Oct. 19, 1948. A. J. MEHLER, JR 2,451,854

DRY SPINNING APPARATUS

Filed June 15, 1944

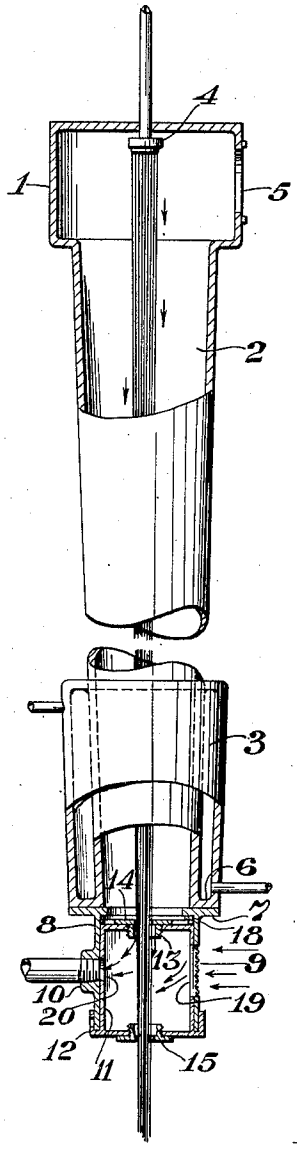



Fig. 1

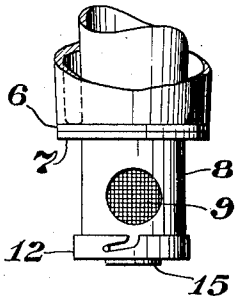



Fig. 4

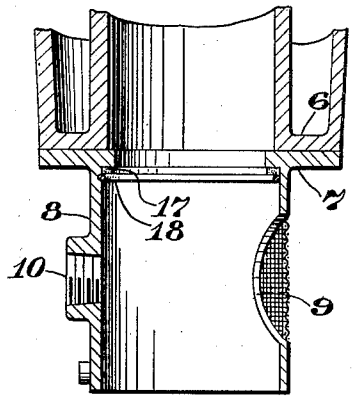



Fig. 2

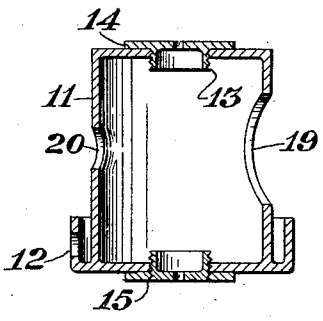



Fig. 3

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Patented Oct. 19, 1948

2,451,854

# UNITED STATES PATENT OFFICE

2,451,854

## DRY SPINNING APPARATUS

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Application June 15, 1944, Serial No. 540,471

1 Claim. (Cl. 18—8)

1

This invention relates to the dry- or evaporative-spinning of filaments of organic acid esters of cellulose. More particularly, it relates to improvements in apparatus for dry-spinning an acetone solution of cellulose acetate in an evaporative atmosphere containing a high concentration of acetone vapor.

It is known to form, by the dry- or evaporative-spinning technique, large denier filaments of cellulose acetate which are substantially round and smooth and which have high elongation (45% to 60%) and hence a high degree of toughness and which are particularly suited for use in rug pile and the like.

To produce such filaments it is essential that the filament-forming solution be spun into an evaporative atmosphere consisting almost entirely of acetone vapors with some air in the immediate vicinity of the spinneret. Various new arrangements and modifications of existing dry-spinning cell structures have been developed for the purpose of providing and maintaining such an evaporative atmosphere. However, those cells which have proven most satisfactory from the standpoint of the characteristics and quality of the yarn producible therefrom feature in every instance such a complex arrangement of orifices and by-passes to provide control that operation of the system is delicate in the extreme and generally it is necessary to adjust each cell individually and to repeatedly check the adjustment in order to secure the desired yarn properties and spinnability. Moreover, elaborate precautions must be taken to render the cells leak-proof.

An object of this invention, therefore, is to provide means for maintaining the requisite high concentration of acetone vapors in the dry-spinning cell, and the proper amount of air about the spinneret, which means is of simple economical construction, does not involve delicate adjustments, is constant in operation, and is insensitive to minor leaks which may develop in the course of operation. This and other objects will more clearly appear hereinafter.

My invention, which takes advantage of the fact that acetone vapor (even when hot) has a greater density than air at room temperature, resides primarily in a special yarn outlet arrangement or assembly to be attached at the bottom of a standard dry-spinning cell. Essentially this outlet comprises a tubular member adapted to seal the lower end of the cell except for an orifice or passage in the upper end of the tubular member, the orifice being of such size that the acetone vapor flowing therethrough of its own

2

weight, plus acetone vapor entrained with the yarn, approximately balances the evaporation of acetone from the filaments into the cell. An outlet for the yarn is provided in the lower end of the tubular member and two openings, preferably, one large and the other small, are provided at diametrically opposed points in the side wall of the tubular member intermediate its ends. In operation the small opening is connected to an aspirating system whereby a current of air is created cross-wise of the tubular member which picks up acetone vapor for recovery of acetone, if desired.

From the following description in which is disclosed certain embodiments of my invention as well as details of what is believed to be the best mode for carrying out the invention, it will be apparent how the foregoing objects and related ends are accomplished. The invention will now be described with reference to the accompanying drawing wherein:

Figure 1 is a diagrammatic representation, in cross-section, of a typical dry-spinning cell embodying the device of my invention;

Figure 2 is an enlarged cross-sectional view of the outer member of the yarn outlet assembly;

Figure 3 is an enlarged cross-sectional view of the inner member of the yarn outlet assembly; and

Figure 4 is a side view showing a preferred means of removably fitting the inner member of the yarn outlet assembly to the outer member of said assembly.

Referring now to Figure 1 of the drawing, reference numeral 1 designates a conventional dry-spinning cell having a cold section 2, a jacketed hot section 3, and a spinneret 4 located in the upper end of the cell. The usual sight opening 5 customarily used to inspect the spinning action at the spinneret is provided opposite the spinneret.

The lower end of the spinning cell is preferably provided with a flange 6 to which is removably attached through the flange 7 an outer open-ended tubular member 8 having a screened side opening 9 (see Figures 2 and 3) and a diametrically opposed side opening 10 preferably threaded, as shown, for convenient connection to an aspirating system. The opening 9 is preferably, but not necessarily, larger in area than opening 10. Fitted within outer tubular member 8 is an inner closed-ended tubular member 11 which has outwardly and upwardly turned flange 12 at its lower end to provide a recessed seat for the lower edge of member 8. The upper end of tubular

member 11 is provided with a tapped central opening to receive the threaded skirt 13 of an orifice plate 14 having a central opening therein. This latter arrangement allows for the easy interchange of orifice plates having different sized orifices whereby an orifice exactly the right size for the particular spinning conditions can be used in every instance. Preferably, a replaceable lower orifice plate 15 is fitted in the same manner into a centrally located opening in the bottom of tubular member 11. However, the size of the lower opening is not critical and hence the use of a replaceable lower orifice plate is not essential. The upper end of member 11 tends to bear against an inwardly extending flange 17 on member 8 and with an intermediate gasket 18 forms a gas-tight seal between the two tubular members so that the end of the cell is sealed except for the orifice in plate 14. Tubular member 11 is also provided with large side opening 19 and small side opening 20 which register with openings 9 and 10, respectively. Tube 11 is locked in place to tube 8 preferably by means of a bayonet type pin and slot connection as shown in Figure 4.

By means of the simple arrangement above described the requisite high concentration and distribution of acetone vapor may be easily but precisely controlled. It is only necessary that the size of the orifice in the orifice plate 14 be so chosen that after the spinning has been initiated and the proper concentration of acetone vapor in the cell has been reached the amount of acetone vapor flowing through the orifice of its own weight, plus the amount of acetone vapor entrained by the yarn, is slightly less or substantially equal to the rate of evaporation of acetone from the yarn in the cell whereby a column of concentrated acetone vapor extending from the bottom of the cell to within the immediate vicinity of the spinneret is maintained. If acetone enters the cell faster than it flows out the bottom via the yarn outlet orifice, the excess acetone will overflow through the sight-box opening. Under such conditions a large sight-box opening should be used.

The size of yarn outlet orifice to be employed depends, of course, upon the size of the air inlet opening, the size and number of filaments being spun, the concentration and temperature of the spinning bath, the temperature of the cell and the speed of spinning, and in any case is readily determined by experimentation following the principles previously stated.

The acetone issuing from the bottom of the cell is subjected to a cross-draft sufficient to carry it through the small side opening in the yarn outlet assembly from which point it is conducted to a suitable unit for the recovery of acetone for reuse. The suction needed to create the necessary cross-draft is slight and has no appreciable effect on the pressure conditions within the cell.

As stated above, air is most conveniently introduced into the cell through the conventional sight-box opening. However, the air opening may be at any other point in the cell wall adjacent the spinneret.

In spinning a plurality of yarns simultaneously in one cell it is preferred to use a slot instead of a round orifice at the bottom of the cell. The slot may be made easily adjustable by having one side at least made of a movable plate held in position by screws or other clamping means. Likewise the tubular members may be of round, rectangular or any other desired cross-section, and a single tube may be used in place of the double tube arrangement hereinabove described.

To further illustrate the principles and operation of my invention the following specific examples are given.

*Example I*

A cellulose acetate spinning solution comprised of 25% cellulose acetate (about 54% of combined acetic acid), 2.1% water, and 72.9% acetone, heated to 59° C., was extruded through a 10-hole spinneret, each hole being 0.15 millimeter in diameter, and into a cell constructed as hereinabove described and heated to 120° C. The yarn was drawn from the cell through a round yarn outlet orifice 3.9 millimeters in diameter. The sight-box opening was 2.4 inches in diameter. The extrusion rate of the spinning solution was such that with a windup speed of 125 yards per minute, a 150 denier-10 filament yarn was produced.

The yarn so produced had a bean-shaped cross-section, a dry strength of approximately 1.2 grams per denier and a dry elongation at the breaking point of 50% as measured on a Scott inclined tester. Moreover, the yarn was remarkably uniform in quality and very few breaks occurred during the course of the spinning which is, of course, indicative of stable cell conditions.

*Example II*

A 150 denier-10 filament cellulose acetate yarn was spun under the conditions of Example I except that a sight-box opening of 1.0 inch in diameter was used which necessitated increasing the yarn outlet orifice to 4.1 millimeters in diameter in order to obtain a yarn of substantially the same properties.

*Example III*

The spinning solution of Example I was extruded through a 10-hole spinneret having holes 0.17 millimeter in diameter, and the yarn was drawn from the cell through an orifice 5.0 millimeters in diameter. The diameter of the sight-box opening was 1.4 inches.

A 170 denier-10 filament yarn having properties similar to those of the yarns of Examples I and II was produced.

*Example IV*

Yarn was spun under the conditions of Example III except that the size of the sight-box opening was reduced to 0.09 inch in diameter. The yarn outlet orifice had to be increased to 6.0 millimeters in diameter to secure yarn of the same properties.

*Example V*

The spinning solution of Example I was extruded through a 20-hole spinneret, each hole being 0.15 millimeter in diameter, and the yarn was withdrawn from the cell through an orifice 5.2 millimeters in diameter. The sight-box opening was 1.75 inches in diameter.

A 300 denier-20 filament yarn of substantially the same properties was obtained.

*Example VI*

Yarn was spun under the conditions of Example V except that a 1.0 inch sight-box opening was used. It was necessary to increase the yarn outlet orifice to 6.8 millimeters in diameter to secure yarn of the same properties.

While my invention is described specifically

with reference to the spinning of an acetone solution of cellulose acetate, it is not so limited but is applicable to the spinning of cellulose acetate dissolved in any of the well known volatile solvents therefor, the hot vapors of which are heavier than air at room temperature. Also, in place of cellulose acetate other synthetic filament-forming cellulose organic ester materials known to be spinnable by the dry- or evaporative-spinning technique may be similarly spun with advantage by employing the apparatus of this invention. Examples of such materials are cellulose propionate, cellulose butyrate, cellulose acetopropionate, cellulose aceto-butyrate.

A principal advantage of my invention is that it avoids the necessity for precise manipulation which attends the operation of prior arrangements involving elaborate systems of orifices, pressure control, and the like.

Furthermore, when the yarn outlet orifice structure of this invention is used, the pressure differential at the upper end of the cell where leaks usually occur is very small; hence, no special precautions against leaks need be taken.

Fewer yarn breaks and greater uniformity in quality of the yarn produced are further advantages attending the use of my invention, and in addition the yarns produced are of greater toughness than yarns heretofore obtainable.

From the economic standpoint, the yarn outlet structure of my invention is simple and inexpensive to manufacture and repair, and it can be applied to present equipment without extensive alterations. Further economies reside in the fact that the apparatus of my invention is stable in operation and requires a minimum of attention and adjustment.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that this invention is not limited to the specific embodiments thereof except as defined in the appended claim.

I claim:

In a spinning cell comprising a sight-box opening at the upper end thereof and adapted for the spinning of cellulose acetate yarn from acetone solutions of cellulose acetate, the improvement



which comprises a yarn outlet means at the bottom of the cell, said yarn outlet means comprising an open-ended tube provided at its upper end with an outwardly extending flange through which said tube is removably attached to the bottom end of the spinning cell; a small opening in the side wall of the tube adapted to be connected with an aspirating line, a large screened opening in the side wall of the tube diametrically opposite said small opening, a second tube removably fitted snugly within said open-ended tube in such manner that vapors cannot pass between the walls of said tubes, said second tube being closed at the top except for a removable plate having an orifice therein, said orifice being of such size that the amount of acetone vapor flowing therethrough of its own weight, plus the acetone vapor entrained by the filaments, substantially balances the amount of acetone formed in the cell by evaporation, and a small opening and a large opening in the side wall of the second tube registering with the small and large openings respectively in said open-ended tube, the lower end of said cell being sealed except for said orifice in said removable orifice plate.

ALBERT J. MEHLER, JR.


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