Aug. 8, 1961 J. C. RIEDEL 2,995,417
PROCESS FOR THE CONTINUOUS, AUTOMATIC SPINNING
OF THERMOPLASTIC MATERIALS
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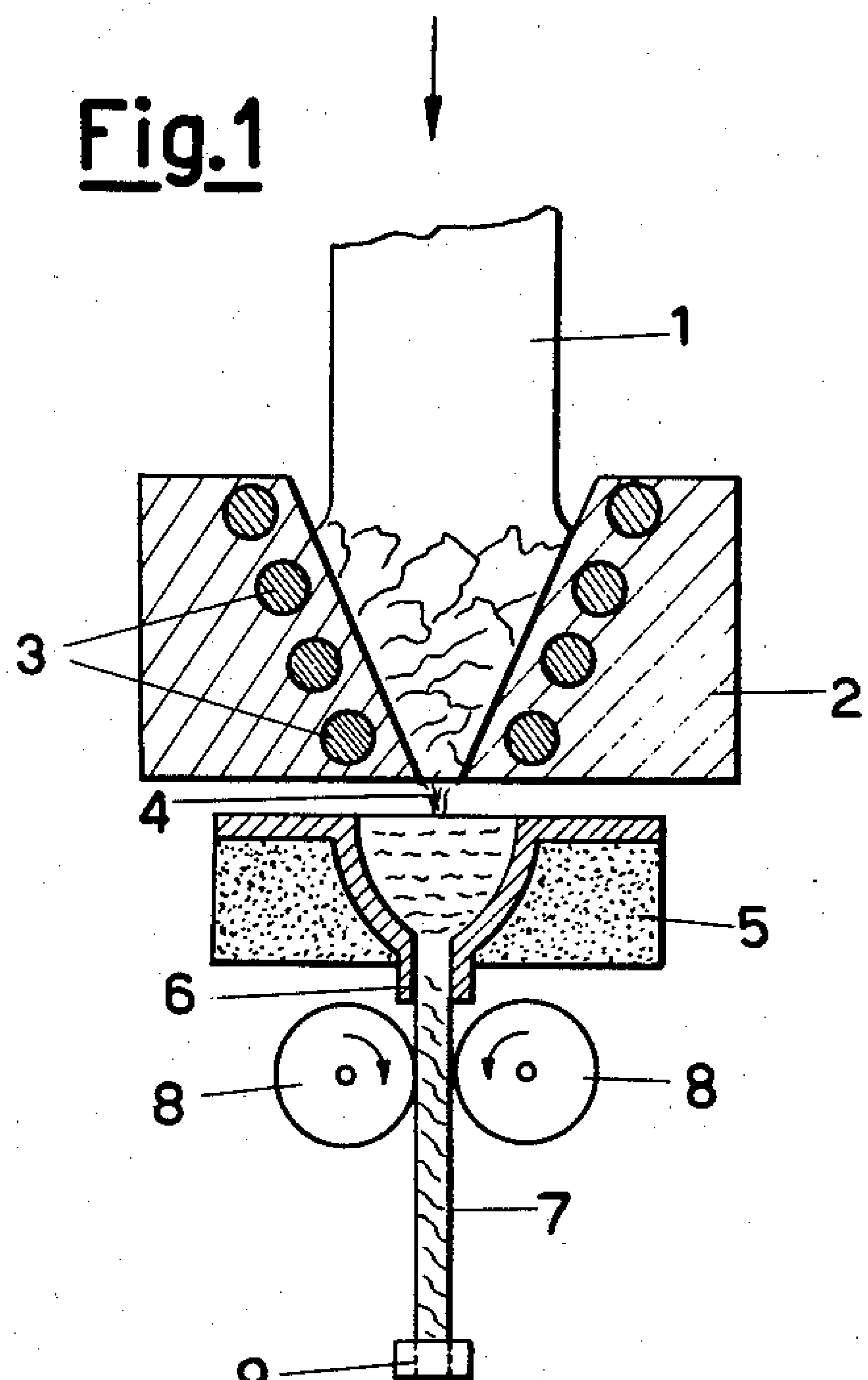
Fig.1



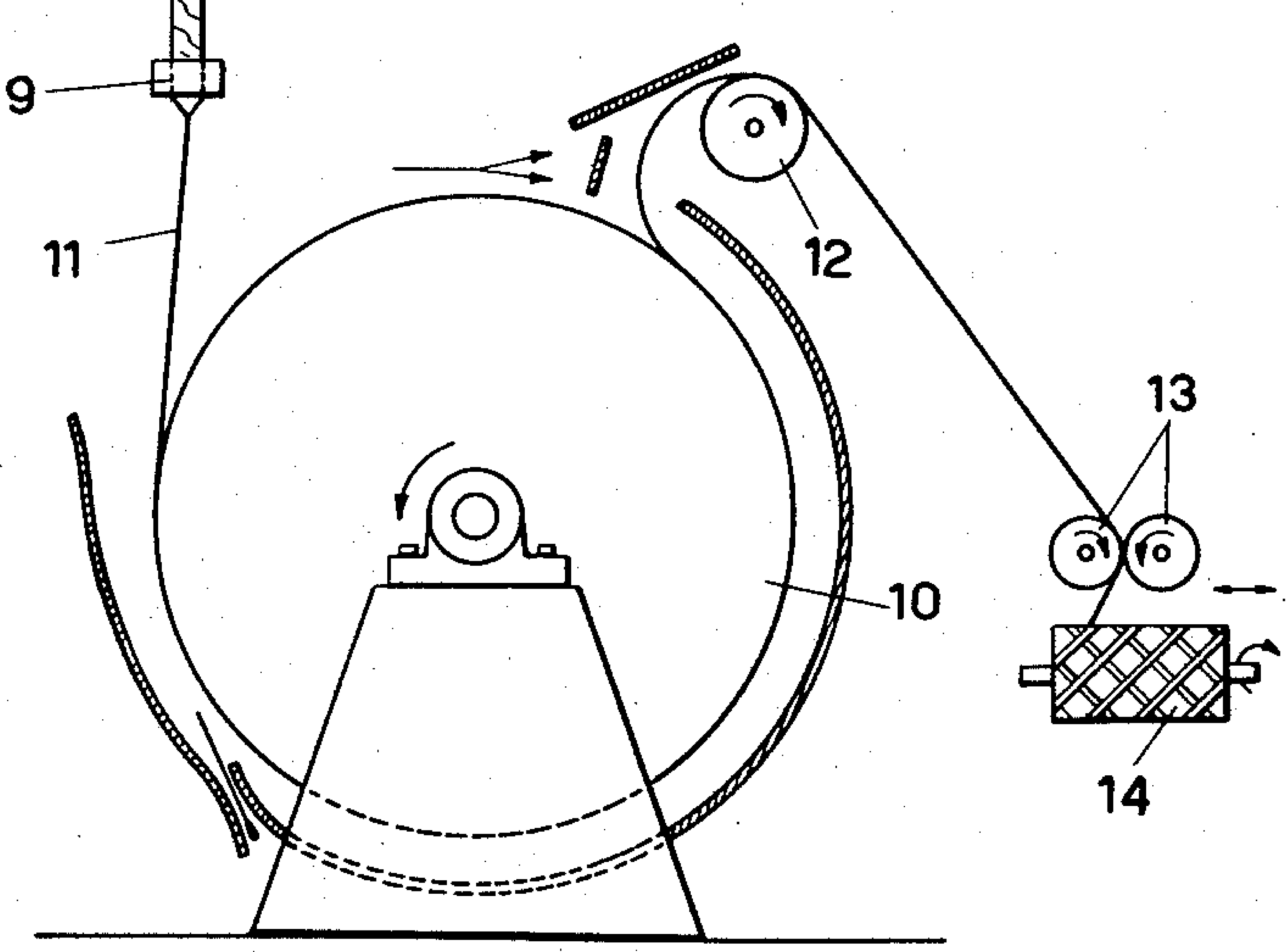


Fig.2

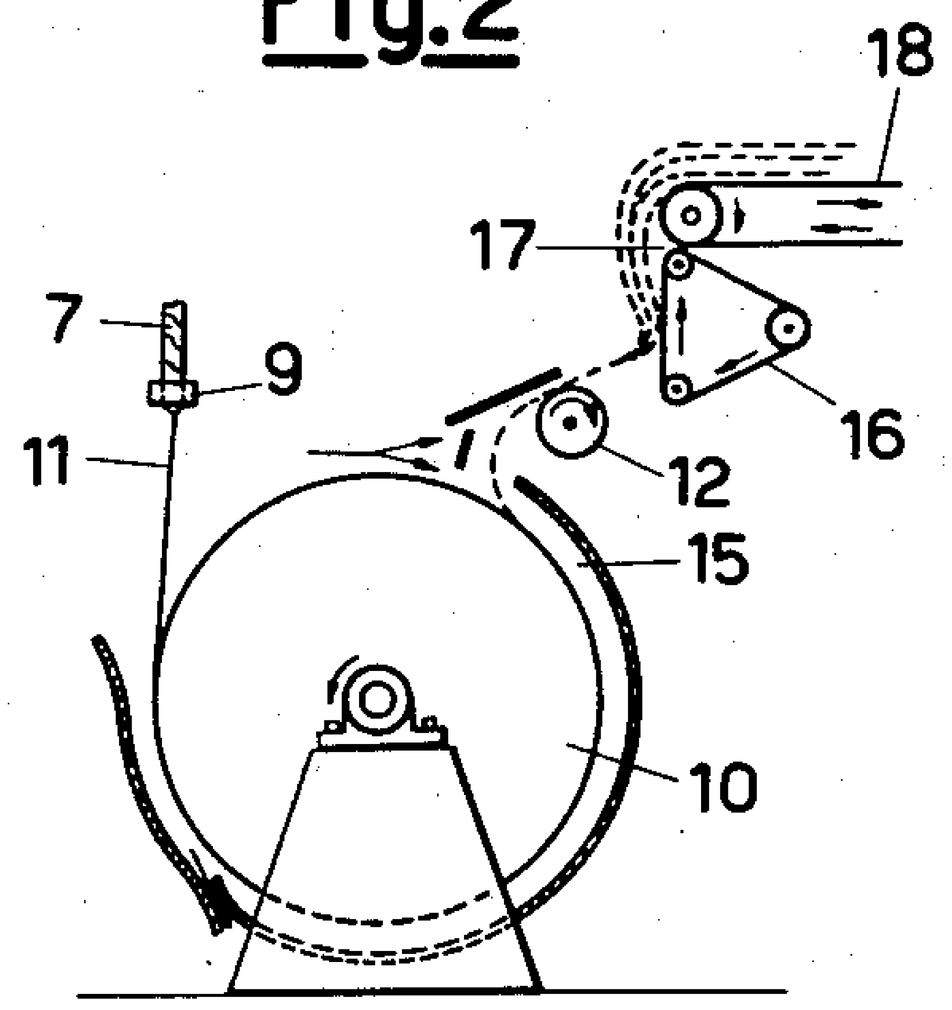


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Fig.4

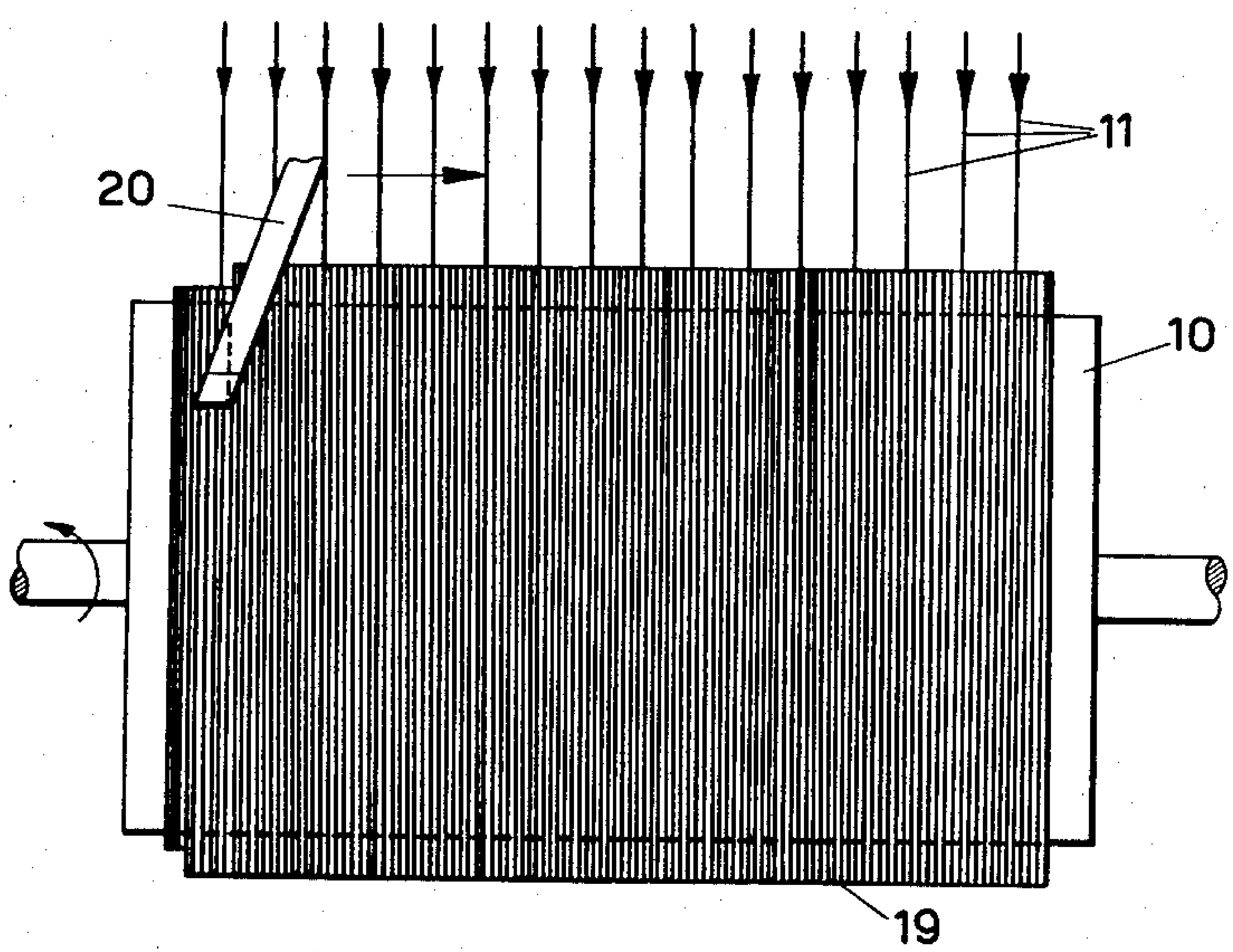
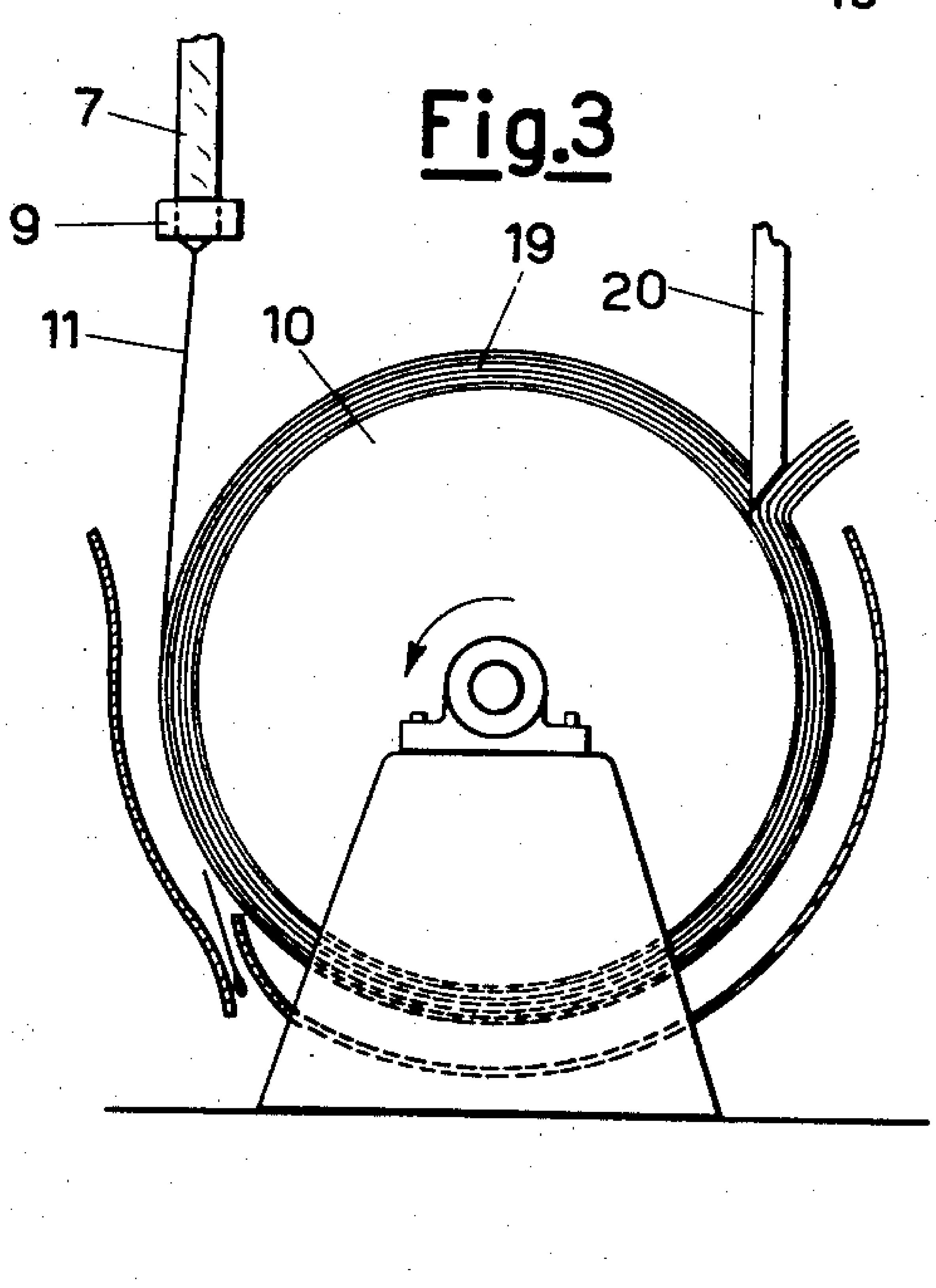


Fig.3



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PROCESS FOR THE CONTINUOUS, AUTOMATIC SPINNING OF THERMOPLASTIC MATERIALS

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1 Claim. (Cl. 18—54)

This invention relates to a process for the spinning of thermoplastic masses, in particular glass, into very thin threads.

The spinning of thermoplastic masses, particularly, glass, into thin threads is achieved with various known processes which are essentially based upon the drawing of threads—mostly by means of a rotating drum—either from the tips of finished rods which are heated to spinning temperature, or from a melt by means of nozzles ("spinnerets"). The threads are then either wound up on the drum and taken off it at determined intervals while the rotation of the drum is halted, or the threads are taken off before the drum has completed one revolution and are placed in divided or non-divided condition upon a moving support to form a yarn or a fleece.

The spinning process which involves drawing the thread from a rod possesses the advantage that constant cross-sections of the thread can be obtained, provided the cross-section of the rod is constant, the penetrating speed into the zone of spinning temperature is constant and the speed at which the thread is drawn is constant as well. Moreover, that process affords the advantage that, in case of breakage of the thread, the spinning process is started again automatically since the rod end extended into the spinning-temperature zone there keeps forming a droplet which drips off after a short time and draws along with it a thread which adheres to the turning drum and continues spinning. On the other hand, it is a definite disadvantage of that process that the continuity of operation cannot be maintained because the rods can be manufactured only with the determined maximum lengths and, therefore, after termination of the spinning of one rod there occurs an unavoidable interruption until the starting of the spinning of the next rod. Further it must be pointed out that that process is comparatively costly since a finished rod is needed as the starting material, and the manufacture of such finished rod is performed in other complicated devices.

The second of the processes mentioned hereinbefore, namely the drawing of threads by means of spinnerets from a melt, affords the advantage, over the described rod method, of being cheaper, since in lieu of costly rods cheap glass scrap or fragments may be used as the starting material. However, this process is not reliable with respect to constancy of the thread diameter and, above all, it is not suited for automatic production. The thread diameter is essentially influenced by the temperature of the melt while the thread is being drawn from the spinneret, even if the drawing speed is constant and the spinneret orifices are supposed to be constant. Temperature variations in the melt are almost unavoidable in industrial practice. Thus, for example, a diminution of temperature may take place owing to the introduction of new material into the melt, which diminution suffices to diminish the diameter of the thread being spun, whereby breakage of the thread may occur in the extreme case. Although a droplet is formed at the orifice of the spinneret following such breakage, that droplet either remains hanging at the orifice without dripping off, thus clogging the orifice; or, if additional heating means are provided around the orifice as has already been proposed—the melt may flow off without automatic re-starting of the spinning phenomenon. Hence it appears that, with the

existing process using a spinneret, it is necessary, in the case of breakage of any threads, to manually restart the spinning process for each individual thread.

For the sake of completeness another existing process should be mentioned, which attempted to combine the process normally employed for the manufacture of rods from the melt with the spinning process using rods as the starting material as mentioned above. With the last mentioned process it was intended to draw from the melt, by means of drawing rolls, rods which then were to be continuously extended into a spinning-temperature zone to be spun into threads therein. The purpose was to combine the advantages of the two processes mentioned before and to provide a continuous method of manufacture of threads from rods obtained from the melt. However, the last mentioned process overlooked the fact that, in the manufacture of rods by means of drawing members causing a stretching of the mass issuing from the outlets of the tank containing the melt, changes occur—as with the spinneret process—in the flow characteristics of the still plastic, drawn liquid and, therefore, it is impossible to keep the diameter of the spun threads constant. Moreover, it should be noted that the described combined process does provide continuous operation which is restarted automatically. As a matter of fact, if any disturbances and interruptions occur in the flow between the delivery outlets of the tank containing the melt, and the drawing members, then there is no possibility of automatically re-starting the operation.

It is an object of the invention to eliminate the above mentioned inconveniences of all of the spinning processes known heretofore and to provide a method which really affords continuous and completely automatic spinning of thermoplastic masses into very thin threads.

This object is attained according to the invention by causing the starting material continuously to melt in a vessel while continuously maintaining in said vessel a pre-determined level of molten mass at flowing temperature, extruding the molten mass in rod-like shape from cool outlet channels projecting somewhat from the bottom of the vessel, with the continuous hydraulic pressure of the head of melt causing the extrusion, whereby the rods thus continuously extruded are brought to a spinning zone wherein there is maintained a spinning temperature and with a thread being continuously drawn from the spinning tip forming at every rod by means of a turning drum, said threads being subsequently removed from the drum, by conventional means, to form yarn or fleece.

It is essential for the process according to the invention, that the mass leaving the melt-container in rod shape is not drawn or pulled therefrom, extruded only by the hydraulic pressure of the melt in said container. To enable this to be done in a perfect manner it is necessary that the mass in the outlets of the melt-container should be cooled down and possess a higher degree of viscosity than the fluid melt itself. Hence, the outlets of the melt-container project somewhat below the container bottom, so that, of course, they become cooled. The mass extruded from the channels or outlets should be so stiff at the exit point, as not to be any longer plastically deformable. The speed of extrusion depends only on the hydraulic pressure of the fluid melt contained in the melt container or tank, and the mass of melt is kept at a constant level at flowing temperature.

In order to permit additional adjustment of the forwarding speed of the rods so obtained into the zone kept at spinning temperature, it may be convenient to have feed rollers act upon the rods at a point between the outflow channels and the spinning-temperature zone, however any pulling action of such feed rollers on the rods is avoided. The space between those feed rollers corresponds to the diameter of the outflow channels and, hence, to the diameter of the rod, so that any drawing of the rods passing through this space is impossible.

In order that the invention will be clearly understood, several practical embodiments are described hereinafter with reference to the drawings and refer, merely by way of example, to the preparation of glass threads or yarns or fleeces from the glass melt, but it is to be understood that the invention is not limited to that perticular thermoplastic material. In the drawings:

FIG. 1 is a diagrammatic side elevational view, partly in section, of a device for the continuous preparation of a yarn by the process embodying the invention;

FIG. 2 is a detail view illustrating the further processing of the threads drawn off the drum to form a fleece; and

FIGS. 3 and 4 are respectively side and front elevation views of a device for the continuous preparation of a yarn of any thickness or count by taking off a plurality of parallel threads from the rotating drum.

With particular reference to FIG. 1, in which there is shown a single spinning location, it is to be understood that commonly a plurality (even 100 and more) of such locations are provided side by side and/or above one another in one machine. The starting material, for instance a glass plate **1**, is introduced—in a manner known per se and not illustrated in detail—automatically and continuously into a melting furnace **2**. The walls of the furnace **2** contain heating members **3** of any kind, which heat the furnace up to the melting and refining temperature of the glass. From a bottom aperture **4** of the furnace **2** the glass melt flows into a vessel **5** provided closely thereunder, and in which is maintained a constant level of fluid glass maintained at flowing temperature (about 1000° C.) by heat radiated or otherwise transmitted from the furnace **2**. The bottom of the vessel **5** has outflow channels or outlets **6**, preferably of circular cross-section, which project somewhat below the bottom of the vessel **5** and through which, under the hydraulic pressure of the melt in vessel **5**, there is extruded a glass rod **7** for each channel. It should be noted that the mass of glass that moves through each outlet or outflow channel **6** undergoes a temperature drop of about 10° C. per 1 mm. by reason of the heat removal from the projecting walls of the channel, so that by natural cooling along the channel, the required degree of thermoviscosity of the melt is obtained automatically. Under those conditions the glass rod **7** is extruded with a speed of about 10 mm. per minute and, on leaving the channel **6**, it is already solidified to such extent as not to be any longer plastically deformable.

The rod **7** being extruded under the constant hydraulic pressure of the melt in vessel **5** thus reaches a zone wherein by means of convenient heating means **9** there is maintained a temperature suitable for spinning (about 950° C.) From the spinning point formed in that zone, it is possible to continuously draw a thread **11**. If the thread should break for any reason, the spinning process is restored automatically because, at the spinning point of the rod **7**, there forms a droplet which drips off and drags a new thread along with the droplet.

In order to permit additional adjustment of the feeding speed of the rod **7** into the spinning-temperature zone—which speed depends on the hydraulic pressure of the melt in the vessel **5** and on the higher or lower degree of thermoviscosity of the lot of glass in the outflow channel **6**—there may be provided feed rolls **8**, preferably at a spot between the outflow channel **6** and the heating means **9** of the spinning-temperature zone. The rolls **8** are driven in such a way as to exert no pulling or stretching action whatsoever upon the rod section between the outflow channel and the passageway between the rolls **8**. The width of the space between the rolls **8** corresponds to the diameter of the channel **6**, so that any stretching of the rod is impossible.

The further processing of the threads **11** drawn from the spinning points of the rods **7** in the spinning-temperature zone may be carried out in different ways which are continuous in operation.

In the arrangement of FIG. 1, the threads are wound on the periphery of a speedily rotating drum **10** and are transformed into a yarn. To that end the threads are taken off the drum periphery before the latter has completed a single revolution, in a known manner and are wound upon a bobbin **14** as a yarn, by means of guide and feed rolls **12**, **13**.

In the arrangement of FIG. 2, the threads, which are here also taken off the drum periphery continuously before the latter completes a single revolution, are divided by a cutting device on the roll **12** or by known aerodynamic means provided, for instance, in the wind tunnel **15**, and are placed on a moving net-like support **16** so that a fleece **17** is continuously formed which is taken off by a conveyor belt **18**.

It is unnecessary here to describe more in detail those conventional devices for drawing off and further processing the spun threads, except to point out that such devices can be operated continuously and automatically with the spinning process according to the invention and, therefore, permit fully automatic operation.

Another interesting possibility afforded by the invention is the further processing of the threads spun into a yarn which is formed of a plurality of any number of parallel threads, as diagrammatically represented in FIGS. 3 and 4. In that case, the spun threads **11** are wound up on the continuously rotating drum **10**, until a layer **19** having a certain thickness is formed thereon. By means of a tool **20** directed against the drum surface and being fed slowly in the direction of the drum axis, it is possible to continuously take off a yarn of any count desired, the tool **20** being fed by a turning cutter and being quickly shifted back as soon as it has arrived at the end of the drum **10**, in order to start a new working stroke. It should be understood that thet feed velocity of the tool **20** and the winding up speed of the threads **11** should be harmonized conveniently with each other, and the cutting depth can be adjusted at will. The hank of parallel threads taken off the drum is then collected in a convenient manner and is finally wound up as a continuous yarn on a bobbin or the like.

The method described above for further processing of the threads into a yarn is applicable only if the spinning process is carried out in accordance with the invention because it presupposes a continuous and automatic spinning of the threads, without which it would be impossible to obtain a continuous yarn in the manner indicated.

As mentioned above, window or panel glass scrap is particularly suitable as the starting material for the process embodying the invention by reason of the fact that such scrap has a chemical composition which is well suited to the requirements during spinning as well as for the use as glass thread and is cheap and can be obtained in big quantities. Of course, any glass of other shape and composition may be used as well.

To attain safe adherence of the threads to the drum **10**, the piezoelectric electro-static charging of the threads may be utilized, or the threads may be provided with a convenient contact means, such as, oil, and the former has the advantage over the latter that the threads need not be provided with any sizing and have clean surfaces when they are to be used for weaving or the like.

I claim:

A process for continuously extruding rods of thermoplastic material for use in the spinning of thin threads therefrom, comprising the steps of continuously supplying the thermoplastic material, in melted condition, to a melt-container, maintaining a constant level of melted thermoplastic material in said melt-container, extruding the melted thermoplastic material through an outlet which projects downwardly from said melt-container so as to be subject to cooling by the atmosphere, the rod thus extruded being forced through said outlet of the melt-container while being gradually cooled therein solely under the pressure of the constant head of melted thermoplastic material in the melt-container and said cooled rod being no longer plastically deformable upon issuing from said outlet, continuously feeding the extruded rod to a spinning zone, and heating the leading end of the rod to the spinning temperature at said spinning zone.

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