Aug. 27, 1963 A. J. ROSENSTEIN ETAL 3,101,521

METHOD OF PRODUCING CRIMPED CONTINUOUS FILAMENT YARN

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FIG. 1.

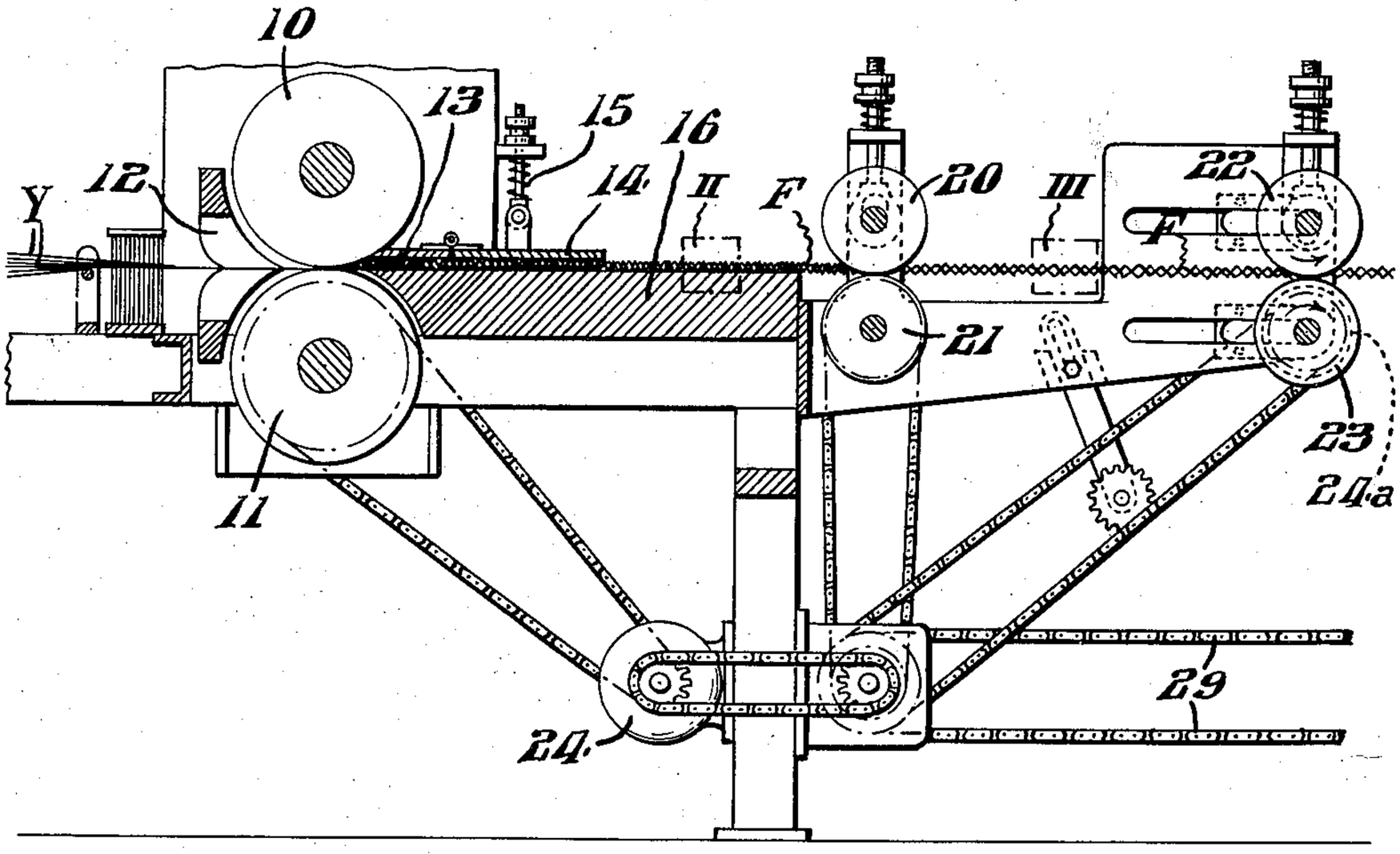


FIG. 2.

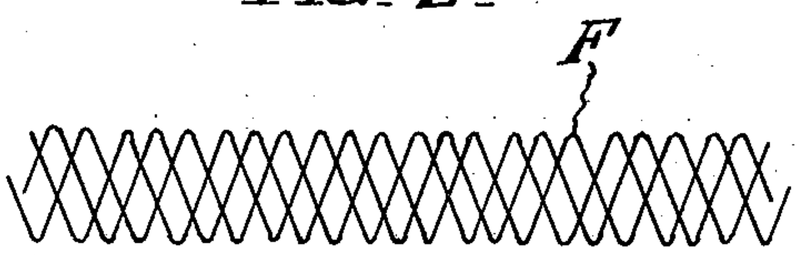


FIG. 3.

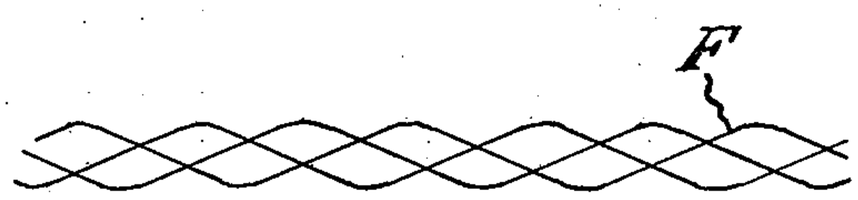
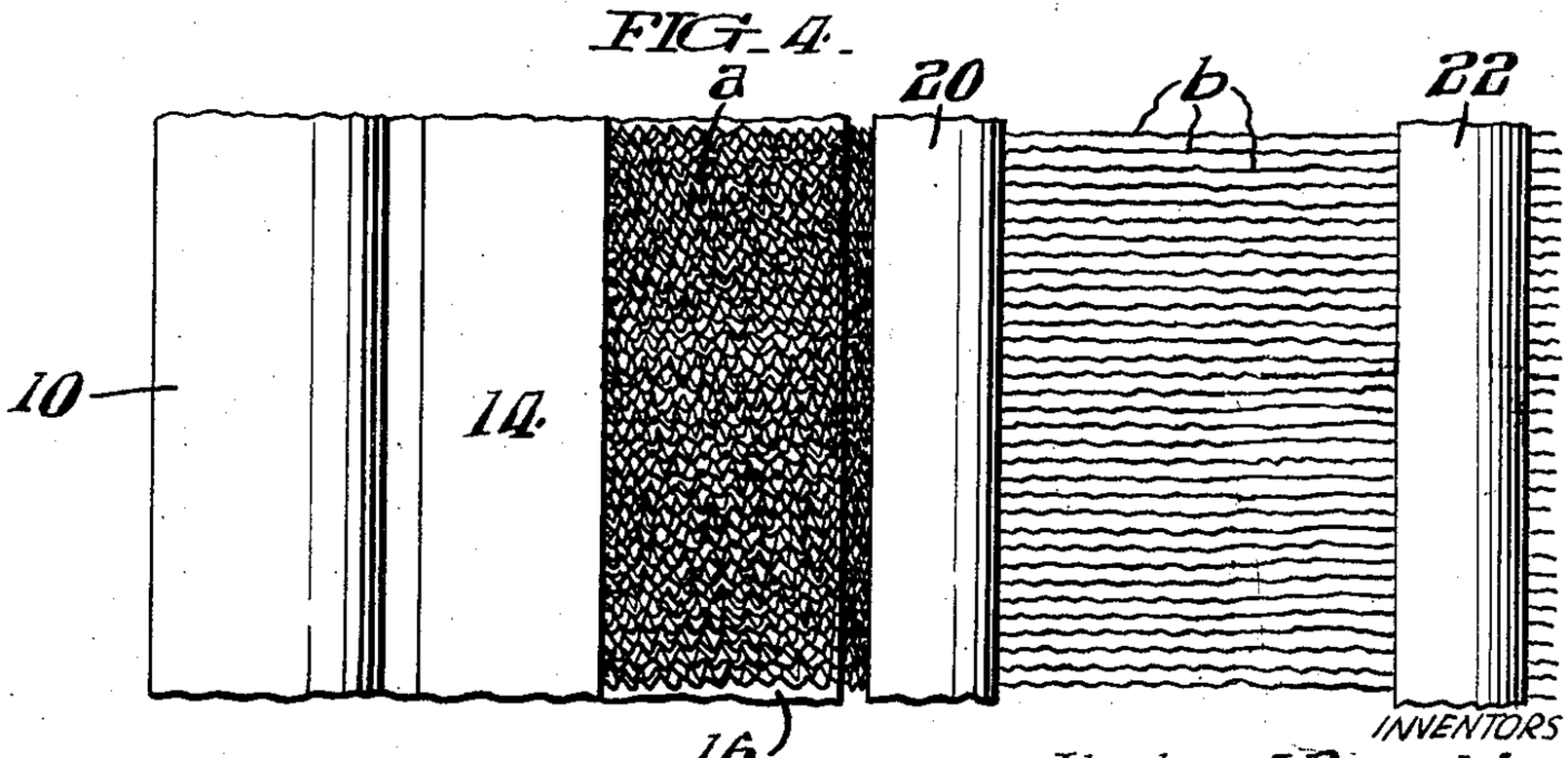


FIG. 4.



INVENTORS
Abraham J. Rosenstein,
Nathan Rosenstein & Thomas F. Suggs,
BY Paul & Paul
ATTORNEYS.

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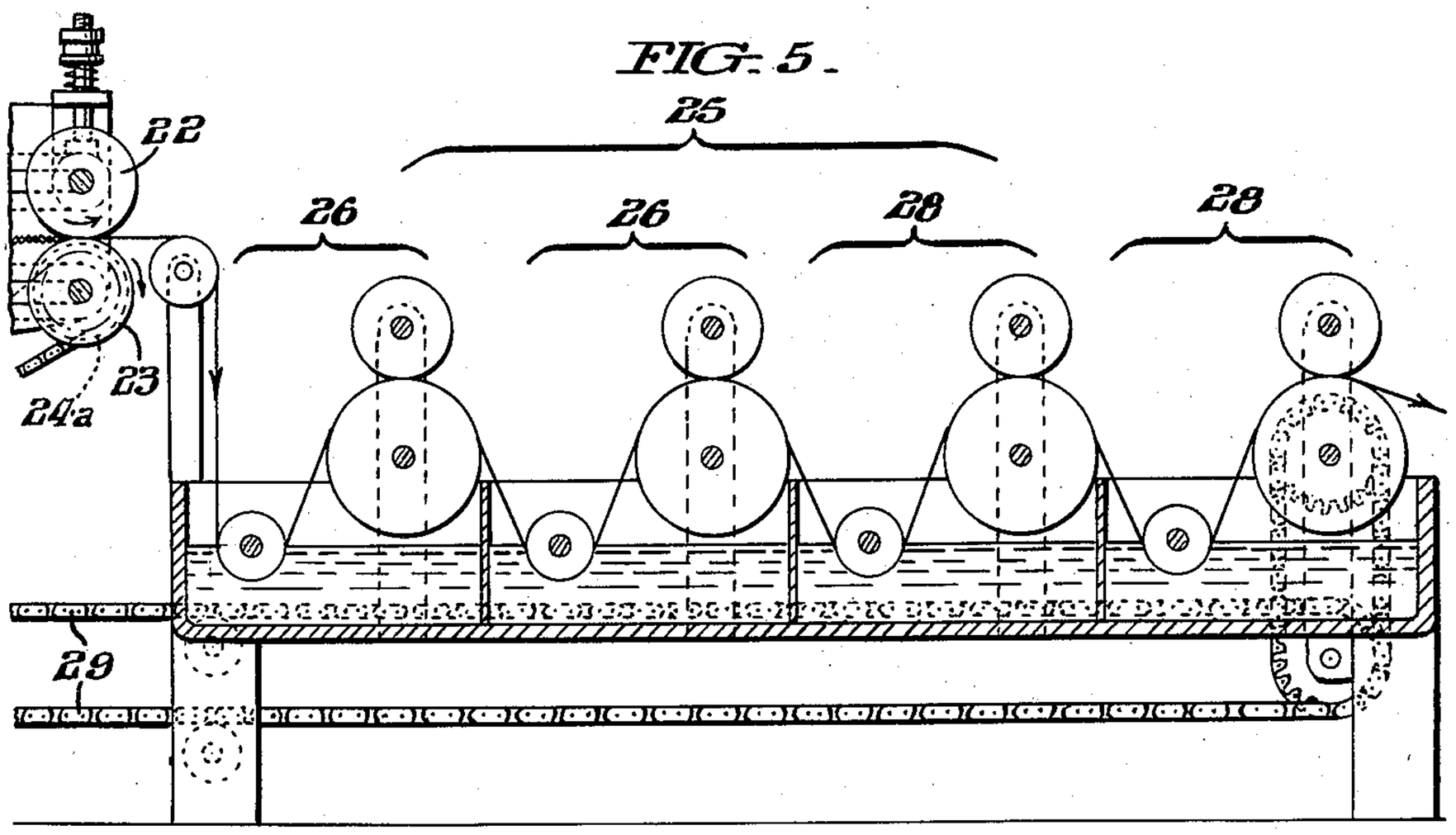
FIG. 5.



INVENTORS.
Abraham J. Rosenstein,
Nathan Rosenstein & Thomas F. Suggs,
BY Paul & Paul
ATTORNEYS.

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METHOD OF PRODUCING CRIMPED CONTINUOUS FILAMENT YARN

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FIG. 6.

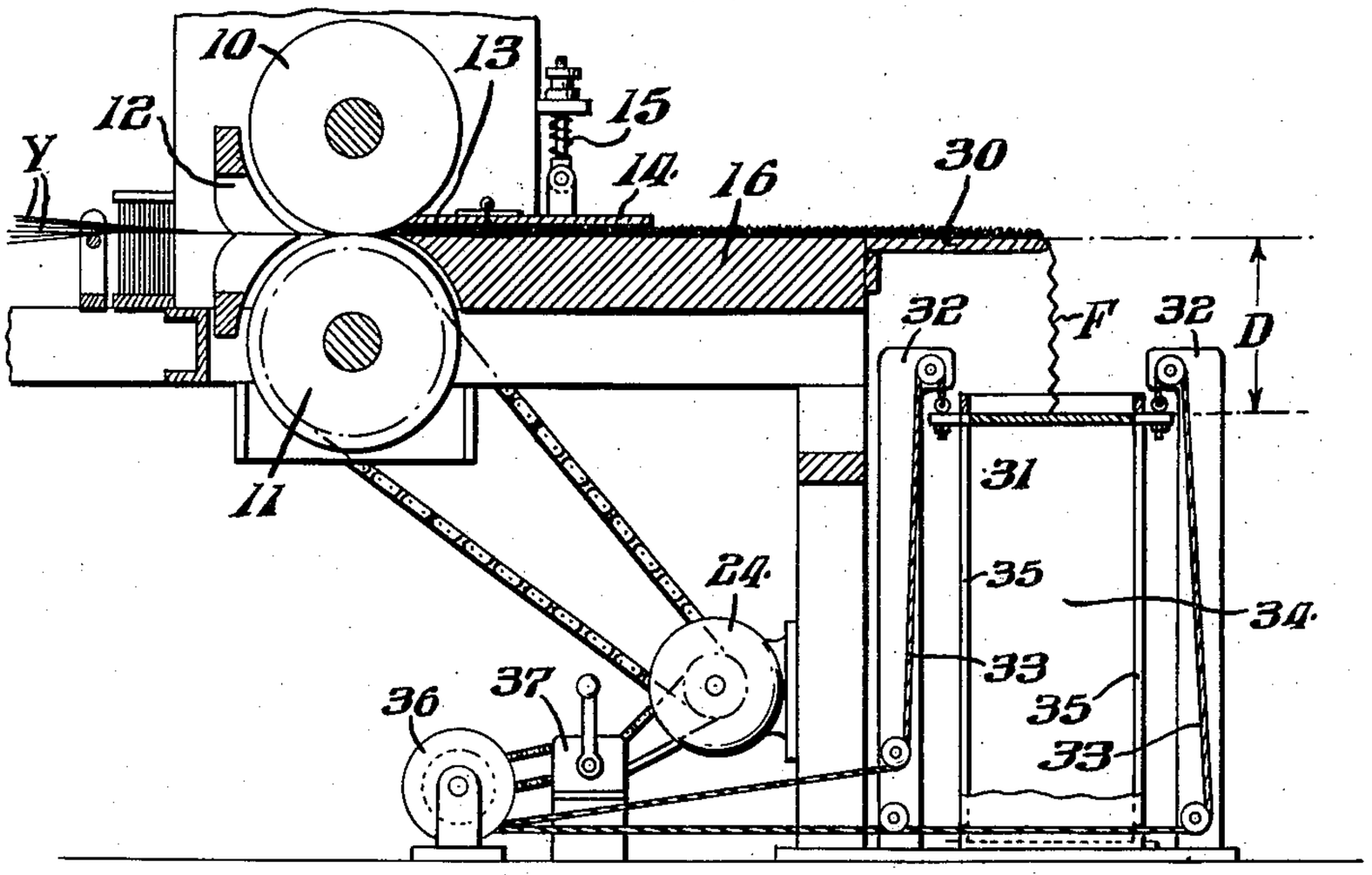
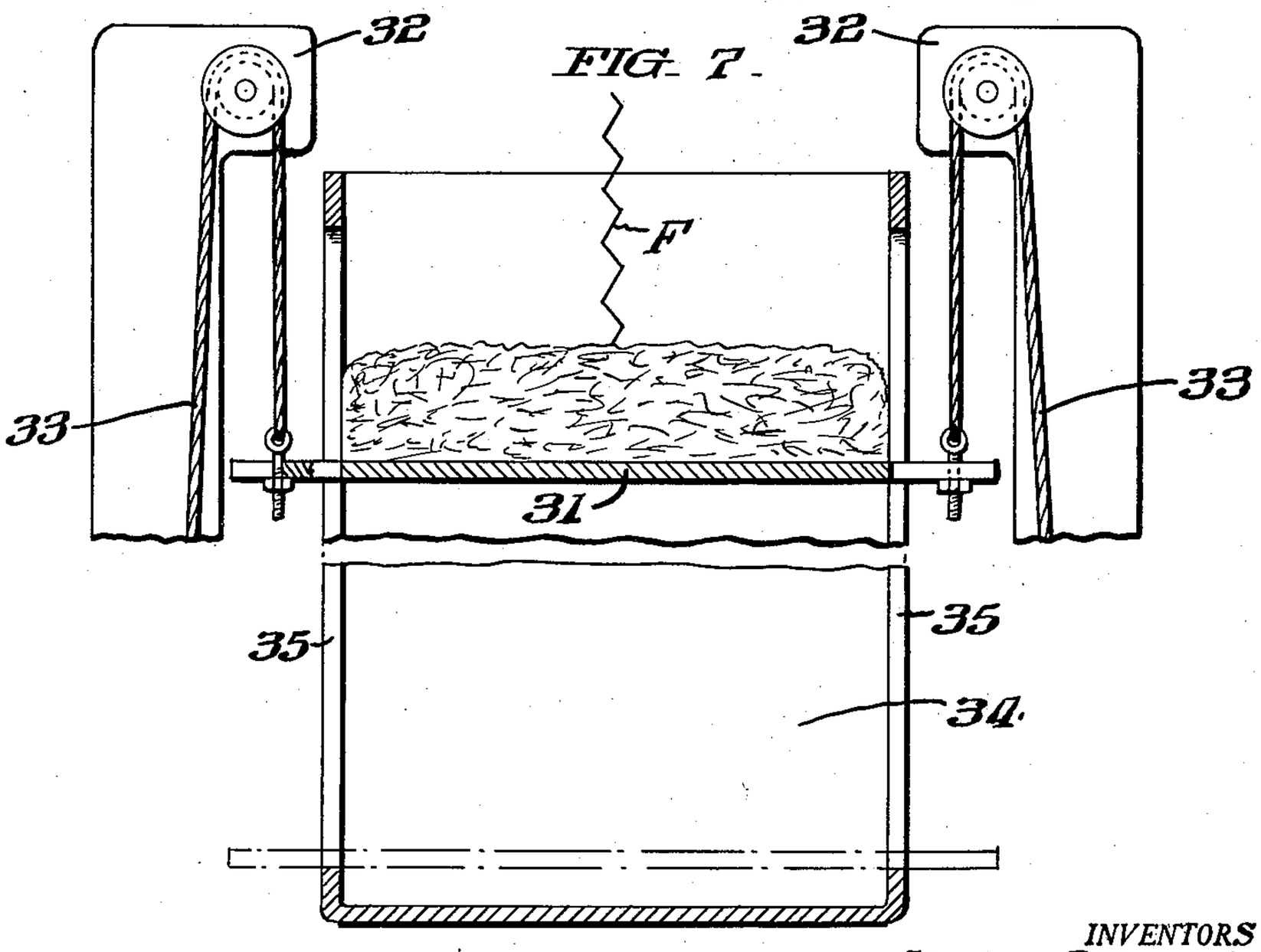


FIG. 7.



INVENTORS.
Abraham J. Rosenstein
Nathan Rosenstein & Thomas F. Suggs,
BY Paul & Paul
ATTORNEYS.

United States Patent Office

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METHOD OF PRODUCING CRIMPED CONTINUOUS FILAMENT YARN

Abraham J. Rosenstein, New Marlboro, Mass., Nathan Rosenstein, West Hartford, Conn., and Thomas F. Suggs, Gastonia, N.C., assignors to Spunize Co. of America, Inc., Unionville, Conn., a corporation of Connecticut

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10 Claims. (Cl. 28—72)

This invention relates to an apparatus and method for producing crimped continuous filament yarn (mono- or multi-filament) and particularly relates to the production of crimped continuous filament yarn having zig-zag multi-planar or uni-planar crimps which are arranged at a relatively low crimp angle. More specifically, this invention relates to an apparatus and method for producing crimped continuous filament yarn wherein the filaments of the yarn are crimped at an angle of about 180° and are then drawn out to a controllably limited degree in order to produce a product which retains a lower degree of crimp so as to afford greater dimensional stability.

In the patent to Rosenstein et al., No. 2,719,309, there is disclosed a method of making crimped continuous filament yarn wherein a continuous resin filament yarn is fed between smooth rolls into a crimping chamber having a restricted exit. The rotataion of the rolls feeds the continuous filament yarn into the chamber, folding the yarn over upon itself producing a series of crimps wherein the yarn is crimped at an angle of approximately 180° to its longitudinal axis.

Heretofore, in practicing the invention of the aforementioned Rosenstein et al. Patent No. 2,719,309, the yarn produced by the crimper was desirably subjected to heat after it emerged from the crimper, thereby setting the crimp. The heat setting operation was found to have many advantages, among which was the high crimp retention of the product, which gave it a very substantial amount of bulk and loftiness.

It has now been found that, for many purposes, it is desirable to produce a crimped continuous filament yarn having a degree of crimp which is less than that produced in accordance with the aforementioned Rosenstein et al. patent, but having a degree of crimp which may be critically limited and controlled. Continuous filament yarn having a lesser but controlled degree of crimp is useful in and of itself, and is further useful in combination with highly crimped yarns of other types, or in combination with one or more other yarns.

Although the invention is highly advantageous for the preparation of crimped synthetic polymer continuous filament yarns such as nylon, "Dacron," "Orlon," "Acrilan," rayon, the cellulosic fibers and the like, it is similarly applicable to a wide variety of other synthetic fibers.

It is accordingly an object of this invention to provide a novel apparatus and method for preparing crimped continuous filament yarn which has a lesser degree of crimp than the yarn produced in accordance with the Rosenstein et al. U.S. Patent No. 2,719,309, but which yarns have a controlled degree of crimp and greater dimensional stability.

Another object of this invention is to provide a method and apparatus for producing continuous filament yarns having a very substantial number of crimps per inch, but having a lesser degree of crimp than yarns which have been crimped in accordance with the aforementioned U.S. patent.

Still another object of this invention is to provide a novel means for manufacturing a crimped continuous filament yarn which has a series of zig-zag crimps, all arranged at multi-plane angles to one another, wherein the

degree of such crimp and the magnitude of such angle is substantially controlled.

Another object and advantage of this invention is to provide a crimped continuous filament yarn having a relatively low degree of crimp, which can be dyed more readily and efficiently.

Other objects and advantages of this invention, including the simplicity and economy of the same and the ease with which the degree of crimp may be accurately controlled will further become apparent hereinafter and in the drawings whereof:

FIG. 1 is a view in side elevation, with parts shown in section, of an apparatus for producing crimped continuous filament yarn in accordance with one form of this invention.

FIG. 2 is an enlarged schematic view showing a relatively sharply crimped continuous filament yarn produced in one stage of the process.

FIG. 3 is a schematic view similar to FIG. 2, showing the crimped continuous filament yarn after it has been subjected to a uniform tension.

FIG. 4 is a partial-plan view of the apparatus appearing in FIG. 1, illustrating how the crimped web of yarn is drawn out in accordance with this invention.

FIG. 5 is a schematic view in side elevation showing an apparatus for combined drawing-out and continuous dyeing of continuous filament yarn.

FIG. 6 is a view in side elevation, with parts shown in section, showing an alternate form of the invention and FIG. 7 is an enlarged view of a portion of the apparatus shown in FIG. 6.

The specific forms of the invention shown in the drawings are not intended to define or to limit the scope of the invention, and should be taken as illustrations of preferred forms thereof. Similarly, the following description relates to the specific forms of the invention as shown in the drawings, and does not limit the scope of the invention which is defined in the appended claims.

Turning now to FIGS. 1–3, the numbers **10**, **11** designate matching rollers, the axes of which are urged toward one another thereby forming a nip. A feeding device **12** is provided for feeding multiple continuous filament yarns Y into the nip between the rolls **10**, **11**.

The number **13** designates a chamber which confines the yarn Y after it has passed between the rolls **10**, **11**. An exit door **14** is provided which is urged by the spring **15** toward a table **16**. This maintains the yarn Y compressed when it is within the chamber **13**, thereby causing the yarns to bend upon themselves and to be crimped at an angle of substantially 180°. The internal pressure formed within the chamber **13** continuously forces the resulting crimped yarn out past the door **14** onto the table **16**. At that location, the yarn has a rather high crimp such as the crimp appearing in FIG. 2.

The numbers **20**, **21** designate further rolls which are urged against one another and which form a nip for the crimped yarn coming from the table **16**. Spaced apart from the rolls **20**, **21** is another set of rolls **22**, **23**, between which the fibers also pass. As will be apparent in FIG. 1, a motor **24** operates through chains and sprockets to drive the rolls **11** and **21** and also through a slip clutch **24**(*a*) to drive the roll **23**. The gear ratios of the sprockets are such that the roll **23** is rotated at a greater peripheral velocity than the roll **21**, thereby causing a limited but controlled uniform tension to be applied to the fibers which are between the rolls **21** and **23**. This tension draws out the fibers F, producing a crimp of lesser angle, such as the crimp appearing in FIG. 3.

The rolls **22**, **23** are preferably mounted on a slotted support so that they are adjustable toward and away from the rolls **20**, **21**.

The product from rolls 22, 23 is led to any suitable device such as a quiller, twister, skeiner or coner, for example, or even a continuous dye machine as hereinafter described.

FIG. 4 shows how the limited degree of tension modifies the crimped web to advantage. After crimping, the web consists of filaments that are interlocked, providing a mass (*a*) wherein the individual filaments are attached to adjacent filaments. After limited tension has been applied, the individual filaments are separated as indicated at (*b*) in FIG. 4.

FIG. 5 shows a novel and advantageous apparatus and process wherein the web, crimped and drawn out as in FIG. 1, is passed directly from the rolls 22, 23 into a continuous dyeing machine generally designated 25. The details of the continuous dyeing machine are themselves not a part of this invention, and may be widely varied. The dyeing machine as shown has, for example, two dyeing sections 26, wherein the drawn-out filaments are concurrently dyed and heat-set, and two wash sections 28. Other treating sections may be used if desired. The drive 29 for the dyeing machine 25 is preferably interconnected with or at least driven in timed relation with the drive motor 24 of the crimper and the rolls 22, 23. Preferably all the rolls of the dyeing machine, and the roll or rolls ahead of it, are dependently driven in order to avoid additional tensioning of the yarn. On the other hand, the rolls 22, 23 may themselves be incorporated into the dye bath so that the dye bath itself provides the tension to draw out the crimp.

Turning to FIGS. 6 and 7, table 16 has an extension 30 having a rounded end over which the crimped yarn continuously passes. Located at a predetermined distance D beneath the end of the extension 30 is a substantially horizontal plate 31 which is suspended from a pair of side bars 32 by means of cables 33, 33. The number 34 designates a container having slots 35, 35 through which portions of the plate 31 extend. Accordingly, the plate 31 has capacity to move up and down in the container 34. The cables 33, 33 are wound around a capstan 36 which is selectively reversibly driven from power source 24 through a change gear mechanism 37, in order to cause the plate 31 to move downwardly at a controlled speed that is related definitely to the bulk of the fiber F, and both such factors are related in a manner to provide a yarn length which draws itself out by the action of gravity alone.

In operation, the apparatus of FIGS. 6 and 7 produces a highly crimped yarn as in FIG. 1, before it passes between rolls 20 and 21, and the yarn utilizes its own weight in order to draw out the crimp by applying tension which is caused by gravity alone. The distance D in FIG. 6 is maintained substantially constant by the capstan 36 which gradually lowers the plate 31 as the container 34 is gradually filled with crimped yarn. When the plate 31 is on the bottom of the container 34, the container itself is full of crimped yarn having a carefully controlled degree of crimp, at a much lesser crimp angle that the crimp angle of the fibers produced at the crimping chamber itself. In order to remove the container full of crimped yarn, the entire container 34 together with the plate 31 at the bottom thereof is removed.

Preferably, the crimped continuous filament yarn as produced in accordance with FIGS. 1–4, 6 and 7 is subjected to a heat-setting operation for the purpose of retaining the residual crimp. The heat-setting may be accomplished in a variety of ways, as by subjecting the yarn continuously to infrared or other heat, or by heat-setting in batch style in a steam chest, or the like. However it is highly preferred in accordance with this invention to set the residual crimp by subjecting the yarn to a simultaneous dyeing and heat-setting operation, wherein hot aqueous dye is provided, and wherein the crimped yarn is maintained immersed in such hot dye for a predetermined period of time and at a heat-setting temperature.

The yarn may also be formed into a fabric before heat-setting, and then heat-set or dyed.

Accordingly it will be appreciated that continuous filament yarn may be crimped utilizing the aforementioned Rosenstein crimping process, without any heat-setting, after which the crimped product is then intentionally drawn out or subjected to limited and controlled tension in order to provide a predetermined lesser degree of crimp.

It is important to emphasize, however, that it is not necessary in every case to provide an ultimate heat-setting step. The continuous filament yarn, without any heat-setting but after the crimp is partially drawn out, can be fabricated directly into a fabric or other material, either by itself or in combination with one or more other yarns. The continuous dyeing method ordinarily provides much less heat-setting than pressure dyeing at higher temperatures, for example, and either form may be used.

It is important and advantageous that the degree of crimp retention is subject to continuous and accurate control throughout the crimping and drawing out process. The degree of crimp retention may be maintained at a substantially uniform value as the yarns or fibers pass continuously through the crimping and drawing out operation.

It will be appreciated that the means for partially drawing out the crimp may be modified in a wide variety of ways, depending upon the extent to which the tension is to be limited, the nature of the crimped filaments and many other variables. For example, the rolls 22 and 23 could be replaced by a single drum with the crimped web wound spirally around it and with the drum controllably rotated or even idled in order to provide a very small tension which greatly limits the extent to which the crimp is drawn out.

The products which result from the proces of this invention may readily be utilized for the production of textile fabrics, by knitting, weaving and other fabricating operations, or even by the formation of non-woven textiles. They may be used alone or in combination with other yarns for the production of a wide variety of textile fabrics including hosiery, sweaters, rugs, carpets and the like.

Although this invention has been described with reference to specific forms and embodiments, it will be appreciated that many changes may be made without departing from the scope of the invention. For example, equivalent elements and method steps may be substituted for those specifically described, parts and method steps may be reversed, and certain features may be used independently of other features, all without departing from the spirit or scope of this invention as defined in the appended claims.

Having thus described our invention, we claim:

1. In a method of forming crimped continuous filament yarn, the steps which comprise crimping at least one filament of said yarn without heat-setting at an angle of approximately 180° to the longitudinal axis of said filament, and thereafter subjecting the crimped yarn to a controlled degree of tension, thereby partially drawing out the crimp initially produced while retaining a predetermined crimp in the yarn of substantially uniform value.

2. The method defined in claim 1, wherein said yarn is monofilament yarn.

3. The method defined in claim 1, wherein said yarn is multifilament yarn.

4. The method defined in claim 1, wherein the tension is applied continuously to the yarn while said yarn is moving, by drawing off the yarn at different speeds at spaced-apart locations.

5. The method defined in claim 1, wherein the tension is applied by gravity.

6. The method defined in claim 5, wherein the tension is applied by continuously extending vertically downwardly a predetermined substantially constant length of the

yarn produced in the crimping step, thereby drawing out the crimp under a substantially constant tension.

7. In a method for forming crimped continuous filament yarn, the steps which comprise bending at least one of said filaments through an angle of approximately 180° and exerting pressure on said filament while so bent, thereby crimping said filament without heat-setting, and thereafter, subjecting the crimped yarn to a controlled degree of tension, thereby partially drawing out crimp initially produced which retaining a predetermined crimp in the yarn of substantially uniform value.

8. In a method of forming crimped continuous filament yarn, the steps which comprise bending said yarn through an angle of approximately 180° and exerting pressure on said yarn while so bent, thereby crimping said yarn without heat-setting, therefater subjecting the crimped yarn to a controlled degree of tension, thereby partially drawing out the crimp initially produced while retaining a predetermined crimp in the yarn of substantially uniform value, and then immersing the resulting yarn in a hot aqueous dye solution maintained at a temperature sufficient to heat-set said yarn.

9. In a method of forming crimped continuous filament yarn, the steps which comprise bending a plurality of said yarns through an angle of approximately 180° to the longitudinal axis thereof without heat-setting, thereby

forming a weblike mass of yarns, thereafter subjecting said crimped yarn to a controlled degree of tension, thereby separating said yarns and partially drawing out the crimp initially produced therein while retaining a predetermined crimp in the yarn of substantiallly uniform value.

10. The method defined in claim 9 wherein is included a further step of immersing the resulting yarn in a hot aqueous dye solution maintained at a temperature sufficient to heat-set said yarn.

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