

①② **EUROPEAN PATENT APPLICATION**

②① Application number: 81301913.0

⑤① Int. Cl.³: **D 01 D 5/092**

②② Date of filing: 30.04.81

③① Priority: 13.05.80 US 149370
30.06.80 US 164425

④③ Date of publication of application:
25.11.81 Bulletin 81/47

⑧④ Designated Contracting States:
DE FR GB IT NL

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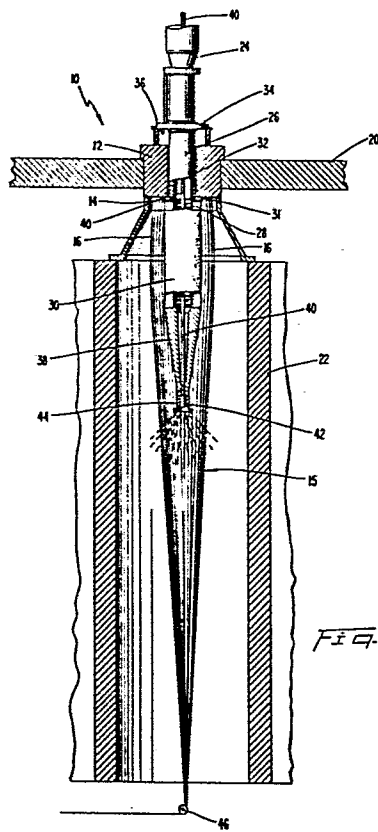
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⑤④ Process and apparatus for melt spinning filaments in which quench gas is introduced to the filaments through the fibre pack and spinneret.

⑤⑦ Process and apparatus for melt spinning filaments, the process comprising extruding molten polymer downwardly through a fibre pack (12) and a spinneret (14) and quenching the filaments (16) with a gas, in which the quenching gas for cooling the filaments (16) is supplied through a conduit (24) extending through the pack (12) and the spinneret (14). In a preferred process, a finish substance is applied to the quenched filaments, such finish substance having been supplied through a conduit (40) located within the conduit (24).



PROCESS AND APPARATUS FOR MELT SPINNING FILAMENTS
IN WHICH QUENCH GAS IS INTRODUCED TO THE FILAMENTS
THROUGH THE FIBRE PACK AND SPINNERET

The present invention relates to the manufacture of
5 melt spun polymeric filaments and, in particular, to the
quenching of spun filaments emerging from the spinneret. One
aspect of the invention is also concerned with the application
of a finishing liquid to the spun filaments after they have
been quenched.

10 The manufacture of melt spun polymeric filaments
is typically achieved by extruding a molten polymer, such
as polyester or polyamide through a spinneret and then cooling
the filaments thus formed. Therebelow, the filaments are
converged and gathered at a guide and delivered to a bobbin or
15 further treatment station. A finishing liquid is applied to
the filaments below the quench zone. The finishing liquid may
comprise a substance suitable for imparting a desired property
to the filaments, such as smoothness, drape, lustre, water
repellancy, flame retardancy, or crease resistance, for
20 example.

The manner in which the filaments are cooled has
a significant impact on the resulting quality of the filaments.
A typical cooling technique involves a gas quench in which
cool air is blown across the filaments as they emerge from the
25 spinneret. In instances where the filaments are extruded
in the form of a circular array, it is common to utilize an
outflow quench technique in which the filaments are passed
downwardly in surrounding relation to an upwardly extending
air pipe, the latter being arranged generally coincident
30 with the central axis of the group of filaments. Quench air
is directed radially or laterally outwardly through the
filament group from an upper, apertured end of the pipe, the
air preferably dispersed by a porous sheathing surrounding
the apertures. There is thus produced a controlled cooling
35 of the filaments. For example, see US Patents 3 135 811;
3 259 681; 3 858 386; and 3 969 462.

In Figures 1A, 1B there is depicted a conventional melt-spinning apparatus 10 wherein a conventional filter pack 12 carries a conventional spinneret 14 through which a molten polymer, such as polyester or polyamide is downwardly extruded to form filaments. The spinneret is of a conventional type comprising holes arranged in an annular pattern so that a group 15 of circularly arranged filaments 16 is formed. The holes of the spinneret are preferably arranged in a series of circular rows having a common central axis. The spun filaments are split into two groups and travel downwardly to two turning guides 9, or godets or rolls, at which they are gathered and redirected, in conventional fashion.

The pack 12 is mounted on a conventional superstructure 20, and the filaments travel downwardly within a cabinet 22 closed at least on three sides and possibly open at the fourth side for operator monitoring purposes.

Quench gas in the form of air is provided to cool the filaments 16 emerging from the spinneret. The quench gas is delivered through an upwardly extending quench gas conduit 1 which includes a gas supply portion 2 and a gas discharge portion 3, which comprises a perforated hole pattern to obtain a required profile. The gas supply portion extends horizontally into the group of filaments and forms an elbow 4. Openings are provided in the gas discharge portion to discharge quench air radially outwardly, with the desired profile, through the surrounding filaments. A porous sheath 5 surrounds the gas discharge portion to uniformly disperse the discharging air.

The upper end of the conduit 1 includes a pin 6 which is received in an opening of the spinneret 14 to prevent lateral displacement of the conduit 1.

As is apparent from Figure 1B, the filaments 16 are separated into two bunches 7, 8 to avoid contacting the elbow

portion of the conduit 1. The separate filament bunches are gathered and redirected at a pair of turning guides 9.

5 In operation, quench air is delivered via the conduit 1 and is discharged radially outwardly from within the group of filaments emerging from the spinneret. The quenched filaments are separated into bunches 7,8 and are gathered and redirected at the guides 9 for collection, or further treatment.

10 It will be appreciated that the conduit 1 is often of substantial height, thereby increasing the overall height of the machine and rendering it difficult to maintain the conduit in alignment with the longitudinal axis defined by the filament group. This arrangement also renders it difficult to maintain constant the distance from the spinneret to the
15 uppermost quench air stream. Air gaps 16A are formed between the filament bunches 7, 8 which gaps promote undesirable air turbulence. To limit the ability of the filaments to contact the elbow, the diameter of the conduit 1 is minimized, but this restricts the quantity of air flow that can be conducted
20 and also increases the pressure drop.

As previously indicated, the lower portion of the air pipe forms an elbow and passes horizontally through the group of filaments above the turning guide. In order to prevent the downwardly converging group of filaments from rubbing
25 against the elbow, the pipe diameter is minimized and the filament group is divided into two buncles, each bundle fed to a separate turning guide, as depicted herein in Figure 1B for example.

The minimization of the air pipe diameter at low
30 pressures below 0.3515 Kg/cm^2 results in the quantity of air flow being less than that normally desired for optimum cooling performance. In addition, enlarged air gaps are formed between the separated bundles, which gaps promote air turbulence, non-uniform quenching of the filaments, and increased drag action
35 on the filaments. Also, the extra handling of the filaments

increases the overall wear and tear to which they are subjected.

As regards the air pipe itself, the elbow must be placed at a level sufficiently below the quench zone to allow the filaments to be effectively divided into separate
5 bundles. This results in a relatively long air pipe height which increases the overall machine height and renders it difficult to maintain the pipe aligned with the central axis of the filament group to assure that uniform quenching action is achieved.

18 It will be understood that the vertical distance between the extrusion holes of the spinneret and the uppermost stream of cooling air is of critical importance regarding the quality of filaments being produced. It is thus required that a predetermined distance be maintained at all times, a
15 feat not easily accomplished with an air pipe of relatively great height which is anchored somewhere at its lower end remote from the spinneret.

It will also be appreciated that the splitting of the filament group into bundles considerably limits the
20 available free area around the filament travel path and thus restricts the operator's access.

The application of finishing liquid has heretofore been accomplished, for example, by means of a stationary applicator within which the filaments are gathered. Finishing
25 fluid is caused to flow across the applicator surface and onto the gathered filaments. Another technique involves spraying the finishing liquid onto the filaments which have been gathered at the turning guide. It will be appreciated that the quality of the filaments produced is affected by the uniformity of
30 application of the finishing liquid. The application of the liquid to the filaments when the latter are in a gathered or bunched-up condition is difficult to achieve with the desired uniformity.

According to the present invention we provide a melt-
35 spinning process in which molten polymer is extruded downwardly

through a fibre pack and through an annular array of holes in a spinneret to form a circularly arranged group of filaments, quench gas is directed across the filaments emerging from the spinneret, and the filaments are gathered and redirected at a stationary or rotating guide, characterised in that quench gas is delivered downwardly through the pack and spinneret coaxially relative to the array of holes and then redirected outwardly through the group of filaments above the guide.

10 According to one aspect of such a melt-spinning process a finish substance is applied to the filaments, the finish substance having been conducted through the pack and through the spinneret and at least partly internally of the flow of quench gas and being discharged outwardly from within
15 the group of filaments at a level below the discharge of quench gas.

 We also provide an apparatus for the manufacture of melt-spun filaments in which molten polymer is extruded downwardly through a fibre pack and through an annular array
20 of holes in a spinneret to form a circularly arranged group of filaments, the apparatus including quenching means for directing quenching gas across the filaments emerging from the spinneret and a stationary or rotating guide therebelow at which the filaments are gathered and redirected, characterised in that
25 the quenching means comprises a gas supply conduit extending downwardly through the pack and the spinneret being positioned coaxially relative to the array of holes, the conduit including gas discharge means disposed above the guide for discharging quench gas outwardly through the group of filaments.

30 According to one aspect of the apparatus, a means is provided for applying a finish substance on to the filaments, such finish applying means comprising a finish supply conduit extending downwardly through the pack and the spinneret within the quench gas supply conduit, the finish supply conduit
35 projecting below the gas discharge means coaxially within the group of filaments and including a means for discharging finish

on to the filaments.

The objects and advantages of the invention will become apparent from the following detailed description of preferred embodiments thereof in connection with the accompanying drawings in which like numerals designate like elements, and in which.

Figure 1A is a front view in vertical section of a melt-spinning apparatus according to the prior art;

Figure 1B is a view similar to Figure 1A but observed from the side to illustrate the separation of filaments into bunches; and

Figure 2 is a vertical sectional view through a melt-spinning apparatus according to the present invention.

Figure 3 is a vertical sectional view through a modified melt-spinning apparatus according to the present invention including means for applying a finish substance on to the filaments.

An apparatus according to this invention is depicted in Figure 2. Quench gas is delivered by a quenching conduit 24 which includes a gas supply portion 26 and a gas discharge portion 28. The gas supply portion 26 extends downwardly through the pack 12 and spinneret 14 in coaxial relationship with the axis defined by the circular arrays of spinneret holes. Thus, in contrast to the prior art, the presence of an elbow below the quench is eliminated.

The gas discharge portion 28 is disposed immediately below the spinneret 14 and includes a plurality of outlet openings for discharging the quench air laterally outwardly with the desired profile, through the surrounding filaments 16. It will, of course, be appreciated that the hole arrangement for a given profile with this invention is necessarily different from the hole arrangement of the prior art. Preferably, a sheath of porous foam 30 surrounds the conduit discharge portion to uniformly disperse the quench air. A collar 31 may be located on the conduit 24 to position the sheath.

It will be appreciated that quench air passes through the filaments, bellowing them radially outwardly.

5 The section of the gas supply portion 26 extending through the pack 12 is preferably surrounded by an air gap 32 to minimize heat exchange between the quench gas and molten polymer within the pack 12. Alternatively, or in addition, that section of the gas supply portion 26 could be covered with thermal insulation.

10 The gas supply conduit 24 includes a fixed stop collar 34 which rests upon a stop shoulder 36 on the pack to support the supply conduit 24 and fixedly locate the latter relative to the spinneret. In this fashion, the spacial relationship between the spinneret holes and the uppermost stream of quench gas is maintained constant, to achieve uniformity of the quenching action and reduce birefringence variance in the filaments produced. These improvements occur within and between melt-spinning positions.

20 Extending downwardly from the lower end of the discharge portion 28 of the conduit is a gas streamlining member 38 in the form of a downwardly converging cone. The cone occupies a considerable portion of the space bounded by the converging filaments 16. Air normally drawn downwardly by the rapidly travelling filaments is constrained by the cone to flow in a smoother non-turbulent fashion to minimize undesired vibration of the filaments. The cone 38 can be secured to the lower end of the conduit 28 in any suitable manner, preferably in a releasable manner, such as by screws, bayonet coupling, etc.

30 It is preferably that the diameter defined by the innermost circular row of holes in the spinneret be at least 5" to allow sufficient room for the gas supply conduit 26 to pass therethrough. Smaller diameters could be employed, but the gas conduit would then probably be smaller than needed to conduct an optimum gas flow quantity.

35 If desired, a finishing liquid may be applied in a

conventional manner to the filaments in the vicinity of a conventional stationary or rotating guide 46 at which the filaments are gathered and redirected.

5 The apparatus depicted in Figure 3 is similar to that depicted in Figure 2 apart from certain modifications which are now described.

Extending downwardly through the quench conduit 24 and through the air streamlining cone 38 is a finish supply conduit 40 which conducts a suitable finishing liquid. The
10 lower end of conduit 40 projects beyond the bottom of the cone 38 and carries a spray nozzle 42. The spray nozzle 42 is fixed by a collar 44 and is oriented to spray the finish liquid, in mist form, in a downward and laterally outward direction, so that the liquid passes outwardly through the group of filaments
15 16 after the latter have been quenched.

It will be understood that the location of the spray nozzle relatively close to the quench zone and high above the usual guide 46, or godet or roll, advantageously affects the uniformity of the finish application. At such location the
20 filaments are not gathered too closely together to inhibit a uniform travel of the finish substance, and are spaced sufficiently near the central axis of the group to receive a concentrated quantity of the sprayed finish.

The presence of the streamlining cone 38 aids in
25 smoothing-out the flow of air in the vicinity of the nozzle, thereby minimizing undesired turbulent swirling actions which could adversely affect the spraying action.

As a result, the filaments receive a substantially uniform application of the finish substance.

30 Spraying of the finishing substance through the filaments while they are in a separated condition aids not only in achieving a uniform application of finish but also in augmenting the filament cooling step because the finish substance is typically of a lower temperature than are the filaments at the disclosed
35 region of finish application.

By locating the finish supply conduit within the quench gas conduit 24, the finish application can be achieved without reducing access space within the cabinet 22 and without inhibiting the travel of the filaments.

5 In operation, the filaments 16 are formed in circular arrays in conventional fashion. Quench air is conducted downwardly through the pack 12 via the conduit 24 and discharged radially outwardly through the group of filaments to cool the latter. Air currents immediately below the conduit
10 24 are guided in streamlined fashion by the streamlining cone 38 toward the finish spray nozzle 42. Finish substance is sprayed outwardly from the nozzle and uniformly covers the cooled, still separated filaments 16. The smooth air flow established by the cone achieves a low turbulence spray pattern
15 to the filaments. Application of the finish spray also aids in further cooling-down the filaments. Thereafter, the filaments are gathered and redirected at the guide 46.

 It will be appreciated that the application of finish spray from within the filament group and at a level
20 above the midpoint of the distance between the spinneret and the turning guide promotes a uniformity of the application because of the proximity of the filaments to the longitudinal axis and the still-separated condition of the filaments relative to one another. The air streamlining cone minimizes turbulence in
25 the spray pattern to aid in achieving such uniformity. There is also achieved a final cooling of the filaments.

 By conducting the finish substance through the quench gas conduit, operator accessibility within the cabinet is not affected and no hindrance to filament travel is produced.

30 It will be appreciated that the present invention eliminates the need for an elbow in the quench gas supply conduit below the quench zone, and thereby eliminates the need for dividing the filaments into separate bundles. As a result, it is generally unnecessary to restrict the size
35 of the gas supply conduit and thus an optimum amount of quench

gas flow can be provided. Since it is unnecessary to provide a quenching gas conduit of substantial height below the spinneret, the overall machine height is reduced, and it is also easier to align the quench conduit with the axis of the filament group.

Because the quench gas conduit is mounted on the pack, a constant uniform distance between the spinneret holes and the uppermost quench air stream may easily be maintained, thereby assuring uniform quality and minimal birefringence variability of filaments produced.

The filaments are not subjected to extra wear and tear by rubbing against unlubricated surfaces such as quench elbows. Also, since the filaments need no longer be separated into bundles, air gaps previously formed between the bundles, and which promoted air turbulence around the filaments, no longer exist. Turbulence is further reduced by the presence of the streamlining cone which extends below the outlet of the quench gas duct.

Although the invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that additions, substitutions, modifications, and deletions not specifically described may be made without departing from the spirit or scope of the invention as defined in the appended claims.

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CLAIMS

1. A melt-spinning process in which molten polymer is extruded downwardly through a fibre pack (12) and through an annular array of holes in a spinneret (14) to form a circularly arranged group of filaments (16), quench gas is directed across the filaments (16) emerging from the spinneret (14), and the filaments (16) are gathered and redirected at a stationary or rotating guide (46), characterised in that quench gas is delivered downwardly (24,26) through the pack (12) and spinneret (14) coaxially relative to the array of holes and then redirected outwardly (28,30) through the group of filaments (16) above the guide (46).
2. A melt-spinning process according to Claim 1 wherein molten polymer is passed through a plurality of coaxial circular rows of holes in the spinneret (14).
3. A melt-spinning process according to either Claim 1 or Claim 2 in which a finish substance is applied to the filaments (16), such finish substance having been conducted (40) through the pack (12) and through the spinneret (14) and at least partly internally of the flow of quench gas and being discharged outwardly (42) from within the group of filaments (16) at a level below the discharge of quench gas.
4. A melt-spinning process according to Claim 3 in which the finish substance is conducted (40) wholly internally of the quench gas delivered through the pack (12) and spinneret (14).
5. An apparatus for the manufacture of melt-spun filaments in which molten polymer is extruded downwardly through a fibre pack (12) and through an annular array of holes in a spinneret (14) to form a circularly arranged group of filaments (16), the apparatus including quenching means (24, 26, 28, 30) for directing quenching gas across the filaments (16) emerging from the spinneret (14) and a stationary or rotating guide (46) therebelow at which the filaments (16) are gathered and redirected, characterised in that the quenching means (24, 26, 28, 30) comprises a gas supply conduit (24) extending downwardly through the pack (12) and

the spinneret (14) and the spinneret (14) being positioned coaxially relative to the array of holes, the conduit (24) including gas discharge means (28, 30).

5 6. An apparatus for the manufacture of melt-spun filaments as claimed in Claim 5 including means for applying a finish substance on to the filaments (16), such finish applying means (40, 42) comprising a finish supply conduit (40) extending downwardly through the pack (12) and the spinneret (14) within the quench gas supply conduit (24), the finish supply
10 conduit (40) projecting below the gas discharge means (28, 30) coaxially within the group of the filaments (16) and including a means (42) for discharging finish on to the filaments (16).

7. An apparatus as claimed in Claim 5 or Claim 6 in which means (34, 36) are provided to fixedly locate the gas
15 supply conduit (24) relative to the spinneret (14) to maintain a fixed distance from the spinneret (14) to an uppermost stream of the quench gas.

8. An apparatus as claimed in any one of Claims 5 to 7 in which an air gap (32) is provided between the gas
20 supply conduit (24) and the interior of the pack (12) in order to minimize heat exchange between the pack (12) and the quench gas.

9. An apparatus as claimed in any one of Claims 5 to 8 in which the means (42) for discharging finish on to the
25 filaments (16) comprises a nozzle (42) for spraying the finish outwardly on to the filaments (16).

10. An apparatus as claimed in any one of Claims 6 to 9 including a downwardly converging streamlining member (38) located between the gas discharge means (28, 30) and the means
30 (42) for discharging finish on to the filaments (16).

11. An apparatus as claimed in any one of Claims 6 to 9 wherein the means (42) for discharging finish is disposed above the midpoint of the distance between the spinneret (14) and the guide (46).

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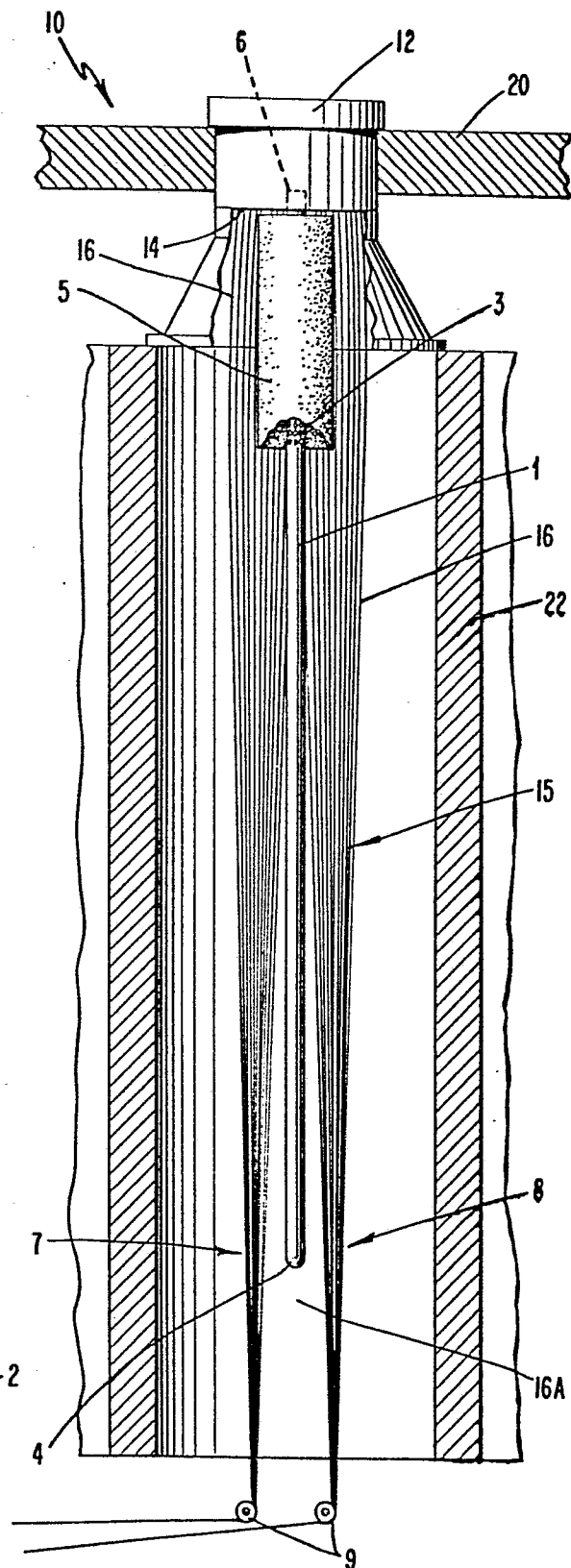
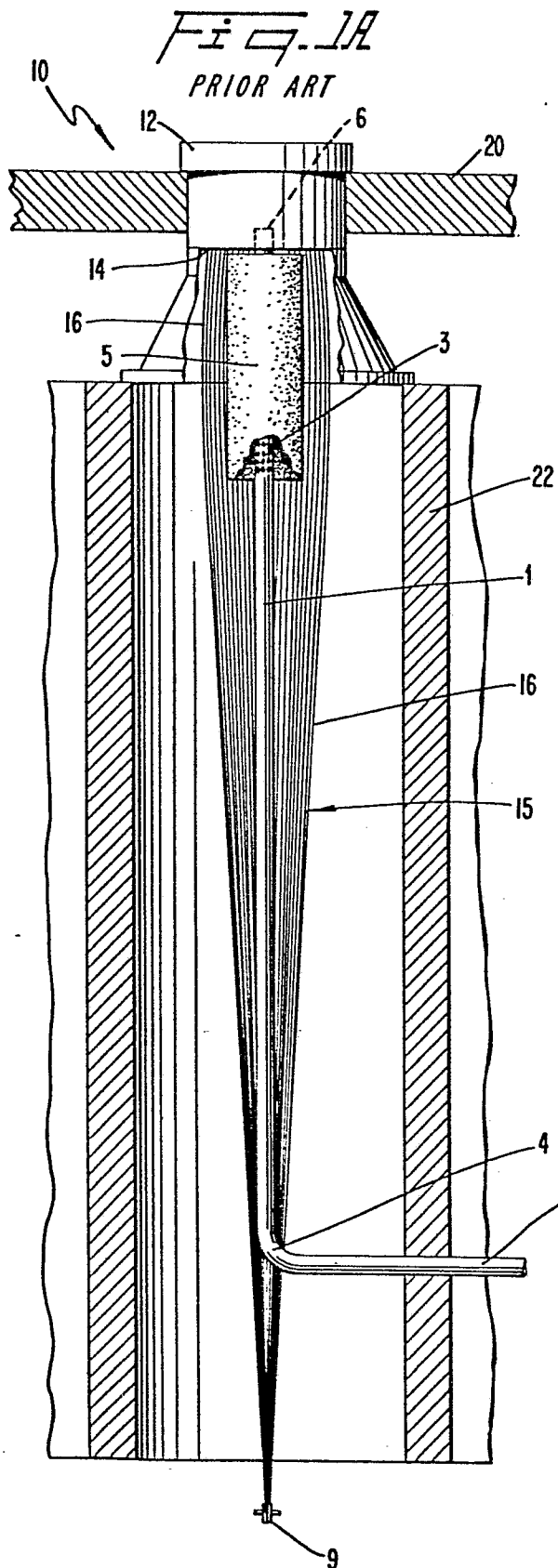
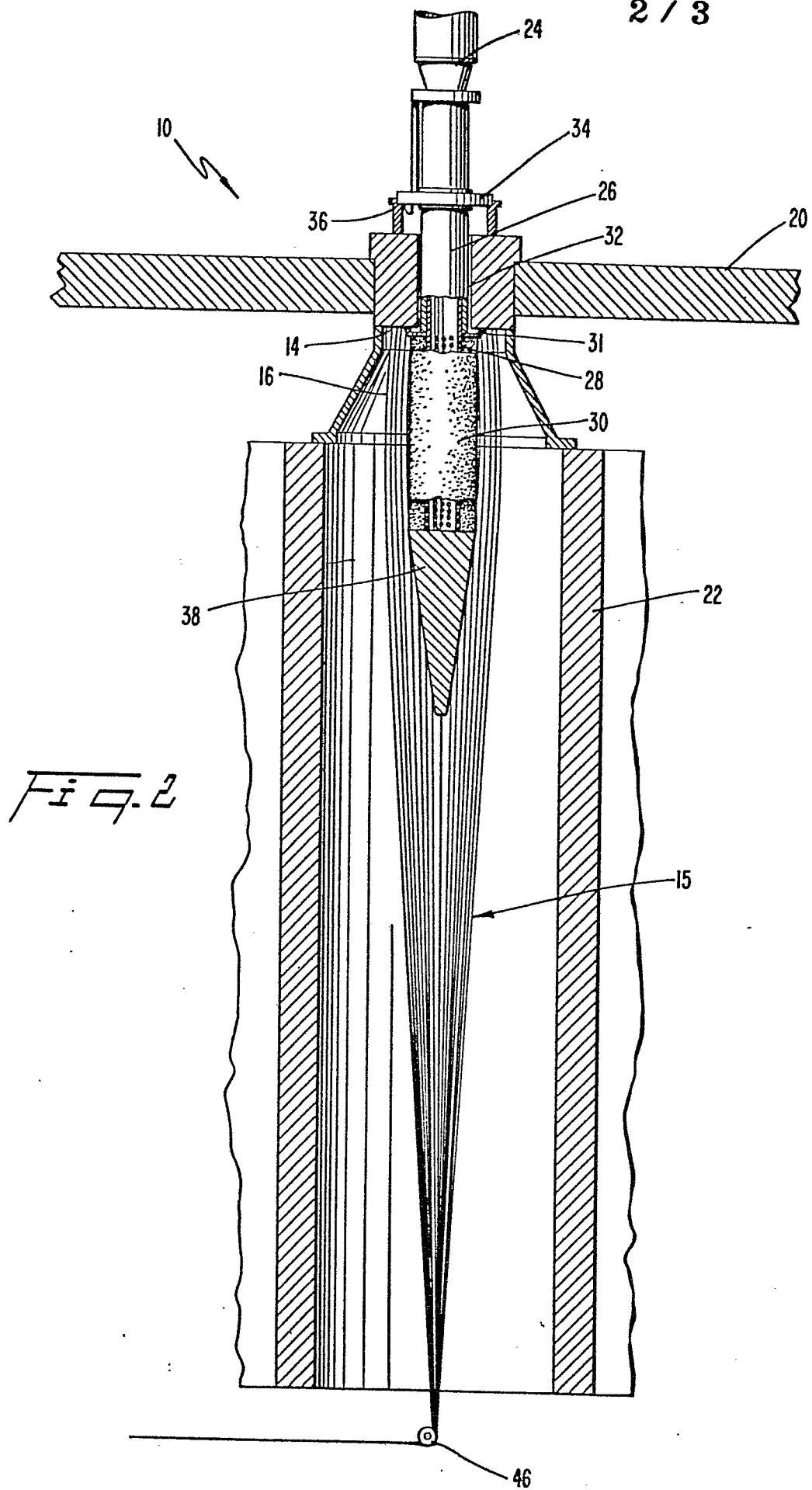
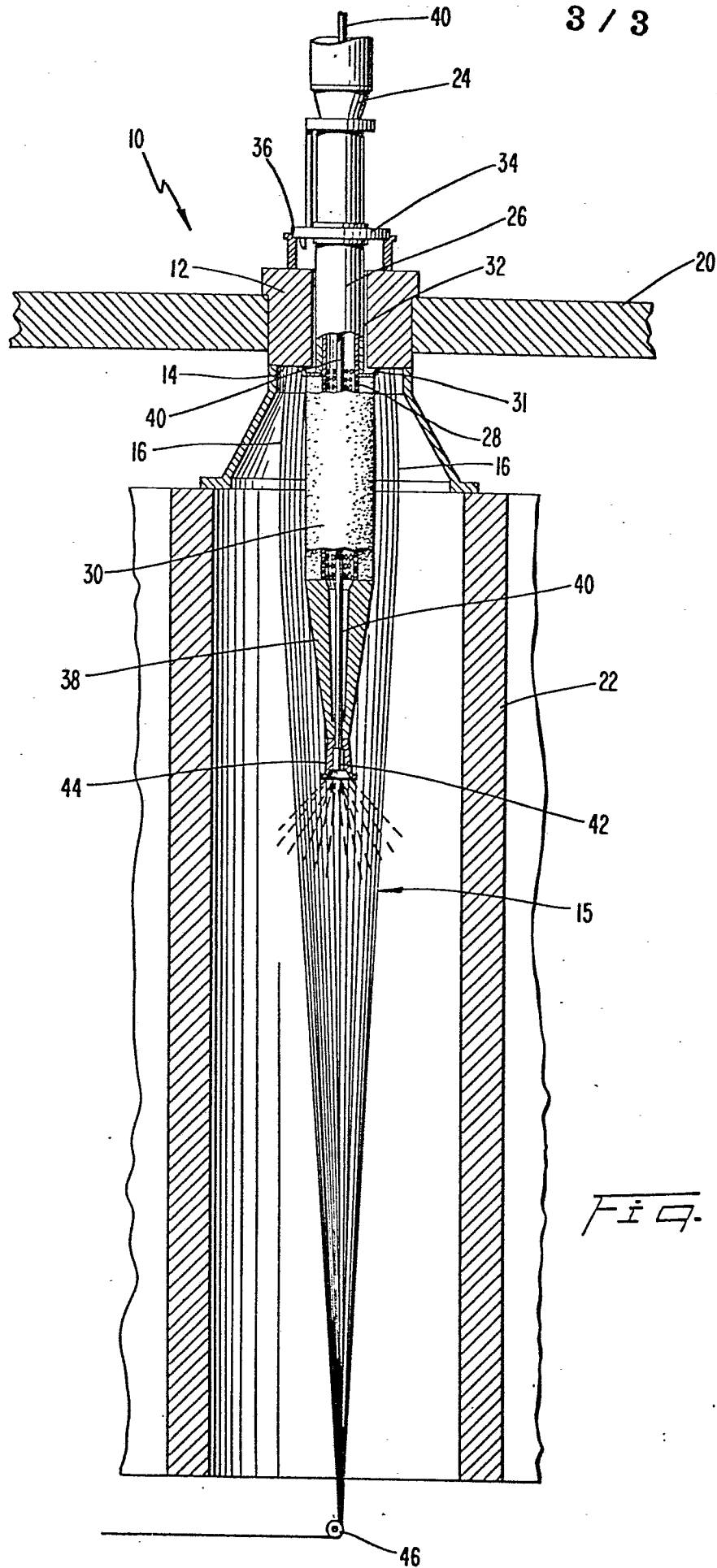


Fig. 1B
PRIOR ART

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European Patent
Office

EUROPEAN SEARCH REPORT

0040482

Application number
EP 81 30 1913

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	PATENTS ABSTRACTS OF JAPAN, vol.1, no.64, Section C, page 987 C 77 & JP. - A - 52 27 815 (TEIJIN K.K.) (03-02-1977) * abstract *	1,2,5	D 01 D 5/092
D	US - A - 3 969 462 (R.H. STOFAN) * claims; figure 1 *	1	
D,A	US - A - 3 259 681 (T.H. BULL) -----		TECHNICAL FIELDS SEARCHED (Int. Cl.) D 01 D 5/092 5/08 5/088 5/084 5/04
			CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
☒ The present search report has been drawn up for all claims			&: member of the same patent family, ·corresponding document
Place of search The Hague		Date of completion of the search 01-09-1981	Examiner VAN GOETHEM