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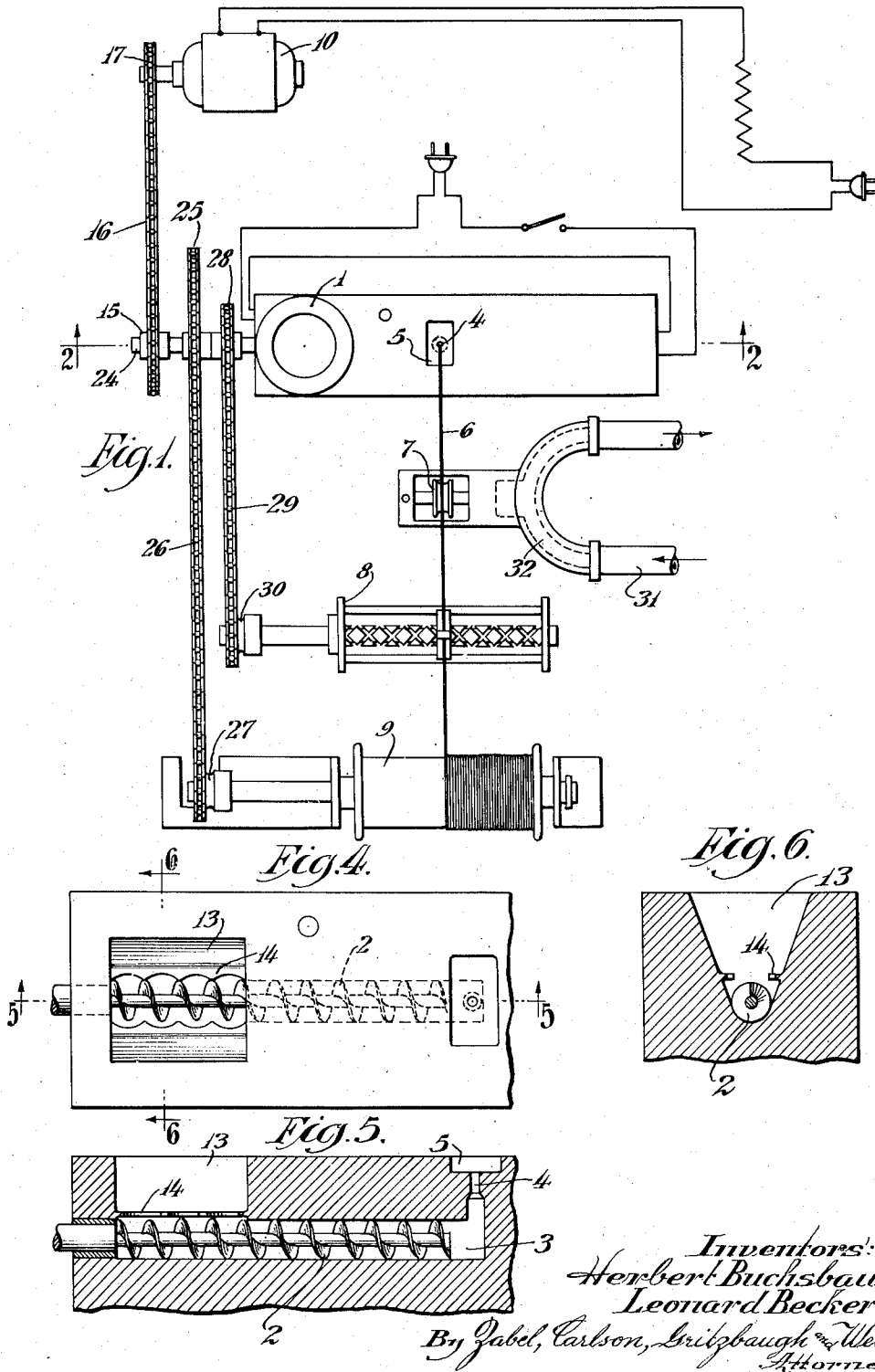
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2,328,125

METHOD FOR MAKING FILAMENTS

Filed Feb. 17, 1940

2 Sheets-Sheet 1



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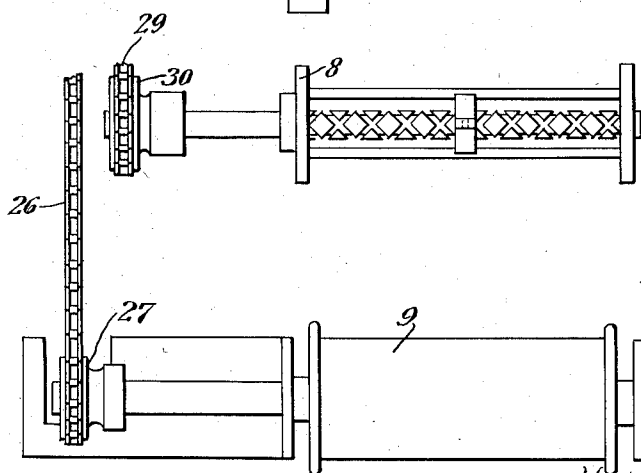
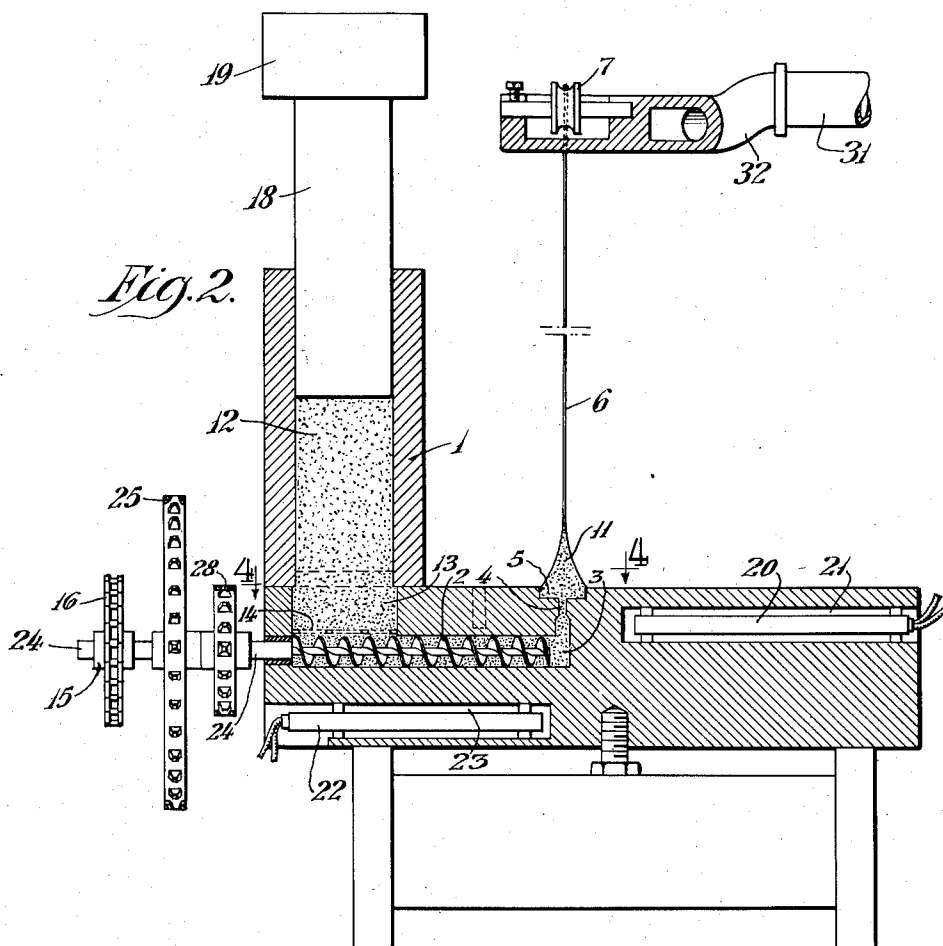
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UNITED STATES PATENT OFFICE

2,328,125

METHOD FOR MAKING FILAMENTS

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4 Claims. (Cl. 18—54)

This invention relates to a method and means for making artificial fibers and filaments and more particularly to an improved method and apparatus for making vinyl resin filaments.

A principal object of this invention is to provide a simple, inexpensive and continuous process of making vinyl resin filaments suitable for textile fibers.

A further object is to provide a process whereby fibers of vinyl resin composition are formed, stretched, set and coned or reeled in one simple continuous operation.

Another object is to provide an improved apparatus for continuously forming, stretching, setting and winding textile filaments.

Other objects and advantages of the invention will become apparent as the following description proceeds, reference being had to the accompanying drawings in which—

Fig. 1 is a diagrammatic plan view showing the process and apparatus of this invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary plan view of the leveling and winding mechanism;

Fig. 4 is a plan view taken along line 4—4 of Fig. 2;

Fig. 5 is a vertical section taken on the line 5—5 of Fig. 4; and

Fig. 6 is a section taken on the line 6—6 of Fig. 4.

In accordance with this invention an elastic vinyl resin composition is heated to a molten and non-elastic state, the molten non-elastic composition continuously drawn into a filament which is placed under elastic stretch, cooled while under such stretch, and then wound on a reel or drum.

In the embodiment of the invention shown in the drawings, the molten non-elastic vinyl resin composition is continuously fed through an orifice 4 to a supply cup 5, then continuously drawn from the supply cup 5 into a filament 6 which is cooled, and finally continuously wound on a reel or drum 9. The rate of winding and rate of feeding the molten composition to the supply cup is so regulated that a continuous supply is always available at the supply cup for drawing into the filament.

The molten composition in the process of being drawn into a filament 6 from the supply cup 5 first forms a cone 11 which diminishes in cross-section into the filament 6 of the size of a textile fiber. The composition when it first emerges from the supply cup is hot and in a non-elastic

state. As the composition in the form of a filament travels from the supply cup the atmosphere quickly cools it to an elastic condition and gives it strength sufficient to withstand the constant pull from the winding mechanism.

The winding mechanism is run at such a rate as to give a filament of the size of a textile fiber, and also at such speed in relation to the feed mechanism as to stretch the filament. The stretched filament is cooled by passing the filament over a cold roller or pulley 7 or by other suitable means. Cooling of the stretched filament to below 75° C. and preferably to below 30° C. sets the fiber, gives improved tensile strength and other characteristics of value for textile fibers.

In one embodiment of the invention the stretched filament instead of being cooled by the atmosphere or by passing over a chilled roller is drawn through water which may be regulated to any desired temperature, such as 0° C. or any other temperature at which the stretched fiber tends to set. In this manner the advantageous effect of water on vinyl resin fiber is quickly and economically utilized.

In order to obtain further improvement the fiber made by the continuous drawing, stretching and cooling process may be immersed in hot water, viz. water at 212° F., stretched to substantially its elastic limit, and immersed while still stretched in cold water, viz. water at 32° F. This process may be repeated several times with advantageous results.

In carrying out the continuous process of this invention, it is desirable to employ an elastic vinyl resin composition which is thermoplastic and relatively non-elastic at temperatures above normal room temperature and below the decomposition temperature. Such compositions should be solid and non-tacky at normal room temperatures and preferably within a range of from 0° F. to 100° F. Another important characteristic is that the material in the form of a filament of .05 mm. in diameter should be capable of being creased without appreciable cracking. The material should also have an ultimate tensile strength of at least 1000 lbs. per sq. inch and an elastic extensibility of at least 100% of its length. Preferably, under a tensile stress of 1,000 lbs per sq. inch the material should stretch 100% of its length within the elastic limit in a period of at least 10 seconds, and on removal of the tensile stress, the material should also return substantially to its original dimensions and require a period to return from 100% to 50% of its original dimensions of from

5 to 20 seconds. Such a material has the characteristics which make it suitable for continuous direct drawing, stretching, cooling and winding.

Suitable compositions ordinarily consist essentially of a vinyl resin having an average macro molecular weight of at least 15,000, combined with a plasticizer which gives the required flexibility and elasticity without lowering the tensile strength below 1000 lbs per sq. inch or below the limits necessary for continuous drawing, stretching and winding.

The class of vinyl resins particularly useful in this invention are those such as are described in Patent 1,935,577 to E. W. Reid, and these resins may be made by the processes described by that patent or by other means such as the process described in Patent 2,064,566 to E. W. Reid. Of these conjoint polymers of vinyl halides with vinyl esters of aliphatic acids, the preferred resins are those which contain from 80 to 95% by weight of the halide in the polymer. Within this range those resins formed from vinyl chloride and vinyl acetate which contain in the polymer about 85% to 90% by weight of the chloride are especially desirable. However, the invention is not limited to the use of these particular vinyl resins but may be carried out with other types of vinyl resins such as the polyvinyl chlorides, polyvinyl acetals, mixtures of polyvinyl chlorides and polyvinyl acetates, provided the resin has the desired strong, flexible, thread-forming physical characteristics described above or may be modified by the addition of plasticizers to obtain the described characteristics. In the case of conjoint polymers of vinyl chloride and vinyl acetate having an average molecular weight of at least 15,000, the resin desirably should be modified with substantial proportions of plasticizer in order to obtain the characteristics necessary in order to make it suitable for continuously drawing, stretching and winding, and this in general is desirable for all the vinyl resins which have tensile strength suitable for textile fibers.

Suitable and preferred proportions of plasticizer will vary somewhat with the type of vinyl resin and the type of plasticizer. It is highly important that the amount and type of plasticizer should not be such as to give a tacky composition at normal room temperature, and preferably between temperatures of 0° F. to 100° F. At the same time the plasticizer must be of such type and present in such amount that the tensile strength of the composition is suitable for continuous drawing, stretching and winding, and such that the filament can be readily flexed. We have found it desirable to use over 21% by weight of plasticizer on the vinyl resin and preferably over 23%. In order to obtain the non-tackiness, it has been necessary to choose the plasticizer carefully since most plasticizers in such high proportions will give tackiness even to a vinyl resin. The plasticizers which we have found to be suitable in this high range are triethylene glycol di-2-ethylbutyrate and dibutyl sebacate and mixtures of dibutyl sebacate with dimethoxyethyl phthalate, in which the ratio of dibutyl sebacate to dimethoxyethyl phthalate is not less than 7 to 20. Even with such types of plasticizer the upper limit of plasticizer in order to obtain non-tackiness should not be greater than approximately 32% and preferably should not be greater than 30%. The ideal proportion is about 25 parts by weight plasticizer to 75 parts

by weight of conjoint polymer of vinyl chloride and vinyl acetate in which the vinyl chloride is in major amount compared with the vinyl acetate.

The invention is further illustrated in connection with the drawings. In making filaments the vinyl resin composition is added to a supply chamber 1, where it is heated until it has substantially no elasticity but is capable of plastic flow. The hot molten material is then fed by a worm 2 or other device through a conduit 3 and the orifice 4 to the supply cup 5. A portion of the material in the supply cup 5 is grasped with a pair of pliers or other means and drawn through the atmosphere in the form of a filament 6. This filament is stretched as it travels over the chilled rolls 7 where the filament is farther cooled in its stretched state to substantially room temperature (20° C.). The cooled filament then proceeds to the leveling reel 8 and winding reel 9 where it is continuously wound by means of the motor 10. The fineness of the filament and the degree of stretch is regulated by changing the speed of reeling, the more rapid the rate of reeling the finer the filament and the greater the stretch. To some extent the diameter of the filament may also be regulated by changing the temperature of the molten composition, the hotter the composition the finer the filament. However, the upper and lower limits of temperature for the molten mass suitable for the drawing process are determined by the decomposition temperature of the vinyl resin composition, by the proportion of plasticizer to vinyl resin, by the type of vinyl resin, and by other factors so that the temperature may only be varied within narrow limits.

For a conjoint polymer of vinyl chloride vinyl acetate in which the vinyl chloride is in major amount compared with the vinyl acetate, and the resin is in admixture with 27% of a mixture of "methox" 20, dibutyl sebacate 7, the lower and upper temperature limits are approximately 340° F. to 358° F., respectively. The ideal temperature is about 347° F. With 75 parts by weight of the conjoint polymer to 25 parts of triethylene glycol di-2-ethylbutyrate the lowest temperature should be about 350° F., the upper temperature about 368° F., and the ideal temperature about 358° F.

A filament speed of 24 ft. per minute will give a filament of approximately .05 mm. diameter for the vinyl resin compositions of the preceding paragraph drawn from the compositions at the ideal temperatures of 347° F. and 358° F., respectively.

The molten composition may suitably be drawn without the aid of any extrusion. The composition is pulled from a source of supply in the form of a cone of diminishing cross-section.

Filaments may be made by the process and apparatus of this invention varying from approximately 11 mm. to .01 mm. diameter. The continuous drawing process is particularly suitable for producing elastic filaments of .05 mm. diameter.

The following examples show compositions and procedures which have been found suitable, but it is not intended to limit the invention to the specific compositions, temperatures and other details shown.

EXAMPLE I

	Per cent by weight
Dimethoxyethyl phthalate ("Methox")	20
Dibutyl sebacate	7
Vinyl resin	73

The materials in the above formula were mixed together by milling. A portion of the mix was then calendered into sheets of .04 inch thickness and cut into strips of .75 inch width for test purposes. Physical tests on the strips are shown in the following tables:

Table I.—Stress-strain

Tensile stress, lbs./in.	Per cent elongation
0	0
83.3	18.2
166.6	39.3
250	39.5
416.6	60.6
583.2	75.9
749.8	100
916.4	115.2
1083	132.0
1249.6	151.7
1416.2	167.0
	Break

Table II.—Time-elongation

Time sec.	Lbs./in.	Per cent elongation
0	0	0
5	333.3	57.2
10	333.3	65.9
15	333.3	68.6
20	333.3	70
25	333.3	71.1
30	333.3	72.9
35	333.3	74.3
0	0	0
10	666.6	65.9
20	666.6	74.9
30	666.6	80.0
40	666.6	83.0
0	0	0
10	1000	94.5
20	1000	108.6
30	1000	114.4
40	1000	117.3
50	1000	118.9
60	1000	120.1

Table III.—Return-time

Lbs./in.	Per cent elongation
749.8	132.5
0	52.5
	40.00
	36.25
	35
	33.5
	32.25
	31.25
	28.75
	25.0
	25.0

The remainder of the composition was then heated to 347° F., fed through an orifice of .161 inch diameter to a supply cup of greater cross-section than the orifice. The composition was then drawn from the supply cup into a filament, the filament partially cooled, stretched, further cooled to about room temperature and wound continuously on a reel or drum as shown in diagrammatic view of Fig. 1, the speed of reeling being such as to give a filament speed of 24 ft. per minute which gave a filament of .05 mm. diameter.

Physical tests on the drawn filament were substantially the same as for the strips but gave somewhat higher tensile strength.

The filament produced by the continuous direct drawing, stretching and cooling process was then unwound from the reel and again stretched to substantially its elastic limit, immersed for fifteen minutes in water at 212° F. and then plunged into

water at 32° F. This procedure increased the strength of the fiber, decreased its elastic extensibility and in general improved its suitability for textiles.

In the formula of Example I, the vinyl resin and plasticizer are shown in the preferred amounts for the carrying out of the continuous direct drawing process, and also for obtaining a filament having suitable "lazy" stretch characteristics. The ratio of dibutyl sebacate to "methox" of 7 to 20 has been found to give the best results consistent with lack of odor and suitable tensile strength. Increasing the proportion of dibutyl sebacate gives an odor to the material which may be objectionable. Both "methox" and dibutyl sebacate are plasticizers. "Methox" is odorless and dibutyl sebacate has an odor. However, the dibutyl sebacate lowers what is sometimes called the freezing point of the composition. When "methox" is used without dibutyl sebacate, the filament made from the composition is apt to crack on flexing at low temperatures, such as temperatures of 0° F., whereas with the dibutyl sebacate the filament may be flexed at a 180° angle without cracking at such a low temperature.

The vinyl resin given in the formula of Example I was a conjoint polymer of vinyl chloride and vinyl acetate made in accordance with the Reid Patent 1,935,577, and included a small amount of basic stabilizer such as described in Grof Patent 1,966,856. The particular vinyl resin used was produced by conjointly polymerizing 80 parts by weight of vinyl chloride and 20 parts of vinyl acetate, and was about 75% insoluble in toluene at 25° C. It was admixed with 1 part of calcium stearate in 100 parts of resin. However, other conjoint polymers of vinyl chloride and vinyl acetate are suitable and include those ranging from 90% vinyl chloride and 10% vinyl acetate to 10% vinyl chloride and 90% vinyl acetate. Preferably, however, the proportion should be 80% or more of vinyl chloride and 20% or less of vinyl acetate with less than 20% of the resin being soluble in cold (25° to 30° C.) toluene, and having an average macro molecular weight of at least 15,000. It is advisable that the resin be freed from exclusively low molecular weight polymers.

The proportion of total plasticizer (dibutyl sebacate and "methox") to vinyl resin may vary quite widely. Filaments having suitable stretch and strength characteristics for intensive direct drawing may be made when the proportion of plasticizer to vinyl resin is as low as 21% and as high as 32%. Preferably, however, the proportion of plasticizer should not be lower than about 22% and higher than about 30% in order to obtain satisfactory elasticity, strength, flexibility, and non-tackiness at temperatures from zero degrees Fahrenheit to 100° F. or such as are within the ordinary range of atmospheric conditions. The specific preferred proportion is that shown in the formula, namely, 27%, which has the physical characteristics heretofore indicated.

Another composition besides that shown in Example I which has been found suitable, is as follows:

EXAMPLE II

	Parts by weight
Triethylene glycol di-2-ethyl butyrate----	25
Counter-odorant -----	Trace
Vinyl resin-----	75

This composition was compounded and made into filament in the same manner as described for the composition of Example I. The material had slightly higher tensile strength than the material

of Example I, and was odoriferous but not objectionably so. Otherwise its characteristics and suitability was substantially the same as the material of Example I. The vinyl resin used was the same as in Example I. The range of suitable and preferred proportions of plasticizer to vinyl resin is substantially the same for Example I.

Suitable and preferred proportions of plasticizer to vinyl resin will vary somewhat with the type of vinyl resin and the type of plasticizer. The proportions and type of plasticizer given in Examples I and II are merely illustrative of proportions and types which give suitable strength and stretch characteristics and are not intended to limit the invention to the specific proportions and kind of plasticizer shown.

The filaments described in this specification such as those made by drawing the compositions of Examples I and II, and compositions in which polyvinyl chloride is substituted for the vinyl resins used in Examples I and II, may be knitted, woven or otherwise fabricated into various articles adapted to be stretched. These filaments give improved characteristics of stretch to the articles without causing discomfort to the wearer. These filaments have the same stress-strain and "lazy" stretch characteristics as the belts, garters, suspender straps and the like, made from the sheets and strips. The filaments have such strength and elasticity that single filaments of the diameter of ordinary thread used in making hosiery can be knitted into a stocking without twisting or doubling the filaments into a yarn or thread.

The apparatus used in carrying out the process is shown in Figs. 1 to 6. Referring to the drawings, the apparatus comprises a supply chamber 1 for holding a supply of the vinyl resin composition 12, and a stoker chamber 13 having a conduit 3 leading from the bottom of the chamber and extending upwardly to form the orifice 4 and supply cup 5. The stoker chamber 13 is in the form of a trough having a grating 14 at its top through which the vinyl resin composition in its molten condition may pass. Below the grating is a worm or screw conveyor 2 adapted to feed the vinyl resin composition to the orifice 4 and supply cup 5. The worm or screw conveyor 2 is driven by a motor 10 through gear 15, chain drive 16 and gear 17. The loaded supply chamber may be closed by means of a plunger 18 having a weight 19 adapted to aid the vinyl resin composition in passing through the opening of the grate 14 so as to come in contact with the conveyor 2.

The vinyl resin composition in the supply chamber and stoker chamber is adapted to be heated by means of a heating element 20 in the chamber 21. A thermostat 22 in the thermo regulator chamber 23 controls the degree of heat.

The worm or screw conveyor 2 is adapted to continuously feed the molten vinyl resin composition through the conduit 3 and orifice 4 to the supply cup 5. In the preferred embodiment of the invention, the orifice 4 has a diameter of .161 inch or slightly larger.

On the shaft 24 carrying the worm 2 is a gear

25 connected by a chain drive 26 to a gear 27 which drives a winding spool 9.

Likewise a gear 28 is attached to the shaft 24 and by means of a chain drive 29 and gear 30 drives the leveling reel 8. Between the leveling reel 8 and the supply cup 5 is a cooling pulley 7 which is cooled by means of cold water circulating through hose 31 and coupling 32.

The leveling and winding mechanism is shown in detail in Fig. 3. The feed device and supply source is shown in detail in Figs. 4 and 5. It is apparent from the diagrammatic view shown in Fig. 1 that the feed device 2 and winding reel 9 are synchronized so that there is a constant supply of vinyl resin composition in the supply cup 5 as the winding reel continuously draws a filament from the molten composition in the supply cup.

While there have been shown and described certain embodiments of the invention, it is to be understood that it is capable of many modifications. Changes, therefore, may be made without departing from the spirit and scope of the invention as described in the appended claims, in which it is the intention to claim all novelty inherent in the invention as broadly as possible, in view of the prior art.

This application is a continuation in part of our co-pending application, Serial No. 318,006, filed February 8, 1940, entitled "Articles of wearing apparel, accessories, and the like."

We claim:

1. The method of making a textile filament which comprises heating a mixture of vinyl resin and a plasticizer to form a molten composition, feeding a portion of said molten composition through an orifice to a supply container having a cross sectional area substantially greater than that of said orifice, and drawing a filament from said molten mass in said supply container without first forming a filament while feeding molten composition to said supply container.

2. In the method of making a textile fiber wherein a textile fiber is directly drawn from a vinyl resin composition without first forming a fiber, the steps of drawing said hot vinyl resin composition at a temperature of above 75° C. into a fiber and cooling and pulling said fiber in a state of elastic extension through a bath of water at a temperature below 75° C.

3. The method of making a filament suitable for textiles which comprises heating an elastic film forming composition to a molten non-elastic state, feeding a portion of said molten composition through an orifice to a supply container having a cross sectional area substantially greater than that of said orifice, and drawing a filament from the molten mass in said supply container without first forming a filament by extrusion.

4. The method of making a textile fiber which comprises directly drawing a fiber from a plastic vinyl resin composition without first forming a filament by extrusion.

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