Feb. 18, 1964 W. HEYNEN ETAL 3,121,254

APPARATUS FOR THE SPINNING OF HOLLOW FILAMENTS

Filed Oct. 13, 1959 4 Sheets-Sheet 1

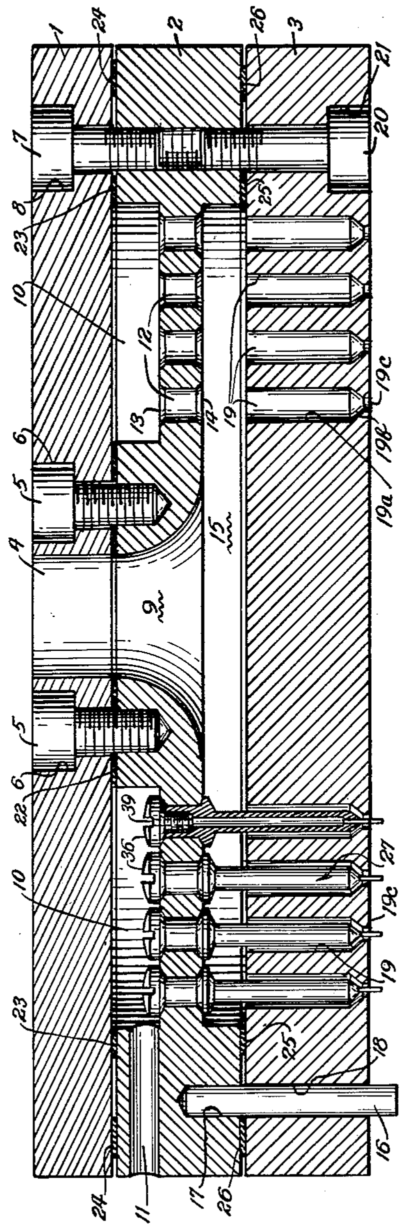

Fig. 1

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Filed Oct. 13, 1959 4 Sheets-Sheet 2

Fig-2

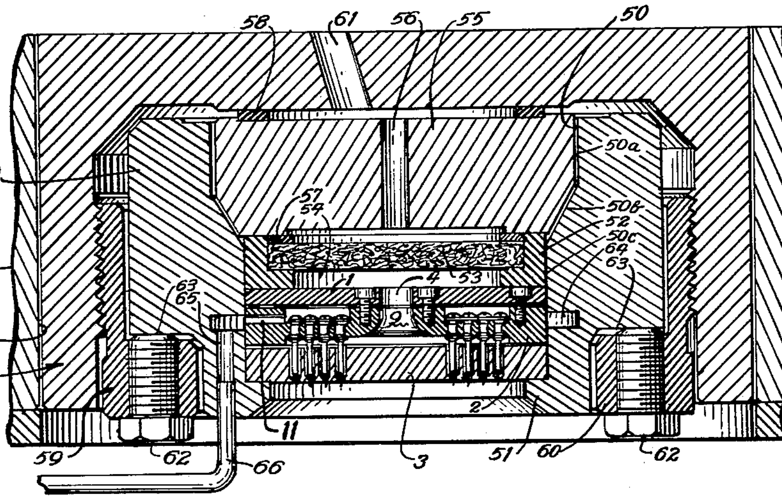
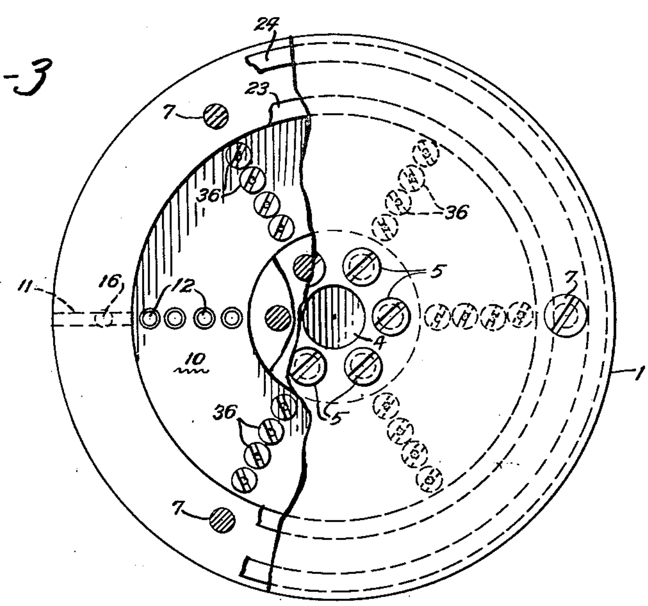


Fig-3



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Filed Oct. 13, 1959 4 Sheets-Sheet 3

Fig-5

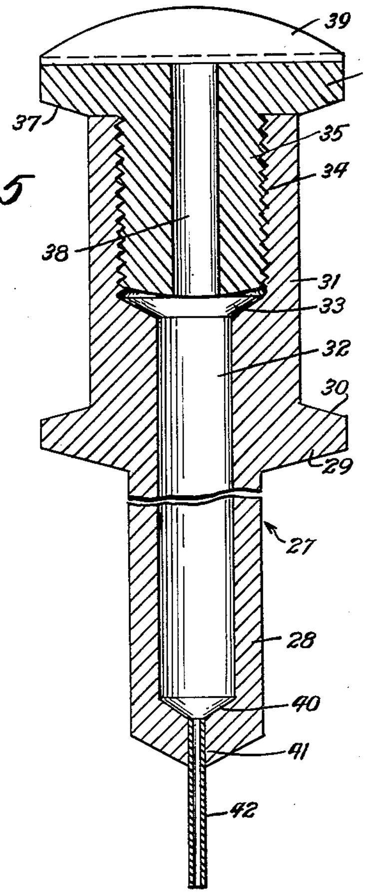


Fig-6

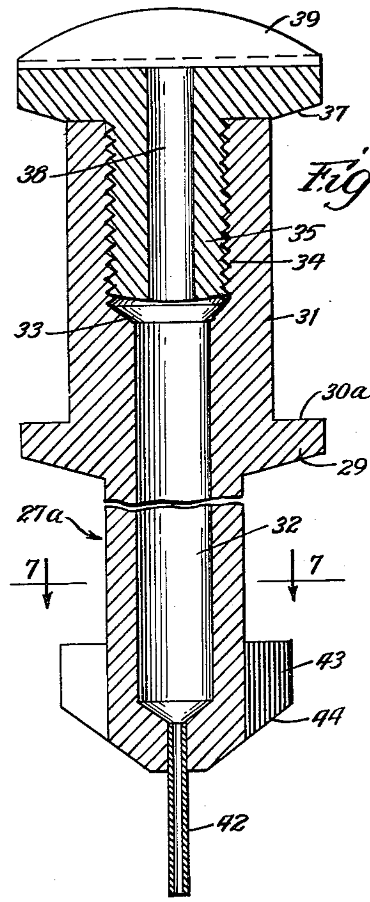


Fig-4

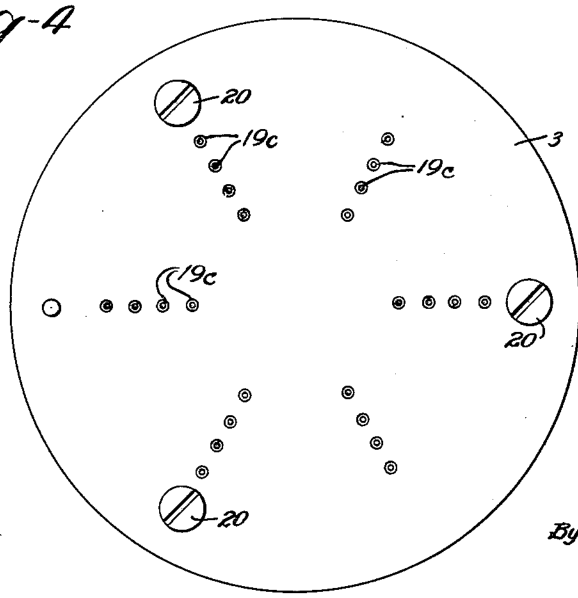
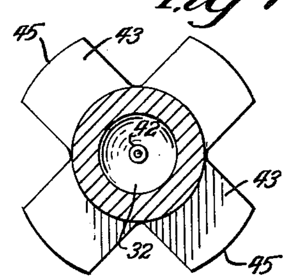


Fig-7



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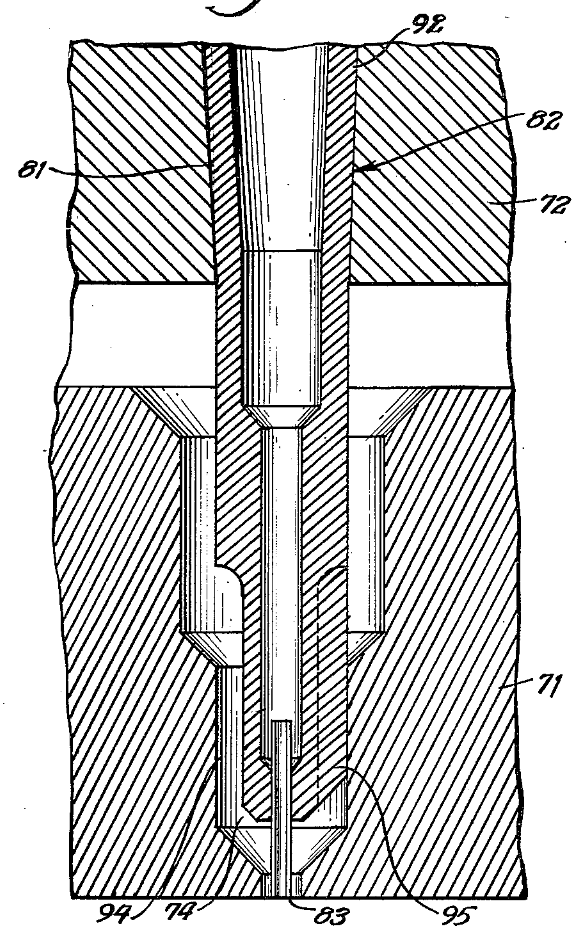
APPARATUS FOR THE SPINNING OF HOLLOW FILAMENTS

Filed Oct. 13, 1959 4 Sheets-Sheet 4

Fig-10



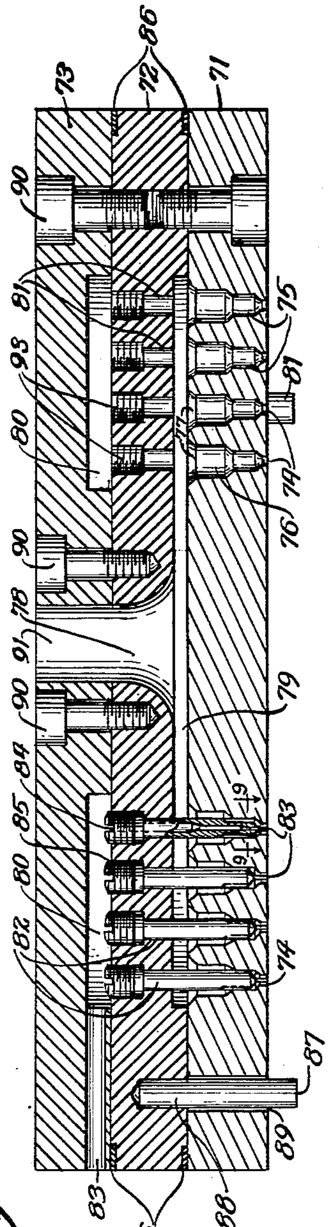
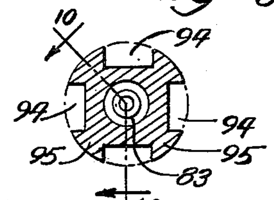


Fig-8

Fig-9



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3,121,254

APPARATUS FOR THE SPINNING OF HOLLOW FILAMENTS

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3 Claims. (Cl. 18—8)

This invention, in general, relates to improvements in spinning nozzles for the spinning of hollow filaments from spinnable polymers and further relates to spinning plates and parts thereof for use in spinning nozzles for spinning hollow filaments. This application is a continuation-in-part of our copending application Serial No. 779,977, filed December 12, 1958, now abandoned.

It is a known practice in the production of hollow filaments to employ spinning nozzles in which, inside the spinning opening proper, a tubular passage is provided. A liquid or gaseous medium is forced through this passage into the interior of the filament as it emerges from the nozzle. In the spinning of viscose filaments, for example, a liquid of the same or similar composition to the spinning bath is conducted through the inner passage so that directly on the emergence of the viscose from the nozzle a coagulation or decomposition of the viscose spinning solution takes place, both from the outside and also on the inside of the hollow filament. In the production of synthetic threads by the melt-spinning process, an inert gas is blown through the tubular passage—preventing collapse of the molten filament emerging from the nozzle.

The manufacture of spinning nozzles useful for production of hollow filaments, especially filaments used by the melt-spinning process, is unusually difficult because the spinning openings must be bored with extreme precicision and the tolerances are very small in the center of the tubular passage through which the gaseous agent is conducted. In the usual spinning of multifil threads of a relatively coarse denier, such as 10–20 denier, the diameter of the spinning orifices is in the order of 700μ. The outer diameter of the tubular passage for the fluid introduced into the center of the filament is in the order of 250μ—leaving a width across the annular opening formed between the spinning orifice and the tubular member in the order of 225μ. It will be apparent that even a slight inaccuracy in the centering of the tubular member in the spinning orifice will result in filaments having a mantle of uneven thickness.

While prior endeavors to obtain a satisfactory spinning nozzle for the spinning of hollow filaments have been somewhat successful, there is still a need for improvement both in ease of manufacture of the spinning plates and in the attainment of spinning plates whose parts are properly positioned with respect to each other, particularly the tubular member in relation to the spinning orifice. The problems of obtaining uniform filaments are even more acute where the spinning plate is designed for the simultaneous spinning of a multiple number of hollow filaments from one nozzle. Nozzle designs known prior to our invention offer no guarantee of completely satisfactory operation. The spinning of multifil filaments from one spinning nozzle with, for example, 100 or more individual filaments has not, to our knowledge, been heretofore possible.

In general, our invention relates to spinning nozzles for spinning plates used therein which have proven extremely successful in actual practice. The spinning plate used in our invention is composed of three individual plates mounted on top of each other in face-to-face relationship—being held together by means of screws or the like.

The lower plate has a large number of spinning openings arranged in any suitable pattern. The middle plate has a central opening through which is fed the spinning mass into a recess in the face of the middle plate opposite the lower plate. This recess serves as a manifold chamber for distributing the spinning mass from the central opening outwardly to the spinning orifices in the lower plate. In the upper face of the middle plate or the lower face of the upper plate, or both, there is provided an annular, ring-shaped recess. A plurality of bores, corresponding to and aligned with the spinning openings in the lower plate, extend through the middle plate between the manifold chamber and the annular recess. Securely positioned within these bores are hollow inserts which extend downwardly into the spinning openings in the lower plate and terminate in a capillary tube positioned centrally in each spinning orifice. The hollow tubular inserts have a passage communicating with the recess in the upper face of the middle plate. The upper plate consists essentially of a solid plate having a central opening communicating with the opening of the middle plate and may have the annular recess in the lower face, as above-described.

Sealing rings are inserted between the individual plates at strategic locations to provide fluid-tight seals between the plates. We have found very thin aluminum washers to be particularly satisfactory for this purpose. By tightening the plates by means of the screws, the thin aluminum washers are compressed and the plates are virtually flat against each other. However, it is also within the contemplation of the invention to use washers or packings of greater thickness. By selecting a washer or packing between the lower and middle plate of the desired thickness, the degree of protrusion of the capillary tube from the spinning orifice can be adjusted to the desired position.

One of the special advantages of the invention lies in the fact that the individual parts may be machined separately and thereafter assembled. Each of the plates can be machined individually by relatively simple machining techniques and thereafter assembled with the hollow tubular inserts being mounted in the middle plate before assembly of the plates. Another advantage is that the assembled spinning plate of this invention can be disassembled very simply for cleaning or replacement of parts. Furthermore, should one of the capillary tubes be damaged or broken, the spinning plate can be repaired by simply changing one of the hollow tubular inserts.

Some embodiments of the invention previously described are shown in the drawings wherein:

FIG. 1 is a diametric cross-sectional view of an assembled spinning plate with the hollow tubular inserts positioned therein on the left hand side of the cross-sectional view and with the hollow tubular inserts being omitted on the right hand section to show the detail of the bores and spinning orifices in the middle and lower plates;

FIG. 2 is a partial, broken view in cross-section of a spinning head showing the mounting of the spinning plate of FIG. 1 in a spinning nozzle which, in turn, is mounted in the spinning head, the latter being only shown in segment;

FIG. 3 is a top plan view of the assembly of FIG. 1 with a portion of the top plate being broken away to show a portion of the middle plate in top plan view—a portion of the hollow tubular inserts being omitted for better illustration of the invention;

FIG. 4 is a bottom plan view of the assembly of FIG. 1;

FIG. 5 is an enlarged diametric cross-sectional view of the hollow tubular insert shown in FIGS. 1, 2 and 3;

FIG. 6 is an enlarged view in diametric cross-section of another embodiment of a hollow tubular insert which may be used in the present invention;

FIG. 7 is a cross-sectional view taken along section 7—7 of FIG. 6;

FIG. 8 is a diametric cross-sectional view of another embodiment of the spinning plates of this invention with the hollow tubular inserts positioned therein on the left hand side of the cross-sectional view and the hollow tubular inserts being omitted on the right hand side of said view to show the detail of the bores and spinning orifices in the middle and lower plates;

FIG. 9 is a cross-sectional view of the tubular insert taken on section 9—9 of FIG. 8; and

FIG. 10 is a cross-sectional view of the tubular insert mounted in the lower plate, shown in segment, with the cross-sectional view of said tubular insert being taken on section 10—10 of FIG. 9.

The spinning plate shown in FIGS. 1 and 3 of the drawing is made up of three disc-shaped, superposed plates which are mounted in face-to-face relationship with each other. For convenience in describing the invention, these plates will be designated as an upper plate **1**, a middle plate **2** and a lower plate **3**. The upper plate **1** has a central aperture **4** for conducting a spinning mass therethrough. The plate **1** is tightly held in face-to-face relationship with the middle plate **2** by means of screws **5**, whose heads are positioned in recesses **6** of the upper surface of the upper plate **1** and also by screws **7** placed about the periphery of the upper plate with the heads thereof in recesses **8** provided in the upper surface of the upper plate **1**. These screws extend into tapped holes provided in the middle plate **2** and thus hold the plates in face-to-face relationship.

The middle plate **2** has a central flaring opening **9** communicating with the opening **4** of the upper plate **1**. In the upper surface of the plate **2**, the surface opposite the plate **1**, there is provided a groove or recess **10** in the form of a circular ring. A radial passage **11** is bored through the plate **2** to communicate the outer edge of the plate **2** with the recess **10**. The bottom wall of the recess **10** has a plurality of radially-aligned groups of bores **12** having countersunk edges **13** and **14**.

The lower face of the middle plate **2** has a cylindrically-shaped recess **15** of substantially the same diameter as the diameter of the outer wall of the ring-shaped recess **10**. This recess serves as a distributing manifold for the spinning mass as will be described hereinafter. The middle plate **2** also has several guide pins **16** frictionally held in apertures **17** provided in the plate **2**. The guide pins **16** are adapted to extend through aligned passages **18** in the lower plate **3** and preferably extend outwardly beyond the lower face of the plate **3** by a distance at least equal to the protrusions of the capillary tubes hereinafter described. The function of the pins **16** is that of guiding the assembly of the plate **2** with plate **3** so that the parts are properly aligned as the two plates are assembled.

The lower plate **3** has a plurality of spinning openings **19** which are positioned therein in radially-aligned groups corresponding with the bores **12** in plate **2**. Each of the spinning openings **19** is composed of a cylindrical portion **19*a***, a tapered portion **19*b*** and the spinning orifice itself, **19*c*** of the desired diameter. The plate **3** is held in face-to-face relationship with the plate **2** by means of screws **20** whose heads are recessed in recesses **21** provided in the lower face of plate **3**.

In order to provide a fluid-tight seal between the plates, thin gaskets or packings **22**, **23**, **24**, **25** and **26** are employed. The gasket **22** is an O-ring gasket having holes therein for the screws **5**. Gaskets **23**, **24**, **25** and **26** are O-ring gaskets.

These gaskets, as heretofore stated, are preferably thin aluminum gaskets.

The supply of a gaseous or liquid fluid to the center of the filaments during the spinning operation is achieved by the use of hollow tubular inserts **27**, which are mounted in the bores **12** of the plate **2** and extend downwardly therefrom through the spinning openings **19**. Reference

is made to FIG. 5 of the drawing where a detailed illustration of the tubular insert is shown. Each tubular insert comprises a lower cylindrical portion **28** having an outer diameter less than the diameter of the portion **19*a*** of the spinning openings **19**. Intermediate the ends of the tubular insert is an annular ring **29** forming an upper shoulder **30** having a taper identical with the taper of the countersunk portion **14** of the bore **12** in the plate **2**. Above the annular ring **29** is an upper cylindrical portion **31**. An axial passage **32** extends substantially throughout the hollow tubular insert **27**. At its upper end the passage **32** widens at **33** into a cylindrical recess **34**, which is internally threaded. The threads of the passage **34** threadably engage the threaded shank **35** of a removable screw **36**. The screw **36** has a tapered lower surface **37** of a taper identical with the taper of the countersunk portion **13** of the bore **12**. The screw **36** also has an axial passage **38** extending therethrough and communicating the passage **32** with the exterior of the screw **36**. The passage **38** terminates in the screw head groove **39**.

The axial passage **32** terminates at its lower end in a tapered segment **40**. At this point the lower end of the hollow tubular insert **27** has an axial opening **41** in which is mounted a capillary tube **42** which extends outwardly from the lower end of the insert **27**. The gas or liquid discharged into the center of the filament exits from the capillary tube **42**.

The hollow tubular insert **27*a***, shown in FIG. 6, is substantially identical with that shown in FIG. 5 and like numerals have been used to designate like parts. The hollow tubular insert shown in FIG. 6 shows a modification in the configuration of the ring **29** in the use of a flat, upper shoulder **30*a*** instead of a tapered shoulder as shown in FIG. 5. By this construction, it is not necessary to employ a countersunk edge such as that shown at **14** for the bores **12**. Also, the embodiment of FIG. 6 illustrates the use of guide vanes or wings **43** which have sloping bottom walls **44** and rounded side walls **45**. The distance between opposite side walls is slightly less than the diameter of the portion **19*a*** of the spinning openings **19** so that these vanes act to guide and center the hollow tubular insert and its capillary tube **42** in the spinning opening when the plates **2** and **3** are assembled.

The spinning plates of this invention are assembled by first inserting the hollow tubular inserts **27**, with the screws **36** removed, in the bores **12** of the plate **2**. Upon threading the screw **36** into the tubular insert, the latter are securely mounted in the middle plate **2**. If desired or necessary, packing material may be inserted between the shoulder **30** and the countersunk portion **14** and between the tapered lower surface **37** of the screw **36** and the countersunk portion **13** to provide fluid-tight seals. After each of the hollow tubular inserts **27** has been properly mounted in plate **2**, the latter is assembled with the plate **3**. Guide pins **16** are employed to align the parts properly to avoid accidental damage or breakage to the delicate capillary tubes **42** when the parts are being assembled. Inasmuch as the guide pins **16** extend beyond the capillary tubes **42**, they assure that the parts will be properly aligned when the capillary tubes **42** begin to penetrate the spinning openings **19**. The capillary tubes **42** may either extend outwardly from the outer edge of the spinning orifices **19**, they may be even therewith, or they may be actually recessed from the outer edge of the spinning orifices **19**. One way of regulating this positioning of the capillary tubes **42** with respect to the spinning orifices **19** is by varying the thicknesses of the gaskets **25**, **26** in the manner previously described. After the plates **2** and **3** are assembled, the screws **20** are inserted and tightened.

Thereafter the upper plate **1** may be mounted on the middle plate **2** after which screws **5** and **7** are tightened—thus giving the assembled spinning plate.

FIG. 2 illustrates the mounting of the spinning plates in a spinning nozzle, which nozzle, in turn, is mounted in a spinning head. The spinning head 46 (only a segment being shown) has a cylindrical bore 47 into which is press-fitted a spinning nozzle designated generally at 48. Inside the spinning nozzle 48 there is provided a holder 49 for holding the plates 1, 2 and 3 in the spinning nozzle. The holder 36 has a central bore 50 composed of a cylindrical portion 50*a*, tapered portion 50*b* and a cylindrical portion 50*c*. At the end of the cylindrical portion 50*c* there is an inwardly-turned flange 51 which bears against the plate 3. Abutting against the plate 1 is an aluminum ring 52 which holds a filter member 53—the latter functioning to screen out any particles which would block a small passage in the spinning apparatus. The filter 53 is spaced from the plate 1 to provide a feed space 54. Also within the holder 49 is a washer-like plate 55 of generally cylindrical shape with a tapered portion corresponding to the taper at 50*b*. The plate 55 has a spinning mass feed passage 56 extending therethrough. O-ring packings 57 and 58 are provided to seal the spinning apparatus against flow of the spinning mass to undesired areas.

The holder 49 and its contained parts are held within the recess of the spinning nozzle 48 by means of a cylindrical sleeve 59 which has an inwardly-turned flange 60. The sleeve 59 is externally-threaded for threaded engagement with internal threads provided on the cylindrical walls of the recess in the spinning nozzle 48. The rear face of the nozzle 48 has a passage 61 through which the spinning mass supplied under pressure to the spinning head passes for subsequent passage through parts of the spinning nozzle from which it eventually emerges as a filament.

After the holder 49 and its component parts are assembled in nozzle 48 in the manner illustrated, the parts are tightly engaged and the packings 57 and 58 compressed by turning down threaded bolts 62 evenly spaced about the inwardly-turned flange 60. These bolts bear against a shoulder 63 on the holder 49. The parts may be thus assembled in fluid-tight relationship.

The holder 49 has in the cylindrical portion 50*c* an annular groove 64. The groove 64 is positioned to correspond with the position of the passage 11 in the plate 2. Thus, a fluid supplied to the annular groove 64 through vertical passage 65 in the holder 49 and the tube 66 inserted therein, will be supplied through the passage 11 to the recess 10.

Then the gas enters the passage 38 in the screw 36 of the hollow tubular inserts 27 and passes therethrough to emerge from the capillary tube 42.

The spinning mass supplied to the spinning head flows through passages 61 and 56, filter element 53, and feed space 54 into the passage 4 of the assembled spinning plates. It then flows through the flared opening 9 into the recess 15, which serves as a manifold for distributing the spinning mass to the various spinning openings 19. The spinning mass then flows downwardly through the annular space formed between the walls of the spinning opening 19 and the tubular inserts 27 and emerges in filament form from the spinning orifice 19. The gases or liquids supplied through the capillary tubes 27 cause the filaments to take the form of a hollow filament.

We have further found that other modifications of the hollow inserts 27 and 27*a* can also be securely seated in the bores in the middle plate. Referring to FIGS. 8 and 9, the hollow inserts of this embodiment of the invention are slightly conically tapered in the upper portion which extends into the middle plate. The taper is a slight taper with the mean diameter of the conically tapered part corresponding to the diameter of the bore in the middle plate in which the insert is mounted. For the mounting of the inserts, screws without flanges are employed. At the tightening of the screws the hollow inserts are fitted securely into the bores of the middle plate. Without any special packing the inserts are so solidly seated in the bores that no penetration or leakage of the spinning mass can occur.

The embodiment of FIG. 8 is a spinning plate of three superposed, disc-shaped plates in face-to-face relationship. The spinning plate comprises a lower plate **71**, middle plate **72**, and upper plate **73**. The lower plate **71** has a series of radially aligned spinning openings **74** in groups of four. Rearward of the spinning openings are enlarged bore portions **75** forming guide walls for a purpose later described, and rearward or above the guide portions **75** are passage segments **76** of even larger diameter with countersunk edges **77**.

The middle plate **72** has a central opening **78** which flares outwardly in the direction of adjoining plate **71** into a feed space **79** formed by a circular recess in the lower face of plate **72**. Alternatively, the recess **79** can be in the contiguous upper face of plate **71**. The upper plate **73** has in the lower surface which is in contact with plate **72** a ring-shaped recess **80**, which serves as a manifold for the distribution of the gaseous or liquid medium. This recess **80** is connected with the feed space **79** in plate **72** by bores **81** aligned with bores **75, 76**.

The hollow tubular inserts **82**, which terminate in capillary tubes **83**, are mounted in fluid-tight contact in the lower part of bores **81** and extend through bores **75, 76** in lower plate **71**. The gaseous or liquid media, which is supplied to the ring-shaped recess **80** through a number of radial passages **83**, pass through the central bores **84** of screws **85** and then through the axial passages in the hollow tubular inserts and the capillary tubes **83** into the filament as it is spun.

Between plates **71, 72** and **73** around the peripheral edges thereof there are inserted thin aluminum sealing rings **86** which, in uncompressed states, have a thickness of about 0.1 mm. They prevent the leakage of the spinning mass from the feed space **79** between plates **71** and **72**, and also the penetration of the gaseous or liquid medium from the feed space **80** between plates **72** and **73**.

Plate **72** is further provided with at least three guide prongs **87**, solidly held in bores **88** in plate **72**. The protruding length of guide prongs **87** is somewhat greater than the thickness of plate **71**. These guide prongs **87** slide in the seating bores **89** of plate **71** and, in the assembled spinning plate wherein the three plates **71, 72,** and **73** are held together by threaded bolts **90**, they project somewhat beyond the lower face.

The spinning mass is supplied through the central passage **91** in plate **73** to the manifold recess **79**. The spinning plate of FIG. 8 may be used in the spinning nozzle of FIG. 2.

The plates **71, 72,** and **73** are assembled as previously described with respect to the previous embodiment. The hollow tubular inserts **82**, however, are mounted in plate **72** in a slightly different manner.

FIGURE 10 shows a hollow tubular insert **82** on a larger scale. Its upper part **92** is slightly tapered from the outer end. The mean diameter of the tapered part **92** substantially equals the diameter of bore **81**. The hollow tubular inserts **82** are inserted from the upper side of plate **72** and are tightly wedged in bores **81** by turning down screws **85**, which are threadedly mounted in the threaded portions **93** in the upper portions of bores **81**. The lower edges of screws **85**, which in this instance have no flanges, drive the inserts **82** downwardly into bores **81**.

At its lower end, the outer wall of the inserts **82** have axial recesses or channels **94** to permit passage of the spinning mass through bore portions **75**, while the ribs **95** serve as guides in contact with the cylindrical wall of bore portions **75** to exactly center of the hollow tubular insert upon assembly of the spinning plate.

The spinning plates and nozzles according to our invention can be produced in the same size as standard spinning nozzles or plates, so that they can be installed in the spinning heads of available spinning machines. With a diameter of 139 mm., as many as 150 spinning openings can be provided.

It will be seen from the foregoing description that the nozzles of the instant invention are made of parts which can be machined relatively easily. The hollow inserts, because they are produced separately, can be produced with the necessary precision. The invention herein described is also advantageous inasmuch as the spinning nozzles can be taken apart, cleaned and reassembled without difficulty and, if need be, the tubular inserts can be changed without replacing other parts of the apparatus.

The invention is hereby claimed as follows:

1. A spinning plate for spinning nozzles for spinning a plurality of hollow filaments comprising a cylindrical first plate with two circular faces, one of said faces having a plurality of spinning orifices therein arranged in concentric, circular rows, the other of said faces being in face-to-face relationship with a circular face of a cylindrical second plate, one of the opposing faces of said first and second plates having a cylindrical recess therein, axial passages extending axially through said first plate corresponding in number to the number of spinning orifices, each of said passages communicating said cylindrical recess with one of said spinning orifices, said second plate having a central, axial passage communicating its other circular face and said cylindrical recess, a cylindrical third plate on said second plate with a circular face of said third plate in face-to-face relationship with said other face of said second plate, an axial passage through said third plate communicating with said axial passage in said second plate, one of said faces in face-to-face relationship of said second and third plates having a ring-shaped recess, axial bores extending through said cylindrical second plate between said recesses, said axial bores corresponding in number to the number of said passages in said first plate and each being in axial alignment with a corresponding passage in said first plate, said spinning plate having a fluid-supply passage extending from said ring-shaped recess to an outer side of said spinning plate, a tubular member in each of said bores, each tubular member having a body portion and a radially enlarged head portion, a screw extending from said ring-shaped recess into each of said axial bores and coacting with each head portion to press said enlarged head portion into fluid-tight contact with annular shoulder means extending around the walls of said axial bores, the heads of said screws being in said ring-shaped recess, each tubular member having its body portion extending into the corresponding passage in said first plate, said body portion being of an outer diameter less than the diameter of said passage to form a passage

therebetween, each body portion having an aperture in its terminal end in which aperture is fixedly mounted a cylindrical, thin-walled capillary tube extending axially from said body portion into a spinning orifice in said first plate, and an axial passage through each of said screws whereby a fluid supplied to said ring-shaped recess via said fluid-supply passage flows through the passages in said screws, said tubular members, and out of said capillary tubes into the spinning masses extruded through said orifices, said spinning masses being supplied to said orifices via said axial passages in said first plate, said cylindrical recess and said passages in said second and third plates.

2. The spinning plate of claim 1 wherein the walls of said bores adjacent said ring-shaped recess are threaded, said screws are threaded in said bores, said shoulder means are inside said bores, and said enlarged head portions are pressed against said shoulder means by said screws.

3. The spinning plate of claim 1 wherein said head portions have internal threads, said screws are threaded in said internal threads, said screws each have a head larger in diameter than said bores, said head portions include annular flanges which are larger in diameter than said bores, and said heads of said screws bear against the side of said second plate in said ring-shaped recess adjacent said bores and said annular flanges bear against said shoulder means which are located on the side of said second plate opposite said first plate adjacent said bores, said screws drawing said annular flanges tightly against said shoulder means.

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