

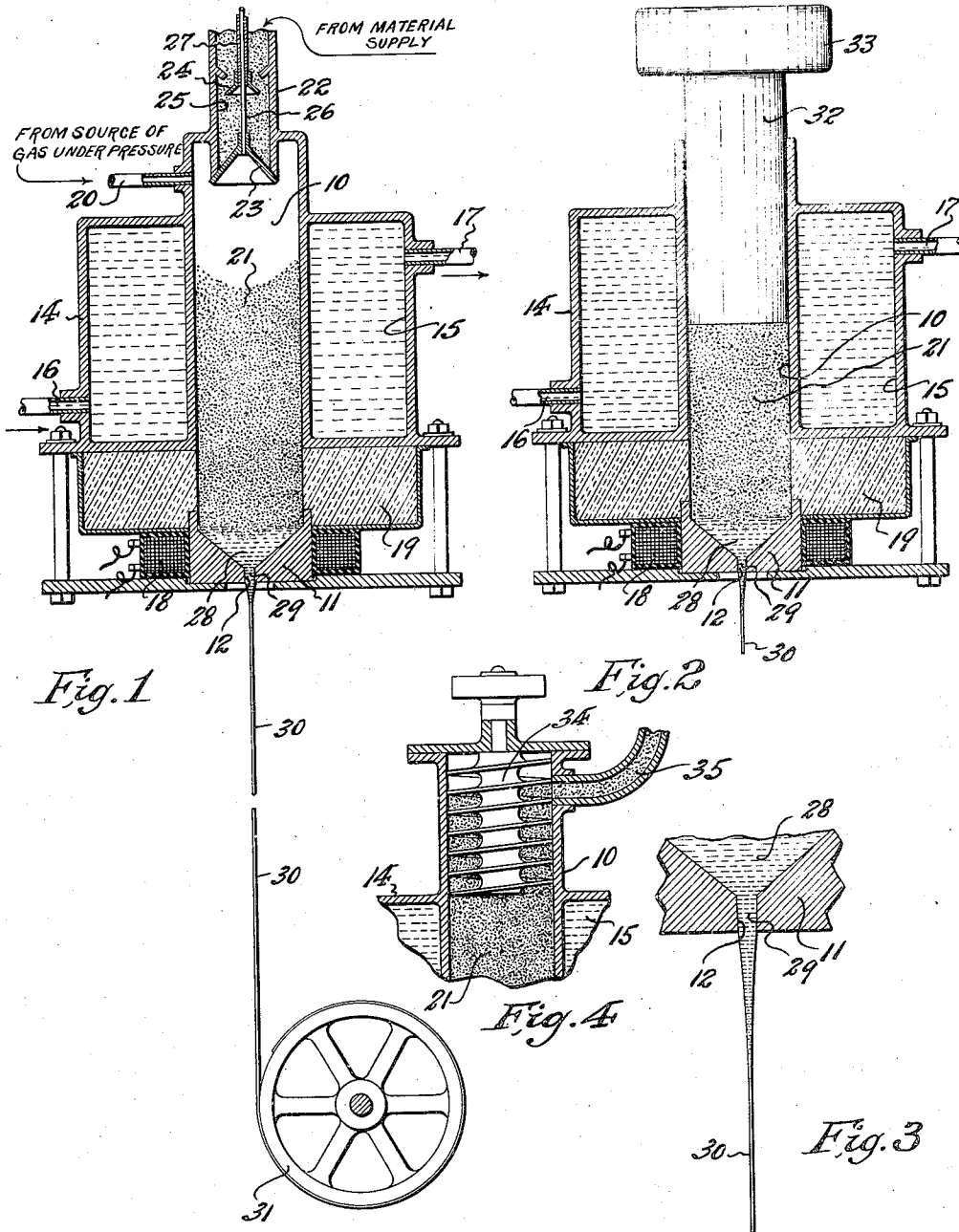
Feb. 13, 1945.

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2,369,506

PRODUCING FILAMENTS FROM MOLTEN ORGANIC COMPOSITIONS

Filed Nov. 15, 1941



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UNITED STATES PATENT OFFICE

2,369,506

PRODUCING FILAMENTS FROM MOLTEN
ORGANIC COMPOSITIONS

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Application November 15, 1941, Serial No. 419,240

1 Claim. (Cl. 18—8)

This invention relates to improvements in method and apparatus for drawing a continuous filament from an organic filament forming composition, such as a synthetic resin or resinoid material.

It has heretofore been the general practice to form or spin continuous filaments from synthetic resins or resinoid materials by forcing flowable solutions or liquefied masses of such materials under high pressure through perforate spinnerets, the minute opening or openings of which determined the diametric size of the filament obtained. The method involved in such practice is an extrusion process, and necessitates the use of very high pressures, with a consequent costly expenditure of power. When the materials so extruded are liquefied by the use of solvents, the solvents must be evaporated from the formed filament, which involves further added cost for expensive apparatus and the operation thereof.

It is an object of this invention to provide a method of drawing continuous filaments directly from molten organic filament forming compositions without necessity for use of costly high pressure extrusion through minute sizing die or spinneret openings, and without necessity for use of solvents or like wasteful and costly material liquefying procedure; the novel method of this invention involving heating the filament forming material in such manner as to provide a constantly maintained molten mass thereof, of a cross-sectional area at the point of filament take-off substantially in excess of the diameter of filament to be formed, from which mass the filament is directly drawn off without necessity for passing the same through a sizing die or spinneret opening, and whereby the diameter of the filament obtained is controlled mainly by the linear speed of withdraw of the filament from said molten mass of filament forming material.

Another object of this invention is to provide a novel method and apparatus for directly drawing a filament from a molten mass of an organic filament forming composition, said molten mass being reduced at the point of filament take-off to a restricted body portion of small cross-sectional area but of substantially larger cross-sectional area than that of the filament which is drawn off therefrom, and said restricted body portion being constantly maintained at the point of filament take-off by application of comparatively low pressure to the molten mass from which it is supplied which is merely sufficient to continuously replace the losses incident to consumption thereof by the drawn off filament formation.

The invention has for another object to provide an improved form and construction of apparatus having means for holding a supply of organic filament forming material in solid pulverulent form, and means for progressively reducing a portion of said material to a molten state, and being further provided with means to restrict, expose and constantly maintain a suitably sized body portion of the molten material at the filament take-off point and from which the filament to be formed is drawn.

The invention has for another object to provide an improved apparatus of the kind and for the purposes stated having means to continuously apply gas under pressure through the solid pulverulent material to the molten portion of said material, whereby to constantly advance the latter so as to form and maintain a restricted body portion of the same at the filament take-off point and from which the filament to be formed is drawn.

The invention has for a still further object to provide an improved apparatus of the kind and for the purposes stated including means to replenish the supply of solid pulverulent material without loss of effective pressure upon the molten portion thereof.

Other objects of this invention, not at this time more particularly enumerated, will be understood from the following detailed description of the same.

Illustrative embodiments of apparatus for drawing plastic filaments pursuant to the method of this invention are shown in the accompanying drawing, in which—

Fig. 1 is a vertical sectional view of one illustrative form of apparatus for supplying molten organic filament forming material to a take-off point from which a filament thereof is drawn; and Fig. 2 is a similar view of a somewhat modified form of apparatus for like purpose.

Fig. 3 is an enlarged fragmentary view of the means for restricting and exposing a suitably sized body portion of molten organic filament forming material at a take-off point from which a filament thereof may be withdrawn.

Fig. 4 is a fragmentary vertical sectional view of the apparatus, showing a modified construction of means for applying feed pressure to another organic material.

Similar characters of reference are employed in said drawings to indicate corresponding parts.

An illustrative form of apparatus for applying and conditioning organic filament forming material preparatory to drawing a continuous filament

therefrom, as shown in Fig. 1, comprises a supply chamber 10, to the lower end of which is suitably secured, for communication therewith, a melting pot 11 having at its exterior end a discharge passage or orifice 12 of suitable length and cross-sectional area adapted to restrict a suitably sized mass or body portion of molten organic filament forming material, the end of which is exposed at the outer extremity of said discharge passage or orifice 12, thereby providing the desirably concentrated take-off point from which the filament to be formed is withdrawn.

The supply chamber 10 is surrounded by a chambered jacket 14, through the interior 15 of which is circulated a cooling fluid, such, e. g., as cold water or the like; and to this end a cooling fluid supply pipe or conduit 16 leads into the jacket interior 15 at a suitable point, and a cooling fluid discharge pipe or conduit 17 leads out of said jacket interior at another point. In this manner cooling fluid is circulated around the supply chamber 10, whereby to maintain the solid organic filament forming material contained in the latter at relatively low temperature, e. g., room temperature, so as to prevent deterioration thereof by undue heat pending delivery thereof into the hot zone of the melting pot 11 wherein the material is fused to the required molten state.

Cooperating with the melting pot 11 is means for applying heat thereto adapted to fuse that part of the solid organic filament forming material which enters therein. Various means for supplying heat may be provided, such, e. g., as by means to circulate a hot fluid around the melting pot 11, or by means for applying electrically generated heat to the latter. By way of illustration, electrical heating means is shown, the same comprising a suitable electrical heating coil 18 which surrounds the lower end or bottom portion of the melting pot from which the discharge passage or orifice 12 leads. In order to concentrate the heat at such lower end or bottom portion of the melting pot 11, and to prevent both undue dissipation of heat and transfer thereof to the supply chamber 10 and its content of solid organic filament forming material, a body of heat insulating material 19 is interposed between the melting pot 11 and its electrical heating coil 18 and the lower end or bottom of the jacketed supply chamber 10.

Communicating with the upper interior of said supply chamber 10 is a delivery pipe or conduit 20 which leads from a source of gas under pressure.

The solid pulverulent organic filament forming material 21 is introduced into the supply chamber 10, the upper end of the latter being suitably closed against escape of the pressure gas entering through the delivery pipe or conduit 20. If the apparatus is desired to be operated discontinuously, i. e., intermittently on the batch by batch principle, after a batch of the material 21 is filled into the supply chamber 10, the upper end of the latter may be closed in any suitable way, as, e. g., by a removable cap or cover (not shown). It may be preferable, however, to operate the apparatus continuously, and to this end to provide means for replenishing the supply of material 21 in compensation for consumption thereof, but in such manner as to suffer no escape or loss of internal pressure of the pressure gas introduced into the supply chamber interior. Illustrative means suitable to attain such continuous mode of operation is shown in Fig. 1, the same comprising a gas lock type of valve mechanism

connected with the receiving end of the supply chamber 10. This gas lock valve mechanism comprises a valve casing 22, the lower end of which opens into the interior of said supply chamber, and the upper end of which is adapted to be connected in communication with a source of material supply (not shown). Said valve casing is provided with a lower or discharge valve 23 and an upper or intake valve 24, these valves being spaced apart to provide an intermediate lock chamber 25. The lower valve 23 is provided with an actuating rod or shaft 26, and the upper valve 24 with a tubular actuating rod or shaft 27 slidably disposed over and around said rod or shaft 26. Mechanism cooperative with their actuating rods or shafts (not shown but of well known mechanical principle) serves to alternately open and close said valves 23 and 24, so that when the lower valve 23 is closed the upper valve 24 opens to admit material 21 into the lock chamber 25, whereupon the upper valve closes and the lower valve opens to discharge material 21 from the lock chamber 25 into the interior of the supply chamber 10.

In the operation of the apparatus above described, the supply chamber 10 being charged with solid pulverulent organic filament forming material 21, the latter will gravitate from the interior of said supply chamber so as to deposit a portion thereof within the melting pot 11. Heat having been applied to the melting pot 11, the material deposited therein is caused to fuse and thus form a molten mass 28, a portion of which will enter and fill the discharge passage or orifice 12 to thereby form a restricted portion 29 thereof, the end of which will be outwardly exposed at the discharge mouth of the latter.

The end of the restricted portion 29 of the molten material which is exposed at the discharge mouth of the passage or orifice 12 is touched with a glass rod, or other suitable implement to which the molten material will adhere, whereby said material may be drawn out and away therefrom in the form of a mono-filament 30. The free end of the filament 30, thus started, is carried away and attached in any suitable manner to a rotated winding drum 31, or to any other suitable mechanism adapted to continuously pull away and wind the filament thus drawn from the molten material.

But little pressure is required to assure continuous movement into and the filling of the discharge passage or orifice 12 with the molten material, in fact pressure ranging from a few ounces up to a few pounds per square inch is generally all that is required to keep the discharge passage or orifice 12 full. The pressure applied may be varied or regulated by test to that which is found sufficient to replace the material consumed by the drawing away of the filament formed therefrom.

It is preferable to supply the required pressure by means of a gas under pressure which is introduced into the interior of the supply chamber 10; first, because the pressure gas will penetrate the interstices of the pulverulent material 21 contained in the latter so as to exert its force directly against the molten mass 28, leaving the pulverulent material free to feed itself downward to the melting pot 11 by gravity, and, second, because gas pressure may be maintained constant while replenishing of pulverulent material is carried on through the agency of the gas lock valve mechanism by way of which said material is delivered into the supply chamber, thus permitting

uninterrupted use of the apparatus whereby the filament forming operation may be continued indefinitely and a continuous filament of great or any desired length may be produced.

Another method and means for applying feed pressure to the material continuously supplied to the chamber 10 is shown in Fig. 4, wherein the upper end of said supply chamber is provided with a feed screw 34 to constantly advance the pulverulent material 21, which is supplied through the intake conduit 35, toward the melting pot 11, and so as to exercise the required pressure upon the molten content of the latter. This feed screw will be of proper pitch and will be rotated at proper speed so as to transmit through the pulverulent material, and thus to the molten material that degree of low pressure which is sufficient to replace at the orifice 12 the amount of molten material withdrawn or consumed by the filament drawing and forming operations.

Optionally, the organic filament forming material may be supplied in batches to the supply chamber 10, and a filament drawn therefrom until a given batch is substantially exhausted. In such case, the feeding pressure may be mechanically applied to the material, in both its solid pulverulent and in its molten condition. An apparatus adapted to operate with mechanically applied pressure is shown in Fig. 2, wherein a pressure exerting plunger 32 is loosely slidable within the upper receiving end of the supply chamber 10, so as to bear upon and thrust downwardly against the solid pulverulent material 21, and thus transmit therethrough pressure to the molten material 28 sufficient to express the same through the discharge passage or orifice 12. Said plunger 32 may be mechanically operated, or it may be operated by the gravity of its own weight or of any additional weight required, as, e. g., by its weighted upper end 33, which may be suitably sized to attain the required degree of pressure. Inasmuch as the relatively large discharge passage or orifice 12 offers but little resistance to movement of molten material thereinto, and since the filament formation and sizing is not required to be obtained by forcing the molten material through a very fine or minute die opening, it follows that merely a low degree of pressure is required, such pressure being used merely to replenish material consumed by the filament drawing operation as carried on according to the method of this invention, and consequently pressure producing methods or agencies involving high operating costs are not required.

It will be obvious that the melting pot may be provided with a plurality of discharge passages or orifices 12, whereby a plurality of mono-filaments may be simultaneously drawn, and thereafter twisted or otherwise worked into multi-filament yarns, threads or the like.

There are many organic plastic compositions, principally in the general class of synthetic resins or resinoid materials, to which the method of filament drawing according to this invention can be applied. Substances such as synthetic fiber-forming linear condensation polyamides (commercially known as "nylon"), co-polymers of vinyl chloride with vinyl acetate (commercially known as "Vinylite" or "Vinyon"), polystyrene, polymethyl methacrylate (of the type commercially known as "Crystalite"), polymerized vinylidene chloride (commercially known as "Saran"), plasticized ethyl cellulose and cellulose acetate and perhaps many other similar compositions are examples of materials which possess, to a greater

or lesser degree, the extensile properties suitable for filament formation by the free hot drawing method of this invention. Such plastic compositions, as prepared for filament formation, may include suitable plasticizers and, if desired, suitable filler material. To the selected composition coloring matter in the form of either dye or pigment may also be added for obtaining desired color appearance of the filament to be produced.

Since no two organic plastic compositions in molten state behave the same, it is not possible to predict the optimum temperature at which a given composition will freely draw out into the desired filament formation. Take, for example, a plastic composition comprising polymerized vinylidene chloride, above and below a certain critical temperature range, the molten composition may flow but will not draw; that is, in molten condition it could be extruded perhaps but could not be freely drawn out into a filament. Furthermore, addition of selected filler material or coloring matter or both tends to somewhat alter its behavior as to extensibility by a hot drawing operation at a given temperature, and consequently some modification of the critical temperature at which it best responds to such operation would have to be made. For these reasons, an optimum or critical temperature at which a given composition can be satisfactorily hot drawn into a filament formation may best be approximately predetermined by a preliminary test.

To approximate optimum temperature at which a given organic plastic composition can be freely hot drawn into a mono-filament of desired diameter, a preliminary test may be conducted as follows:

A small quantity of the selected plastic composition is deposited in a test tube and then heated to a certain temperature by means of a hot oil bath until reduced to a molten state. The molten composition is then touched with a glass rod and the rod withdrawn to extend the composition into a filament formation. This operation is repeated at different specific temperatures until a filament of desired character appears to form. The temperature of the oil bath at which a proper filament appears to form is taken as the approximate temperature which is satisfactory for continuous hot drawing of the particular plastic composition thus dealt with.

The melting pot 11 of the apparatus to be used for continuous filament drawing is then heated to the approximate appearance of the drawn plastic filament, for with feed pressure and speed of draw substantially constant, too low a melting pot temperature will cause unfused particles to appear in the drawn filament, while, on the other hand, if the temperature is too high, dark decomposed particles will appear in the drawn filament or a disruption of the drawn filament is likely to occur due to the presence of gaseous decomposition products.

The diameter of the drawn filament is mainly controlled by the linear speed of filament draw-off, but the feed pressure and temperature of the melting pot will also be contributing factors to some extent, and consequently some adjustment of the latter factors may be required. In general, however, with the latter factors substantially constant, increase of speed of filament draw-off will decrease the diameter of the filament, and decrease of draw-off speed will increase such diameter. To some extent increase of feed pressure, when draw-off speed and temperature remain substantially constant tends to

increase the filament diameter; and, within operable temperature limits, increase of melting pot temperature, when draw-off speed and feed pressure remain substantially constant, tends to decrease the filament diameter. As a consequence of these things, control for diametric sizing of the drawn filament is best attained by relative adjustment or regulation of the three factors, viz., speed of draw-off, feed pressure and melting pot temperature. Under properly established conditions, filaments as fine as .001 of an inch in diameter may be continuously drawn.

It has been found that with most organic plastic compositions, the rapid filament draw-off from a molten portion thereof causes a stretching of the hot filament which renders it considerably more elastic and flexible than is a filament of the same composition which is formed by direct extrusion through a sizing die opening. This is particularly true as to filaments drawn from a polymerized vinylidene chloride or "Saran" composition.

From the above description it will be understood that this invention provides an economical and rapid method of forming linear filaments from organic plastic compositions; and, furthermore, the invention also provides a novel and simple construction of apparatus by means of which the method may be satisfactorily practiced.

I claim:

In an apparatus for hot drawing a filament formation from a molten organic filament form-

ing material, a supply chamber for holding a quantity of the selected material in solid pulverulent form, a gas lock valve means communicating with the upper end of said supply chamber through which the pulverulent material is introduced into the latter, a melting pot with which the lower end of said supply chamber communicates, said melting pot having a discharge orifice adapted to form a restricted body portion of molten material of small cross-sectional area but of substantially larger cross-sectional area than that of the filament to be produced, whereby the exposed end of said restricted body portion provides the take-off point from which the filament is freely drawn, a jacketing chamber around said supply chamber to circulate a cooling fluid around the latter, whereby to maintain the major portion of the supply material at a temperature lower than its melting point, a heating means for said melting pot, means to insulate said supply chamber and its jacketing chamber from said melting pot and its heating means, and means to introduce into and maintain within said supply chamber a gas under pressure adapted to penetrate the mass of pulverulent material contained therein and directly exert a pressure of comparatively low degree upon said molten material merely sufficient to continuously replace the losses of said restricted body portion thereof incident to its consumption by the drawn off filament.

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