

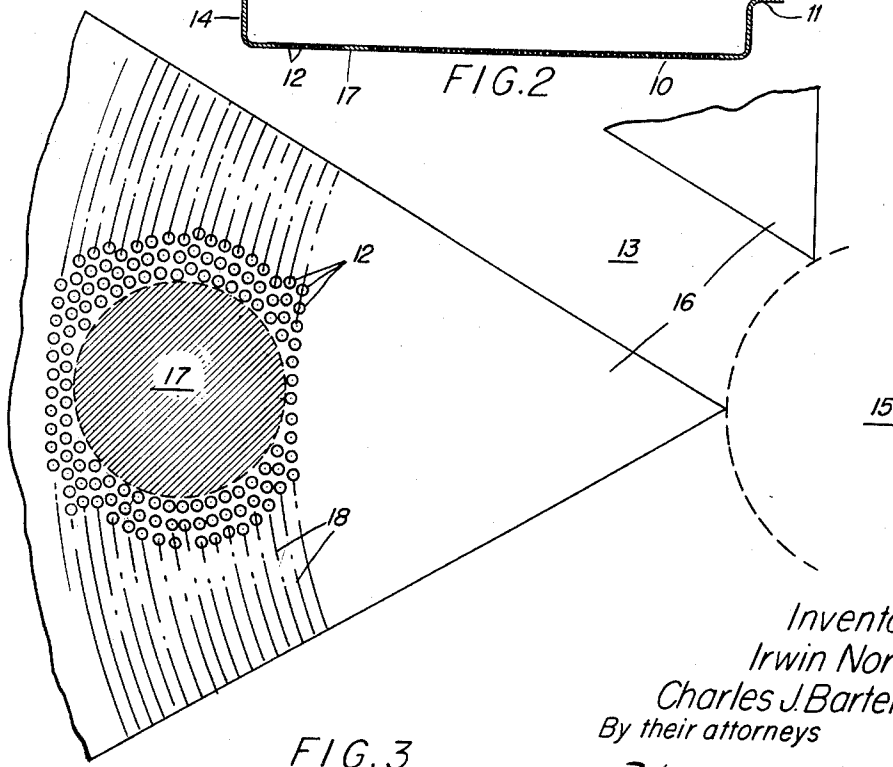
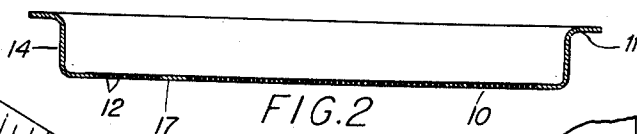
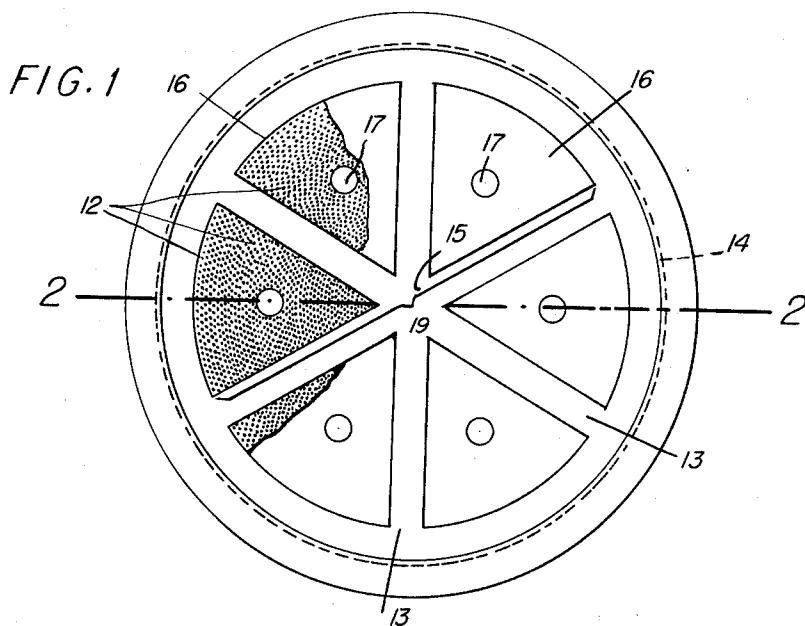
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I. NORMAN ET AL

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SPINNING JET AND PROCESS OF USING SAME

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Inventors
Irwin Norman
Charles J. Barter, Jr.
By their attorneys
Howson and Howson

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SPINNING JET AND PROCESS OF USING SAME

Irwin Norman, West Mobile, and Charles J. Barter, Jr.,
Mobile, Ala., assignors to Courtaulds, Inc., New York,
N.Y., a corporation of Delaware

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13 Claims. (Cl. 18—8)

This invention relates to a spinnerette or jet for manufacturing synthetic staple fibre tow by means of bundles of filaments by a wet spinning process and the process of its use. It is economical to have as many filaments as possible in each individual jet but it has been found that in large sized jets such as those having, say, 5,000 or more orifices, there is a tendency for bubbles to adhere to the surface of the spinning jet. Whenever the orifice density is such that the bubbles tend to adhere to the surface of the spinning jet, filaments from adjacent holes tend to merge before hardening. This forms a solid "splinter." A splinter is considered a fault in spinning. One way to avoid air bubbles is to space the holes further apart. However, as the number of holes increases, the diameter of the jet must be increased to wholly uneconomical and impractical proportions. It has been known to provide imperforate radial clear channels in the face of round jets extending from the periphery toward or to the center to assist the spinning bath in reaching all points on the jet face. It has been found, however, that these free or clear channels are not sufficient to avoid bubbles under all conditions. We have found that adherence of bubbles in these perforated areas can be completely eliminated by what may be described as a special arrangement of the orifices. This arrangement is characterized by leaving an imperforate area in the geometric center of each perforated segment area. By "geometric center" is meant a point which is at the average distance from the exterior points of the perforated area. The geometric shape of the perforated orifice area is not critical and can be anything convenient to manufacture or according to the needs of the spinning conditions. Similarly, the geometric shape of the imperforate area can be similar to the perforated area or any other shape. There are only two essential requirements. One, that the imperforate area be located at the geometric center of the perforated area, and second, that the imperforate area amount to at least two percent but preferably at least five percent of the perforated orifice area. By having this imperforate orifice arrangement of at least about five percent in area at the geometric center of the perforated area, the bubbles can be eliminated.

As a measure of whether a given jet will have bubble adherence, it has heretofore been suggested that if a so-called jet factor K is over 800, then bubbles will be formed. This jet factor equals

$$\frac{AD}{S}$$

in which A is the area of the face of the jet expressed in square inches, D is the number of orifices per square inch in that area, and S is the periphery of the face expressed in inches. A jet factor K of more than 800 is considered unfavorable from the point of view of bubble adherence. This jet factor K of 800 is equivalent to 1500 orifices per square inch.

In the drawings, Fig. 1 is a diagrammatic plan view of the outer face of a jet constructed according to in-

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vention. The orifices are so small and close together that they have been suggested only in part of the face but it should be understood that they are present in all six of the segmental areas shown.

Fig. 2 is a view in vertical cross-section through the jet of Fig. 1 taken on the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic plan view on a much enlarged scale of part of the face of the jet of Figs. 1 and 2 suggesting how the holes may be arranged on wet spinning processes for making tow from viscose or the like. The spinning solution is forced through a jet into a spinning bath and the individual threads are coagulated by the spinning bath before they have a chance to merge and become stuck together. The present invention relates to this jet from which the filaments are ejected into the spinning solution and the method of forming tow from such a jet.

As can be seen from Fig. 2, the jet may be cup shaped, having a face 10 and a rim 11. The jet is held by the rim. The orifices 12 are in the face. In order to make tow a very large number of filaments is desirable and since jets are made of expensive metallic alloys, and for mechanical reasons it is necessary to keep the size of the jet down as much as possible, the orifices 12 occur very close together. Thus, for example, jets for making tow having 6,000 holes would require a face cup diameter of at least 2.5 inches, 10,000 holes would require a face cup diameter of at least 4.0 inches, and 15,000 holes would require a face cup diameter of at least 6.0 inches in the case of a round jet in order for the jet factor K to be less than 800 and thus prevent bubble adherence. However, these sizes are impractical and costly. With the special arrangement of orifices described in this invention, jets for making tow having 6,000 to 15,000 holes may be only 2.0 inches in diameter.

It has heretofore been found that in jets being used for making tow, it is desirable in the case of a round jet to have clear channels 13 running in radiating directions from the center of the jet to the periphery 14 in order to assist in coagulating the threads coming from the holes as individual separate threads. Without such clear channels to improve the circulation of the spinning bath, the individual threads sometimes tend to coagulate together to form the large bunch or "splinter" heretofore referred to. This is generally considered a defect.

However, even with these clear channels it has been found that under certain conditions of density the individual threads from the orifices cannot always be kept coagulated separately, i.e., as individual threads.

While the figure of 800 for the factor K is approximately equal to the maximum number of holes per square inch in certain types of jets heretofore known which can be used without the adherence of bubbles to the face of the jet, we have found that actually a much greater orifice density can be used without bubble adherence if a slightly different structure is used. Thus, assuming that we are dealing with a jet such as shown in the drawings where the jet face 10 is round and there are radiating clear channels 13, and if it is desired to have a center jet portion 15 which is imperforate, the orifice density may be carried much higher than heretofore by the following alteration. As can be seen in the drawings, each clear channel 13 for the introduction of the spinning solution is itself imperforate and in the case of the jet shown the face is there divided into six pie shaped segments 16. Each such pie shaped segment is completely covered with orifices except that, in accordance with the invention, at the geometric center of each such pie shaped segment there is an imperforate area 17 preferably occupying at least five percent of the perforated area of that segment.

The effects of the invention begin to become apparent

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and useful when the area of the imperforate geometric center gets up to about two percent of the total perforated area of that segment; but the maximum effect is always reached by about five percent. We have found that by having an imperforate area located at the geometric center of the segment, the tendency for bubbles to collect at or about that point or any where else on the jet surface is completely avoided and a perfect product is obtained.

In the example shown in the drawings, let us assume that the over-all diameter of the circular jet measured from the periphery 14 is $4\frac{1}{2}$ inches (Fig. 2) and the diameter 19 of the perforated part of the face 10 of the jet is 4 inches. There are 2,500 orifices in each of the six segments of this perforated part, a total of 15,000 orifices. These orifices are arranged in, say, 72 circles 18 (see Fig. 3) around the center of the face of the jet and there are what corresponds to about 125 blocked holes in each imperforate area 17 at the geometric center of each segment. With this layout the pitch between circles will be about .021 inch from circle to circle on the average in the perforated segment. The pitch between orifices will average .022 which, it will be noticed, is substantially the same as the pitch from circle to circle. The pitch from circle to circle and orifice to orifice will generally be close to the same figure. It should be understood that if for any other reason such as the requirements for the final denier desired more than five percent of the perforated area is made imperforate, that will not interfere with the obtaining of the advantage of the invention. The most common arrangement in viscose jets for spinning tow at the present time is to make each perforate area a pie-shaped segment of a circle as shown in the drawings and the most economical geometric center imperforate area would be a circle.

With this arrangement the orifice density factor can be increased considerably beyond the 800 figure of the prior art without getting bubble adherence. For example, jets having holes which number from 10,000 to 25,000 as shown in the table given below can be used without obtaining bubble adherence. Cup face or jet face diameters 19 in this table run only from 2 inches to 5 inches and the average pitch from circle to circle from .019 inch to .024 inch. These figures are all considerably above the jet factor K figure of 800.

Number of Holes	Average Circle to Circle Pitch, inches	Cup Face Diameter, inches
10,000.....	.019-.024	2.0-2.5
12,600.....	.019-.024	2.5-3.5
15,000.....	.019-.021	2.5-4.0
20,000.....	.019-.024	3.0-4.5
25,000.....	.022-.024	4.0-5.0

The invention can be expressed as a process. The steps involved are ejecting the spinning solution from the orifices 12 in each segmental area while making clear channels 13 available along one or more sides of each segment, and the step of preventing the spinning solution going through the orifices at the geometric center of the area, whereby, in spite of the factor K being over 800, bubble adherence is avoided. It will be recognized that this method is applicable to almost any geometric shape for the face 10 of the jet whether it be round or square for example. The clear channels 13 in which the spinning bath can move are, of course, imperforate areas and are merely for the purpose of allowing a free path for the spinning bath to move. The simplest method of preventing ejection of spinning solution at the geometric center is to make the center 17 imperforate as shown in the drawings. The variations in pressure and flow provided by this particular combina-

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tion we have found tend to carry away any bubbles which may try to form on the face of the jet and thus make it possible to have an orifice density factor much higher than that heretofore considered possible without incurring any risk of formation of bubbles and resulting splinters.

What is claimed is:

1. In a multi-filament jet with a large number of orifices for manufacture of synthetic fibers by a wet spinning process, the provision of a plurality of perforated orifice areas with an orifice density in each such area of at least 1500 orifices per square inch, in combination with the provision of an imperforate area at the geometric center of each perforated orifice area, the imperforate area amounting to at least two percent of the perforated area; whereby the adherence of bubbles is avoided.

2. In a metallic jet with a large number of orifices on its face for manufacture of tow by a wet spinning process, the provision of a plurality of perforated orifice areas with an actual orifice density in each such area of at least 1500 orifices per square inch, in combination with an imperforate area in the geometric center of each perforated orifice area, the imperforate area amounting preferably to at least five percent of the perforated area; whereby the adherence of bubbles on the face is avoided.

3. In a metallic circular jet for manufacture of tow by a wet spinning process having a large number of orifices arranged close together, clear, imperforate channels connected with the periphery of the jet dividing the jet face into segmented perforated areas, the density of the orifices in each area being at least 1500 orifices per square inch, in combination with an imperforate area in the geometric center of each perforated area, the imperforate area covering about five percent of the perforated area; whereby bubble adherence on the jet face is avoided.

4. A metallic jet for manufacture of tow by a wet spinning process having an orifice area density jet factor K or more than 800, where K equals

$$\frac{AD}{S}$$

A being the area of the face of the jet in square inches, D the number of holes per square inch and S the periphery of the jet in inches, there being a plurality of perforated areas separated by clear imperforate channels lying in radial directions from the center of the jet, and in which an imperforate area of at least two percent of each perforated area in the jet is located at the geometric center of that perforated area; whereby bubbles are prevented from adhering to the face of the jet.

5. A jet for manufacture of tow by a wet spinning process, said jet having 10,000 to 25,000 orifices arranged in circles, a circle-to-circle orifice pitch of .019 inch to .024 inch with a jet diameter of 2.0 inches to 5.0 inches, there being a plurality of perforated areas and the orifices being arranged in such a way that each perforated area has at its geometric center an imperforate area covering at least five percent of that perforated area; whereby the formation of bubbles is avoided.

6. A metallic jet for manufacture of tow by a wet spinning process according to claim 6, in which the face of the jet is circular, there are clear channels extending from the periphery of the face toward the center, dividing the face into pie-shaped segments, and there are imperforate areas, each imperforate area being at the geometric center of a segment and being at least five percent of the area of the segment in which it is located; whereby bubbles which tend to collect at the center of each segment are prevented from adhering to the face of the jet.

7. A metallic jet for manufacture of tow by a wet spinning process in which a bundle of staple fibre filaments are produced, said jet being of at least 10,000 holes and having the orifices arranged in circles in one or more perforated areas with an average circle-to-circle

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pitch of from 0.19 to 0.24 inch and a jet face diameter of 2.0 to 2.5 inches; there being a plurality of perforated areas and the arrangement of orifices on the jet face being such that each perforated area has at its geometric center an imperforate area covering at least two percent and preferably five percent of that perforated area; whereby bubble adherence is avoided.

8. A metallic jet for manufacture of tow by a wet spinning process in which a bundle of filaments are produced, said jet being of about 12,500 holes having the orifices arranged in circles with an actual average circle-to-circle pitch limit from .019 to 0.24 inch and a jet face diameter of 2.5 to 3.5 inches; there being a plurality of perforated areas and the arrangement of orifices on the jet face being such that each perforated area has at its geometric center an imperforate area covering at least two percent of that perforated area; whereby bubble adherence is avoided.

9. A metallic jet for staple fibre manufacture by a wet spinning process in which a bundle of filaments in the form of tow are produced, said jet of about 15,000 holes having the orifices arranged in circles with an average circle-to-circle pitch limit from .019 to 0.21 and a jet face diameter of 2.5 to 4.0 inches; there being a plurality of perforated areas and the arrangement of orifices on the jet face being such that each perforated area has at its geometric center an imperforate area covering at least five percent of that perforated area; whereby bubble adherence is avoided.

10. A metallic jet for staple fibre manufacture by a wet spinning process in which a bundle of filaments in the form of tow are produced, said jet being of about 20,000 holes having the orifices arranged in circles with an average circle-to-circle pitch limit from 0.19 to 0.24 inch and a jet face diameter of 3.0 to 4.5 inches; there being a plurality of perforated areas and the orifices on the jet face being so arranged that each perforated area has at its geometric center an imperforate area covering at least five percent of that perforated area; whereby bubble adherence is avoided.

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11. A metallic jet for staple fibre manufacture by a wet spinning process in which a bundle of filaments in the form of tow are produced, said jet of about 25,000 holes having the orifices arranged with an average circle-to-circle pitch limit from .022 to .024 inch and a jet face diameter of 4.0 to 5.0 inches; there being a plurality of perforated areas and the arrangement of the orifices on the jet face being such that each perforated area has at its geometric center an imperforate area covering at least five percent of that perforated area; whereby bubble adherence is avoided.

12. A metallic jet for the manufacture of bundles of filaments in the form of tow by a wet spinning process in which there are at least 1500 orifices per square inch, there being a plurality of pie-shaped segmental perforated areas, the pitch between orifices and circles of orifices will be between .019 and .024 inch, the arrangement of orifices avoiding bubble adherence by having an imperforate area in the geometric center of each perforated area in the face of the jet amounting to about five percent of the perforated area in which it is located.

13. A metallic jet for the manufacture of bundles of filaments in the form of tow by a wet spinning process, the jet having at least 5,000 orifices arranged in circles divided into a plurality of perforated segmental areas of any convenient geometric shape, the average circle-to-circle pitch being from .019 to .024 inch and the pitch between orifices being substantially the same, with an imperforate area in the geometric center of each perforated segmental area amounting to about five percent of the perforated area; whereby the orifices can be closer together than otherwise without bubble adherence.

References Cited in the file of this patent

UNITED STATES PATENTS

2,051,861	Jones	Aug. 25, 1936
2,798,252	Cummings	July 9, 1957

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,932,851

April 19, 1960

Irwin Norman et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 62, for the claim reference numeral "6" read -- 5 --; column 5, line 22, for "0.21" read -- .021 --; line 33, for "0.19 to 0.24" read -- .019 to .024 --.

Signed and sealed this 15th day of November 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents