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METHOD FOR FORMING NYLON STRIP STOCK

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Fig. 1.

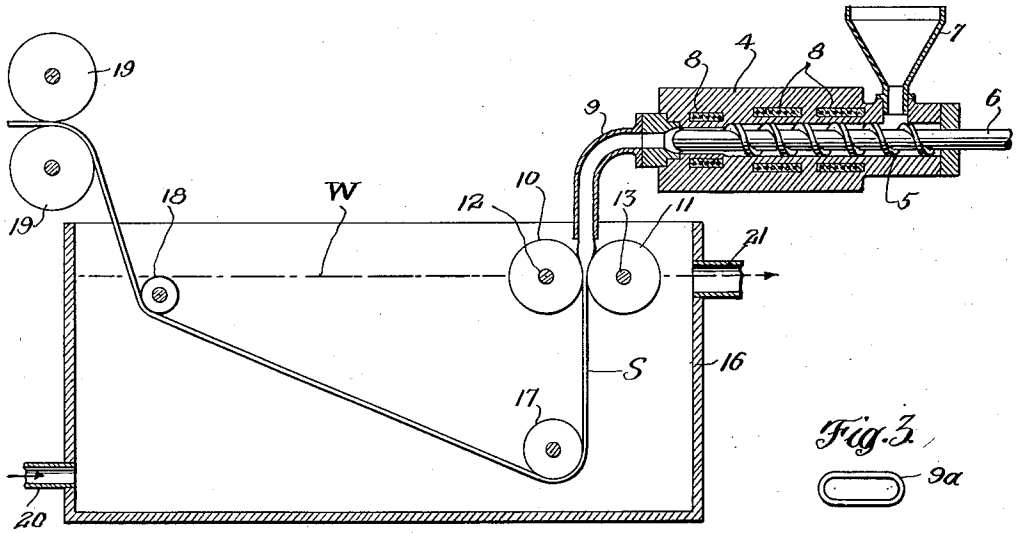
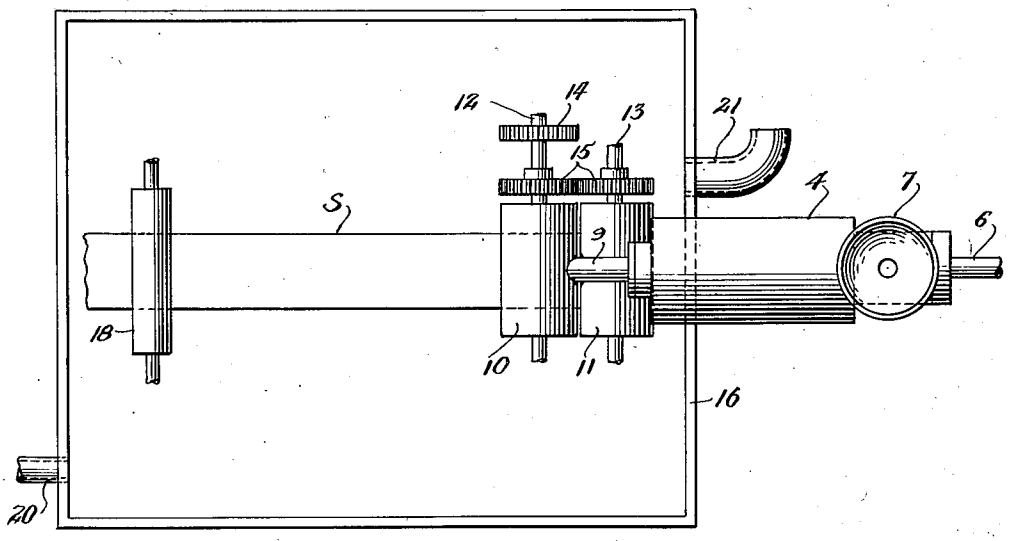


Fig. 3.

Fig. 2.



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METHOD FOR FORMING NYLON STRIP STOCK

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3 Claims. (Cl. 18—47.5)

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This invention relates to the formation of strip stock from high molecular weight synthetic linear polyamides known in the trade as nylon.

The principal object of the present invention is to provide a method for the continuous production of strip stock from nylon. The invention is applicable to the production of strip stock of a variety of sections, and is especially suited to the production of flat strip stock, either the thickness or width of which may be varied over a fairly broad range. As a typical example, the strip stock may be .020'' in thickness and 1½'' in width.

Continuous formation of strip stock from nylon has presented certain problems and difficulties, especially because of certain of the characteristics of nylon, particularly the fact that this material has a sharp melting point and has relatively low viscosity in the molten condition.

According to the invention, a method is provided which effectively meets the special problems encountered and which is exceptionally simple, notwithstanding its capability of continuous production of strip stock.

The invention further provides for adjustment of the operating conditions whereby to enable the production of strip stock of various different sections, for instance various different widths and thicknesses.

In accordance with the invention, the nylon material, for instance polyhexamethylene adipamide, is heated above its melting point and is continuously fed, in molten condition, to the entrance nip of a pair of rolls maintained at a temperature appreciably below the solidification point, whereby to substantially concurrently solidify and roll the molten material.

How the invention is carried into practice and how the foregoing objects and advantages are obtained will appear more clearly from the following description referring to the accompanying drawing, in which:

Figure 1 is a somewhat diagrammatic, vertical, sectional view through equipment arranged for carrying out the present invention;

Figure 2 is a top plan view of the equipment shown in Figure 1; and

Figure 3 is a view illustrating a modification of one feature.

As seen in Figures 1 and 2, the equipment includes a screw feeder comprising a casing 4 having a screw 5 arranged in the cavity thereof, one end of the screw shaft, as indicated at 6, projecting from the end of the casing for association with drive mechanism. The nylon, in flake or

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granular form, is introduced into the feeder through the funnel 7, and as the material is advanced by the screw 5 it is heated to a temperature above its melting point by any appropriate source of heat, such as the inset electrical heating coils 8.

The molten nylon is discharged through a nozzle 9, the discharge end of which is located in close proximity to the entrance nip of a pair of rolls 10—11 which are adapted to be mounted by means of supporting shafts 12—13. Shaft 12 is adapted to be driven by a gear 14 associated with any suitable power source, and the two shafts are geared to rotate together by means of gearing 15. The rolls 10—11 may either be cylindrical or grooved or otherwise shaped so as to produce either flat strip stock or strip stock of shaped section.

Attention is now called to the fact that the rolls 10—11 are mounted within a tank 16, which tank is adapted to contain a cooling liquid such as water, for instance up to the level W, as shown in Figure 1.

The strip of nylon indicated by the letter S, passes downwardly in the tank 16 from the rolls 10—11 and under the guide roll 17, and thence in an inclined path to another guide 18, and finally out of the tank to a pair of rolls 19—19, which latter are preferably driven so as to maintain some slight tension on the strip S. The pressure of interengagement and the coefficient of friction of the rolls 19—19 are preferably such as to provide for slight tensioning of the strip stock, while permitting slippage, due to the coefficient of friction and pressure of interengagement.

The guide arrangement 18 may either comprise a non-rotatable guide bar or a rotatable member, as desired. This is also true of the guide roll 17.

The tank 16 is adapted to be supplied with the water or other cooling liquid through a supply connection 20 and the tank is provided with an overflow pipe 21. The overflow or outlet is desirably arranged to provide for regulation of the water level maintained in the tank. As an example of one simple expedient for this purpose, the overflow pipe as shown in the drawing, comprises an elbow of fairly large diameter, which may be twisted to lower or raise the discharge end thereof, and thereby establish a lower or higher water level in the tank.

It is also pointed out that the invention contemplates adjustment of the space between the rolls 10—11. This may be done by providing a

movable support for shaft 13 on which roll 11 is carried. An appropriate range of adjustment may be secured in this way, notwithstanding the intermeshing gearing 15, since the gear teeth will still function even if the depth of interengagement thereof is varied somewhat.

In operation, the flake or granular nylon is continuously fed into the hopper funnel 7 and as this material is advanced by the screw 5 it is heated to the molten condition and then is fed through the nozzle 9 for discharge to the rolls 10—11.

The cross-sectional shape of the discharge orifice of nozzle 9 may be circular, especially in the case of production of strip stock of which the thickness is relatively great as compared with the width. On the other hand, in the case of production of strip stock of relatively great width as compared with the thickness thereof, a discharge orifice of somewhat elongated cross-section is preferred, for instance as indicated at 9*a* in Figure 3, in which case it is positioned with its major axis paralleling the the axes of the rolls.

It is of importance that the discharge orifice of the nozzle 9 be located in close proximity to the rolls 10—11 so that the nylon is delivered to the rolls while still in molten condition. The close proximity of the discharge orifice of the nozzle is also of importance in minimizing exposure of the nylon to the surrounding air while in molten condition. With the rolls at a temperature well below the solidification point of the nylon, the molten material is substantially concurrently solidified and rolled to the desired strip stock section. The temperature of the molten material delivered to the rolls, the temperature at which the rolls are maintained, and the speed of operation are desirably such that the strip stock is completely solidified as it is delivered from the rolls. In this way the rolls act to perform their "rolling" function at the time the material is actually changing from the molten to the solid state.

With respect to the manner of cooling the rolls and maintaining the temperature thereof at the desired point, it is mentioned that this may be achieved in a variety of ways, although the employment of a water bath is exceedingly simple and therefore very practical. I have achieved particularly effective results in an arrangement as illustrated, with the water level maintained at or close to the level of the axes of rotation of the rolls 10—11. With a water supply of approximately uniform temperature, the temperature of the rolls may be regulated either by regulating the level maintained in the tank or by regulating the speed of circulation. The temperature of the molten nylon and also the speed of operation of the equipment will likewise influence the temperature at which the rolls are maintained, and the several variables above mentioned should all be regulated so that the nylon is completely solidified as it passes through the rolls.

With still further reference to the cooling of the feed rolls 10—11, it is mentioned that I have found that under certain conditions of operation, even air cooling will suffice, in which event the water bath 16 may be completely dispensed with. For most conditions of operation, however, I prefer the employment of a liquid cooling bath for a number of reasons, including the fact that a lower roll temperature is more conveniently provided in this way and the further fact that uniformity of roll temperature may more readily be maintained.

In connection with the matter of temperatures (both of the molten nylon and of the rolls 10—11), several factors should be kept in mind, as follows:

First note that various of the nylon materials, for example polyhexamethylene adipamide, have solidification or freezing points substantially below the melting points thereof. In the case of polyhexamethylene adipamide, the melting point lies quite sharply at about 508° F., whereas the freezing point lies at about 473° F. To ensure complete melting of all parts of the material, this particular polyamide should be heated somewhat above 508° F., for instance from about 515° F. to about 550° F. Moreover, with this particular nylon material, the temperature of rolls 10—11 should be well below 473° F., for instance from about 150° F. to about 350° F. Since the freezing point (473° F.) is well below the melting point, the temperature may be allowed to drop somewhat prior to discharge from the nozzle 9. Indeed I have secured particularly effective results by effecting discharge of the nylon from the nozzle at a temperature below the melting point but above the freezing point.

With any of the high molecular weight synthetic linear polyamides, the temperature of the molten material fed to the rolls is preferably at least 10° F. above the freezing point of the particular polyamide, and the temperature of the rolls 10—11 is preferably at least 100° F. below the freezing point of the particular polyamide.

As illustrative of the method, I have produced strip stock (about 1½" in width and .020" in thickness) from polyhexamethylene adipamide with rolls of 2.78" diameter water cooled to various temperatures ranging from 150° F. to 180° F. I have made similar strip stock with the rolls merely air cooled and operating at temperatures ranging up to 340° F.

It is of particular advantage that the roll temperature need not be maintained at a critical value, uniform results being obtainable over quite a broad range of roll temperatures. Indeed, I have found that strip stock of highly uniform gauge may readily be made even with substantial variations of roll temperature and even with substantial variations in the temperature of the molten material delivered to the rolls.

The strip stock made according to the invention is characterized by exceptional freedom from porosity, voids or other flaws. In considering one important reason for this, it should be kept in mind that bubbles tend to develop in molten nylon materials, especially at temperatures appreciably above the melting point. The action of the rolls, however, tends to rid the material of bubbles by driving them to the edges of the strip stock being formed. In cases where the margins or edge portions of the strip have excessive porosity, or are otherwise non-uniform, they should be trimmed off.

In addition to polyhexamethylene adipamide, other similar nylon materials may be used in the practice of the invention, for instance polyhexamethylene sebacamide or any other similar high molecular weight synthetic linear polyamide having the characteristics of sharp melting point and relatively low viscosity in the molten condition.

I claim:

1. A method for forming strip stock from synthetic linear polyamides, which method comprises feeding the polyamide in solid particle form into a screw feed device, continuously moving said

polyamide through said device, heating said device to melt the polyamide in said device while the polyamide is being advanced therein and thereby provide for delivery of a stream of molten polyamide from the screw feed device, and directing said stream of molten polyamide to the entrance nip of a pair of rotative forming rolls maintained at a temperature below the freezing point of the polyamide to effect formation and solidification of the strip, the rate of melting of the polyamide in the screw feed device being substantially the same as the rate of feed of the molten polyamide to the entrance nip of the forming rolls.

2. A method according to claim 1 in which the stream of molten polyamide delivered to the forming rolls is of elongated cross section with the long axis thereof paralleling the axes of the rolls.

3. A method according to claim 1 and further including the step of slitting a finished strip from the area intermediate the edge portions of the strip delivered from the forming rolls.

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