion of the aerated bath recirculates through the tank, passing first beneath the baffle **18** just to left of the center of the tank in an amount of from 400–500 gallons per minute for a **20** position bath trough. Between baffle **18** and adjacent baffle **19** fresh or plant reconditioned bath is introduced through manifold pipe **20** extending across the width of the tank. It has a number of distribution holes **21** directed downwardly as shown, and delivers about 75 gallons of fresh bath per minute for 20 spinning positions. Due to the position of the baffles, **18** and **19** and openings therein, and the openings **21** in the distributor pipe, the new bath is mixed with the aerated bath quite thoroughly. By the time the composite bath flows over baffle **19**, the turbulence previously created by the air diffuser and by the flow of fresh bath into the tank begins to die out and stream-line flow begins to take place. Additional baffles arranged in a horizontal position may be added to assist in reducing turbulence. As the turbulence diminishes, air bubbles mixed with undesirable by-product gases separate more completely, rise, and collect against the lower surface of the bottom plate **10** of the inclined duct and eventually move along this surface and discharge into the atmosphere. By the time the bath progresses downwardly and beneath a third baffle **22**, extending downward from the end of the duct, the bath is free of gas bubbles, non-turbulent, and of uniform, optimum composition for use at the spinneret.

By having the bath discharge from the duct at a higher elevation than is the bath in the region of the spinnerets, a pressure head is created which induces return flow of bath at a sufficiently high rate to supply the needs of the several spinnerets. This is essential. Without this difference in bath levels the necessary return flow of bath would not be obtained and coagulation and regeneration would take place under much less desirable conditions and a non-uniform product would result. This difference in bath head, between the level at the point of extrusion and the level in the aeration zone, could be varied somewhat from that shown and still obtain good results.

The spinning duct is constructed at an angle with respect to the horizontal to give relatively long bath travel to the tow of freshly formed filaments before the tow emerges from the bath. This angle will depend to some extent on the positioning of the spinnerets but generally should be within the range of from 15° to 30° with the horizontal. The discharge end of the duct should be at least as high as the level of the bath into which it discharges and may be up to 2 inches or more higher than this. Preferably this differential should be about ½–1½ inches. The length of the duct, together with its position and the position of the spinnerets, will determine the length of bath travel of the filament bundle. While the arrangement shown allows a bath travel of 40–46 inches, this may be varied considerably to provide a bath travel in the range of from 30–70 inches or even more. A long bath travel provides more complete and uniform regeneration of the freshly-spun filaments before removal from the bath. This is particularly advantageous when spinning tow of heavy filament denier, such as 5.5 to 10.0 denier per filament, at spinning speeds of 100 or more yards per minute.

The cross-sectional area of the duct is important to give the right balance of filament volume to bath volume therein and to maintain the bath flow at a reasonably good velocity through the duct. The duct should closely surround the filaments. Accordingly, the average cross-sectional area allotted to a spinneret, figured by taking the total cross-sectional area at the entrance end and near the exit end and dividing by two, times the number of spinnerets involved, should be in the range of from 4–8 square inches for a 15,000 denier tow. With this arrangement the bath velocity within the duct will be 25 to 75 yards per minute when the tow is being collected at 100 yards per minute.

The top plate **9** of the spinning duct is arranged to be lifted when stringing up a spinning position. For this purpose it is hinged on the far side away from the operator. This arrangement makes commercial operation practical. The opposite side of the inclined plate from the hinge may be bent over and extend down so that it rests on the lower inclined plate **10**. It is important to construct the duct so that leakage of liquid at the hinge or through the other edges of the top plate is held to a minimum.

As previously indicated, the positive bath head generally employed in connection with tube spinning is desirable to reduce the amount of work which each individual filament must do in pumping its share of bath at the required velocity through the tube. It appears that this work value cannot exceed a certain critical value if yarn of optimum physical properties is obtained. In the instant application the concurrent duct spinning of extremely large filament bundles at a negative bath head of several inches and with the concurrent flow of the extremely large amount of bath for each spinning position still does not exceed the critical work value that may be imposed on the individual filaments. Quite apart from the stream-line, concurrent flow of bath along the length of the duct, the provision of means for effectively aerating the bath while providing turbulence to hasten the mixing of the old bath with the new, and then moving from this turbulent flow into a stream-line flow at or near the spinneret, provides important and essential elements in the spinning combination that gives surprisingly good results by way of uniformly high quality product, higher speed

and continuity of spinning, ease of operation, and economy of bath circulation.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

What is claimed is:

1. A process for spinning a very large number of viscose rayon filaments to form a heavy denier tow which comprises continuously extruding viscose into filaments from a multiplicity of adjacent spinnerets arranged in a coagulating bath, conducting the filaments out of the bath in a generally parallel relationship through a long, upwardly inclined duct, displacing bath through the duct in a concurrent direction solely by the motion of the filaments, discharging the displaced bath at a higher level than the bath level at the spinnerets, aerating the displaced bath and mixing fresh bath with the displaced bath to recondition the bath, and recirculating the reconditioned bath to the spinnerets in streamline flow, the flow of recirculated bath being obtained solely by the higher level of the displaced bath at the duct discharge.

2. Apparatus for spinning viscose rayon tow which comprises a tank for coagulating bath, means including a multiplicity of spinneret orifices for continuously extruding viscose filaments into the bath near one end of the tank, a duct extending at a gradual upward inclination from near said orifices and ending above the bath level at said orifices, means for conducting the filaments from said orifices through said duct and out of the bath, said duct closely surrounding the filaments so that the motion of the filaments produces a concurrent flow of bath through the duct at a velocity of from 25% to 75% of the filament velocity, said duct being so located within the tank that the dicharged bath recirculates by gravity through the tank back to the vicinity of said orifices, and means for aerating the bath discharged from the duct before the bath has recirculated to the vicinity of said orifices.

3. Apparatus for spinning viscose rayon tow which comprises a tank for coagulating bath, means including a multiplicity of spinneret orifices for continuously extruding viscose filaments into the bath near one end of the tank, a duct extending at a gradual upward inclination from

near said orifices and ending above the bath level at said orifices, means for conducting the filaments from said orifices through said duct and out of the bath, said duct closely surrounding the filaments so that the motion of the filaments produces a concurrent flow of bath through the duct at a velocity of from 25% to 75% of the filament velocity, said duct being so located within the tank that the discharged bath recirculates by gravity through the tank back to the vicinity of said orifices, and baffles in the path of the recirculating bath arranged to provide for return of the bath to the vicinity of said orifices with streamline flow.

4. Apparatus for spinning viscose rayon tow which comprises a tank for coagulating bath, means including a spinneret for continuously extruding viscose filaments into the bath near one end of the tank, a bath guiding duct inclined upwardly at an angle of about 15° to 30° with the horizontal and extending from near the face of the spinneret to above the bath level near the opposite end of said tank from said spinneret, means for conducting the filaments from said spinneret through said duct and out of the bath, said duct surrounding the filaments sufficiently closely so that motion of the filaments causes bath to flow rapidly through said duct concurrently with the filaments and be discharged from the upper end of said duct, distributor means for adding fresh bath to the bath discharged from said duct, and overflow weir for removal of excess bath located at the end of the tank opposite from the end where said spinneret is located, and a plurality of baffles to intimately mix the bath discharged from said duct with the fresh bath and remove turbulence by the time the mixture has flowed back to the vicinity of said spinneret.

MORGAN J. RARICK.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,210,116	Dreyfus	Aug. 6, 1940
2,243,116	Ostermann	May 27, 1941
2,514,471	Calhoun	July 11, 1950

FOREIGN PATENTS

Number	Country	Date
477,529	Great Britain	Jan. 3, 1938