Nov. 17, 1953 A. L. EWING 2,659,225

APPARATUS FOR ADVANCING AND PROCESSING STRANDS

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Fig. 2.

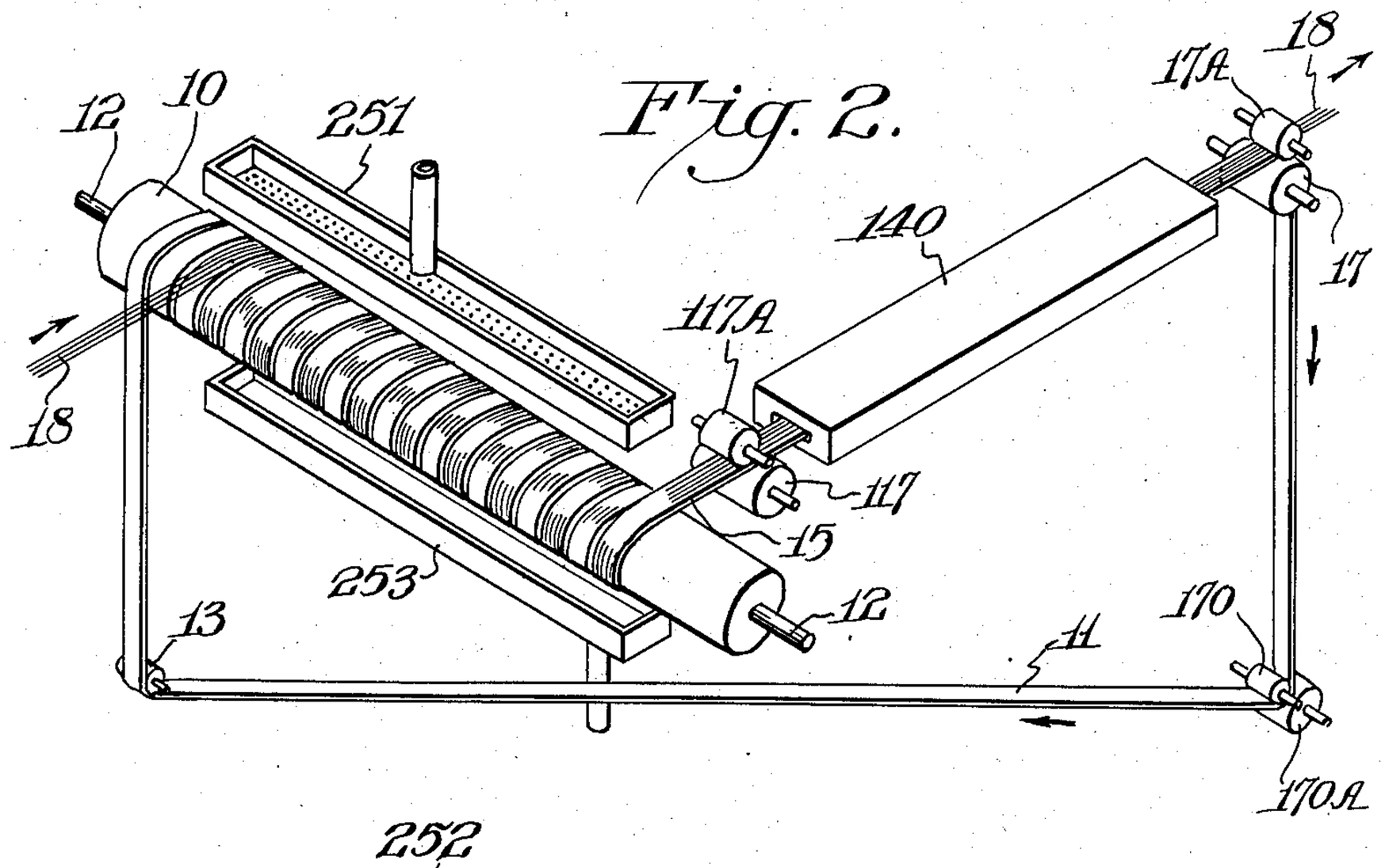
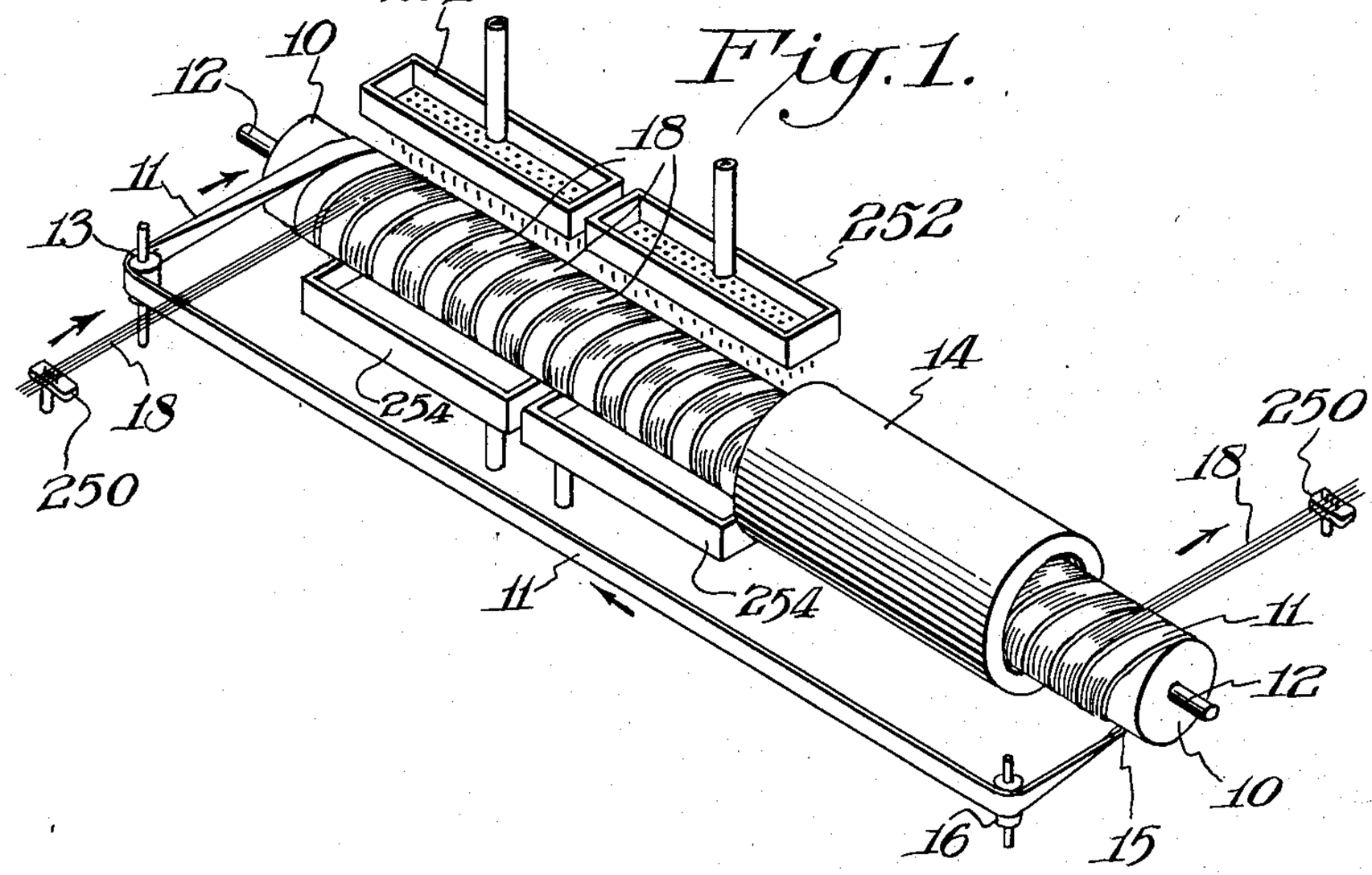


Fig. 1.



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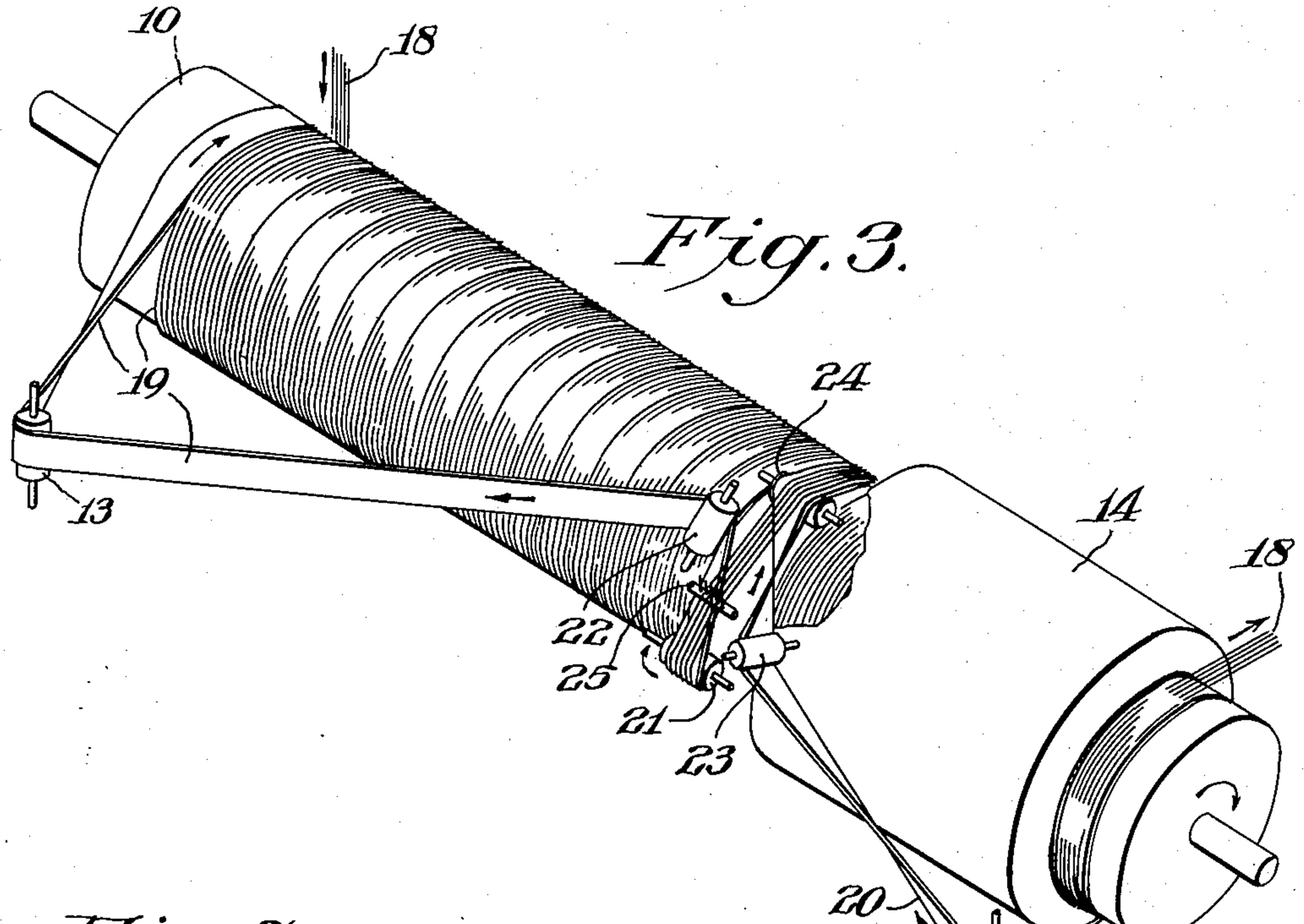

Fig. 3.

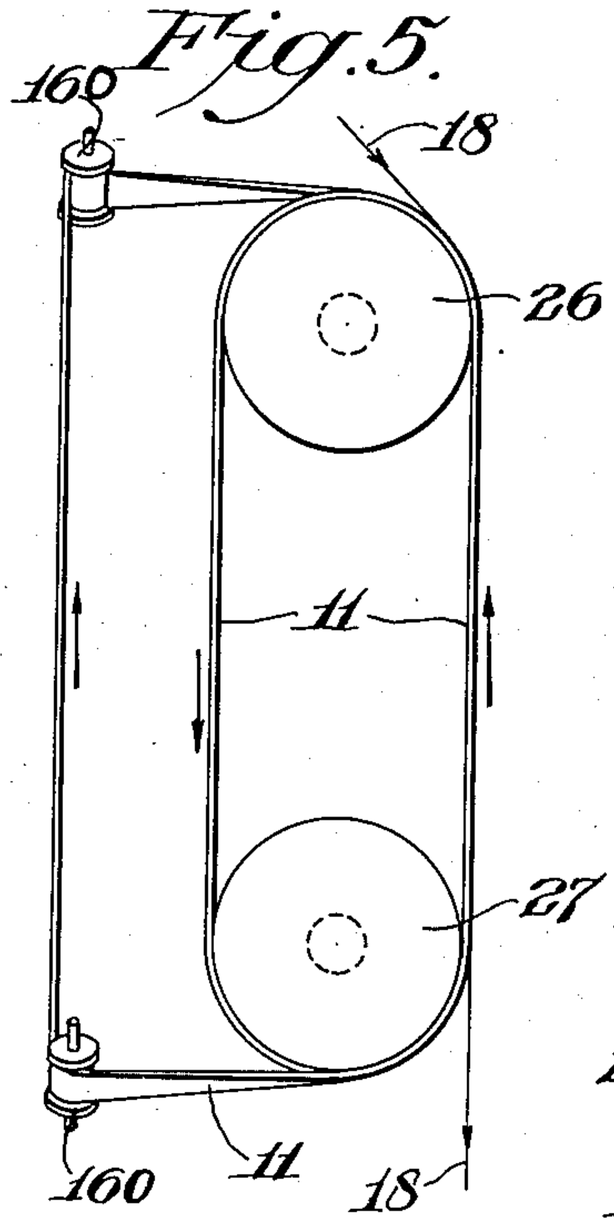

Fig. 5.

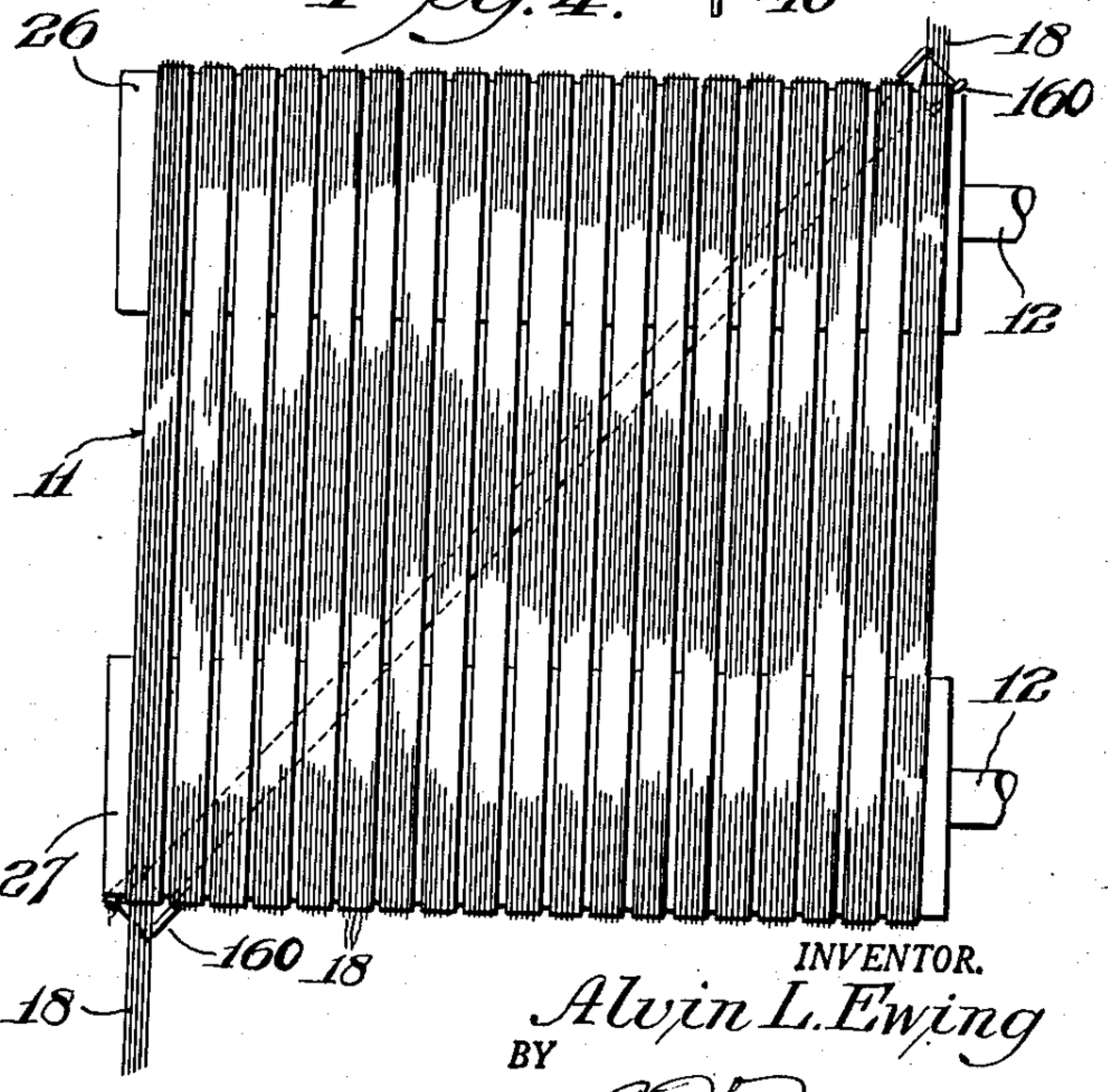

Fig. 4.

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Fig. 6.

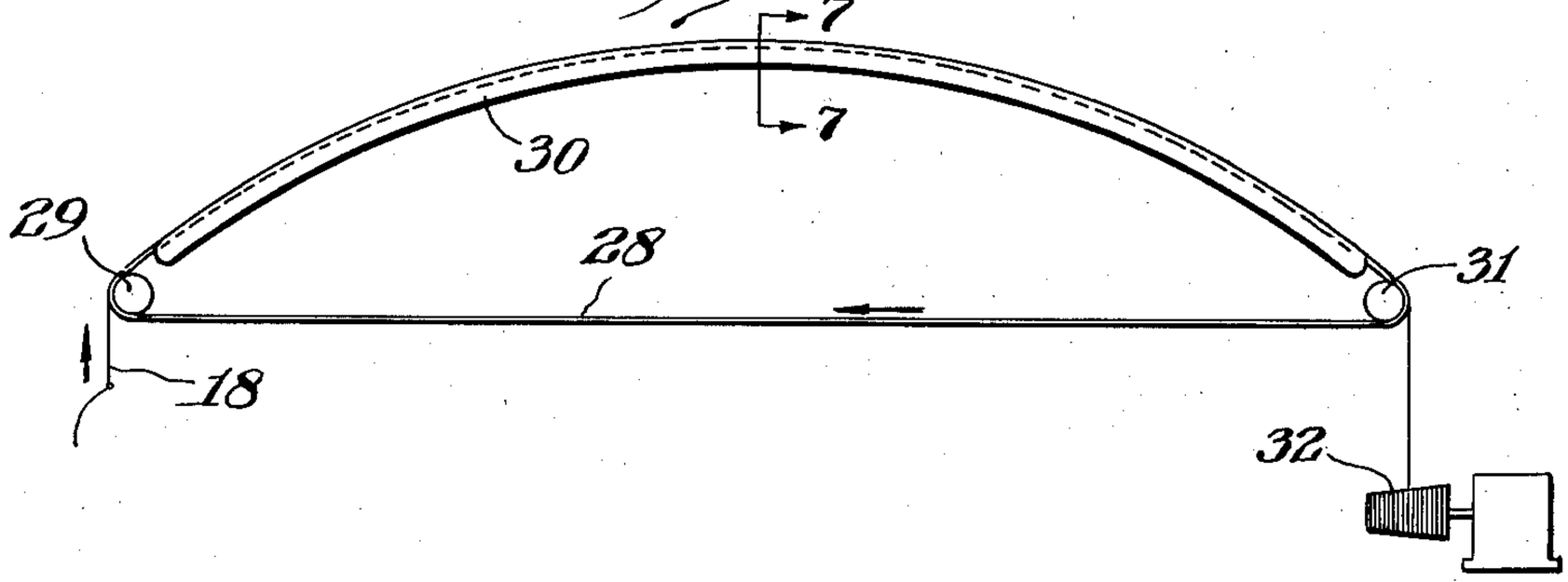

Fig. 7.

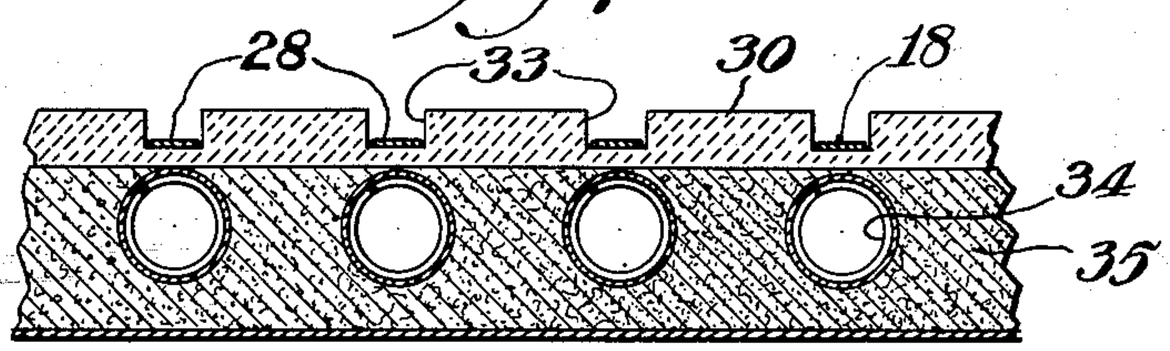

Fig. 8.

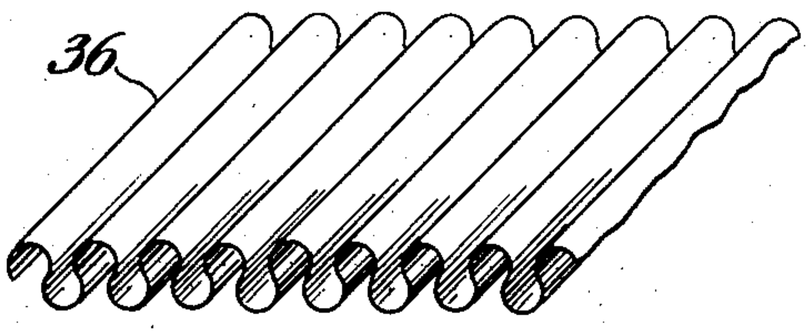

Fig. 9.

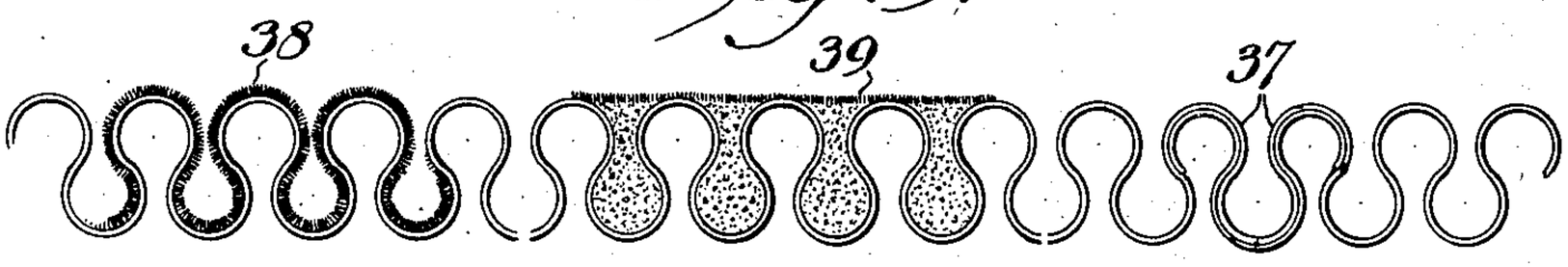

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Fig. 10.

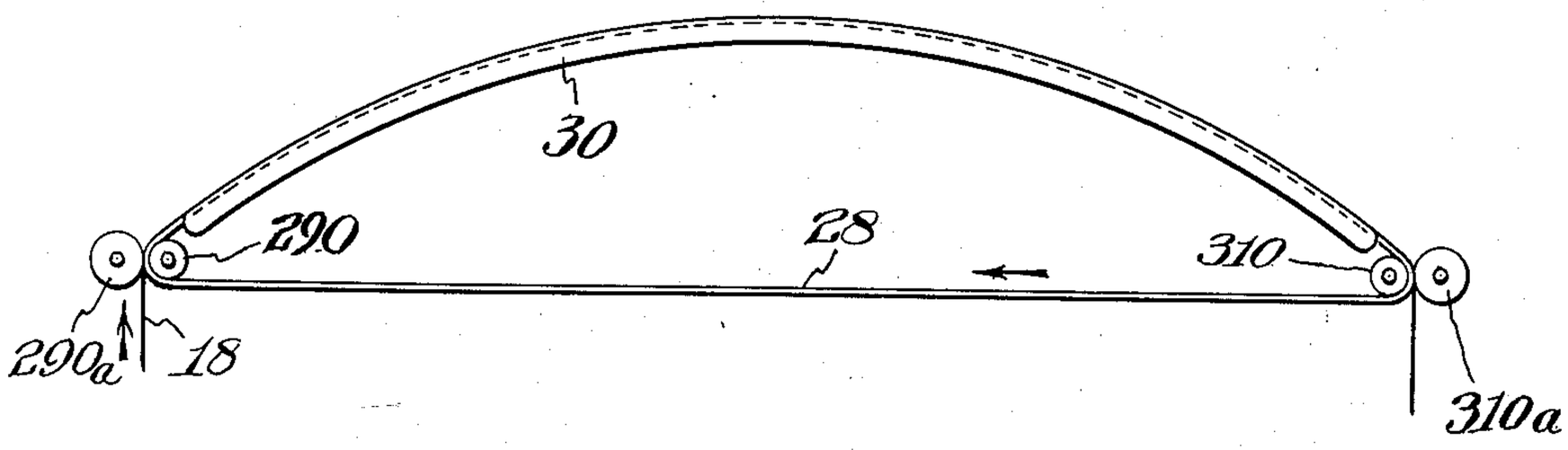
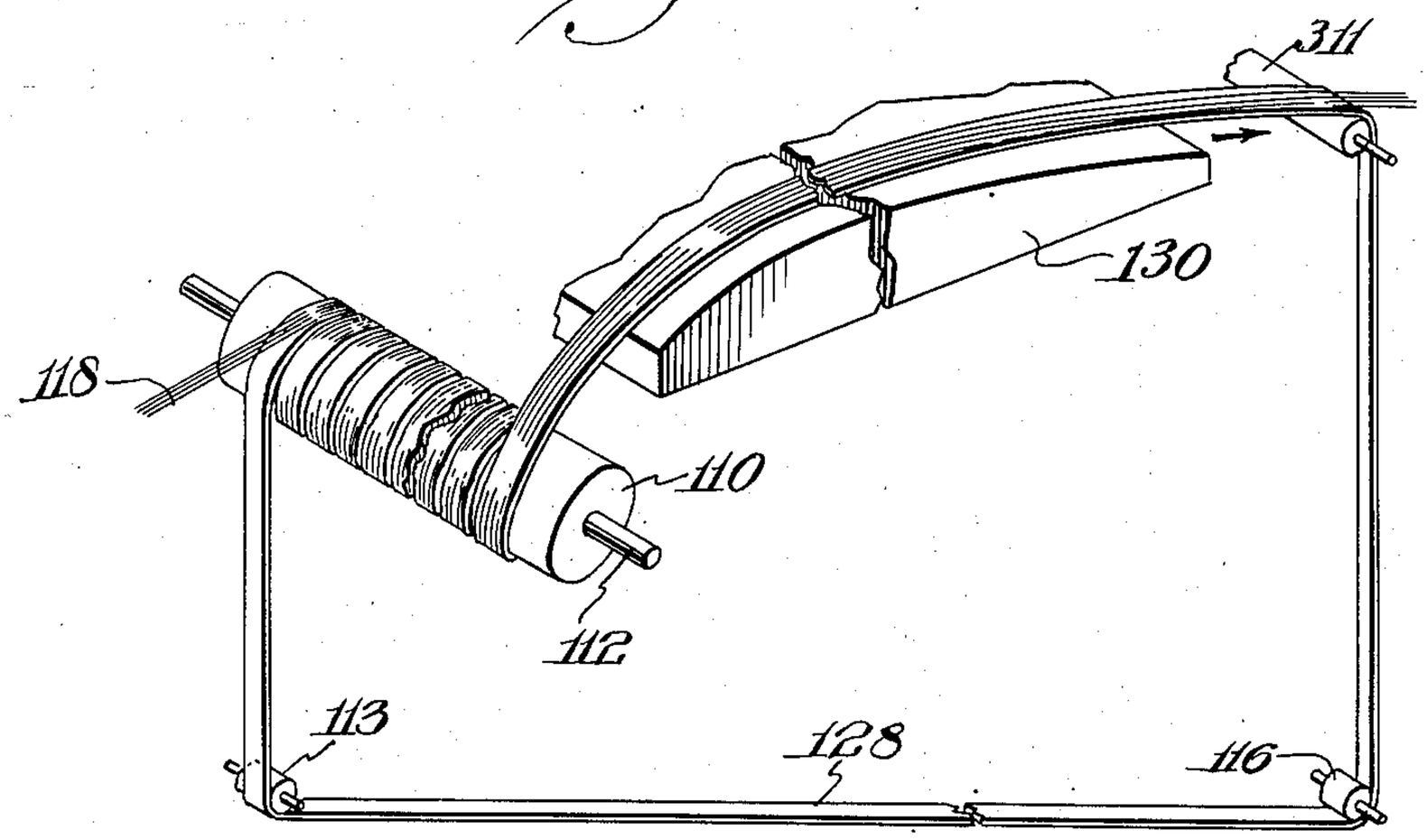


Fig. 11.



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Patented Nov. 17, 1953

2,659,225

UNITED STATES PATENT OFFICE

2,659,225

APPARATUS FOR ADVANCING AND PROCESSING STRANDS

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Application October 9, 1947, Serial No. 778,918

5 Claims. (Cl. 68—19)

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This invention relates to yarn processing apparatus. More particularly, it relates to continuous yarn storing and advancing reels and other advancing mechanisms such as canted or skewed rolls or traveling cylinders and to methods for processing and drying threads in a relaxed state.

Continuously operating yarn storing and advancing reels have been known heretofore, for example, the reels disclosed in United States Patents Nos. 1,938,221 and 2,210,914. Such reels are customarily used in the liquid treatment and drying of yarns in so-called "continuous spinning processes," i. e. continuous operations in which the yarn is spun from filament-forming solutions, subjected to liquid purification treatments, dried and wound in salable packages. The continuously operating yarn storage and advancing reels known heretofore, though commercially adaptable, are not entirely satisfactory in their operation; for example, by reason of rapid wear, non-uniform thread advance, relatively high tension on the yarn, limitation of the length of reels, high investment and maintenance cost, etc. Certain of these disadvantages are also encountered in conventional drying processes. The provision of apparatus and methods for improving yarn quality is a needed advance in the art.

It is, therefore, an object of the present invention to provide improved yarn storing and advancing means which overcome some of the objectionable characteristics of previously known reels.

It is another object of this invention to provide apparatus for yarn storing and advancing which employs reels or advancing means of simple, strong construction, such as canted rolls or traveling cylinders and the like, and which will function to advance yarns smoothly along the length thereof.

It is still another object of the invention to provide an apparatus for yarn storing, advancing and drying which is simple, which functions by moving a yarn spirally about the reel and which permits the advancement, processing and drying of the yarn without the application of objectionable tension and without wear. It is also an object of this invention to provide means whereby yarn can be stored and advanced on a reel so that the yarn is in a relaxed state when being treated with a processing liquid and when so treated is at all times covered with a film of the particular liquid. A further object is the provision of means for drying yarn in a relaxed state.

Other objects will appear hereinafter.

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The above objects are accomplished by first advancing an elastic or expandable, endless strip or belt helically on an advancing reel so that the belt contacts a portion or all of the reel surface as it advances. A plurality of yarns arranged side by side initially under high or low tension as desired, are then laid on the belt surface. These yarns advance from one end of the reel to the other with the belt acting as the direct carrier. The yarns may be either in a relaxed state or under tension during advancement as desired. The belt surface supports a continuous film of applied liquid so that during purification the yarns are at all times covered by a continuous film of liquid and are held in their respective positions on the belt by virtue of their frictional contact with the belt, this contact prevailing throughout the advancement. The yarns after purification are then dried on the same or a similar belt. Relatively free shrinkage of the filaments occurs during purification and drying so that appreciable tension on the yarn does not develop.

The present invention will be more easily understood by reference to the following description when taken in connection with the accompanying illustrations in which:

Figure 1 is an isometric perspective of an advancing means in accordance with this invention;

Figure 2 is an isometric perspective showing slightly different belt travel and yarn advancing, and a modified drying procedure;

Figure 3 is an isometric perspective showing two belts running on the same reel, one carrying the yarn ends through the purification steps and the other through the drying step;

Figure 4 shows the adaptation of the belt to a canted roll;

Figure 5 is an end view of the modified canted roll shown in Figure 4;

Figure 6 indicates the means of adapting the process to a contact dryer;

Figure 7 is a view taken along lines 7—7 of Figure 6;

Figure 8 is an isometric view of a short section of plain corrugated metal belt; and

Figure 9 shows a combination of the expandable metal belt and a material having a pile surface, the method of joining the ends of the belt being indicated.

Figure 10 shows the contact dryer of Figure 6 with squeeze rolls added.

Figure 11 shows in perspective the adaptation

of any of the reels of this invention to use with a contact dryer.

Referring to the figures, reference numeral 10 designates the advancing reel. This may be any reel or advancing mechanism which will advance the belt 11 as shown in the figures. In general, any advancing reel, whether supported at one end only or at both ends, which advances yarn is satisfactory, such reels being described, for example, in U. S. 2,317,747 and 2,287,517. To illustrate, the reel may be constructed with a plurality of sets of parallel yarn carrying rods (not shown), the rods of each set being adapted to move about a separate orbital path, the plurality of sets of rods mounted about a central reel shaft 12 to rotate therewith, all of the rods of the several sets being connected to rod reciprocating means adapted to move the said rods simultaneously in one axial direction while they are in belt carrying contact with a belt positioned about the reel. Such a reel is described in U. S. Patent No. 2,317,747, mentioned above. This invention is not limited to that particular reel, but may be adapted to any reel or other advancing device based on similar or other principles, provided the device will advance a belt spirally in a manner similar to that described herein. The reel may be driven by any convenient means such as by an electric motor (not shown).

The belt 11 is passed around the guiding pin 13 and then to the carrying means of the particular reel used. The advancing belt can be advanced so as to completely cover (Fig. 1) or only partially cover (Fig. 2) the reel. A dryer 14 may be situated around the reel as shown in Figure 1 or it may be located at any point distant from the reel as shown (element 140) in Figure 2. The belt 11 comes off the reel at the take-off point 15 and is directed around the guiding pin 16 and thence to pin 13 and back to the reel. Alternatively, as shown, for example, in Figure 2 or in Figure 6, the belt passes through the dryer 140 or over dryer 30 after leaving the reel. The belt may then pass through squeeze rollers 17 and 17A and then to rollers or pins 16, 13 and reel 10 in that order, as shown in Figure 2. Thus, the belt is endless and is always advancing when the reel 10 is functioning. The pins 13 and 16 may be stationary, idling rollers or power driven rollers as desired. The squeeze roller 17 may or may not be power driven as desired and normally roller 17A is not driven. Generally, roller 17 is power driven by any suitable means (not shown) at speeds somewhat less than the delivery speed from the reel in order to complete the operation with a minimum of tension on the yarns. When the apparatus and process of this invention are employed, it is not necessary to use specially designed reels, such as tapered reels. The filaments are placed on the belt with or without tension and the belt absorbs to an appreciable extent the forces exerted by the advancing reel, thus protecting the filaments from wear and strain.

In Figure 2, additional squeeze rollers 117 and 117A may be situated in front of the dryer 140 also, but are not necessary at that location. Squeezing the wet belt 11 which is carrying wet yarn 18 prior to drying has the advantage of decreasing the dryer load. When the arrangement in Figure 2 is employed, it is desirable to pass the belt 11 and yarn 18 to squeeze rollers after drying to facilitate the separation of the belt and the yarn. The squeeze rollers permit the yarn and belt to be in a relaxed state prior to its passage through the squeeze rollers. The dried yarn is drawn off the belt under a fairly high tension and the squeeze roll prevents this tension from being transmitted to the yarn in the dryer.

The belt 11 is always passed to the reel under tension so that it remains taut on the reel. If a tapered advancing reel, such as that shown in Figure 2, is employed, the tension is first adjusted so that at the end having the smallest diameter the belt is taut on the reel. Thus, if the reel has a 6% taper downward from the acid end through the dryer the belt is discharged at the dryer end at a linear speed 6% less than the speed at which it returns to the reel at the acid end. The belt is then stretched sufficiently to remove slackness between the point of discharge and point of entry on the reel. As described below, the belt has to be sufficiently elastic to permit the stretching. The diameter of the take-off end may be made to approach that of the starting end of the reel. In this way the discharge and feed speeds of the belt are approximately the same and very little or no slippage occurs. If it is not desirable to increase the reel diameter prior to removing the belt, the belt may be passed from the reel to two power-driven nip rolls 170 and 170A rotating at a surface speed equal to the belt speed at the discharge end of the reel. In this way the speed of the belt is held constant and slippage is prevented. The belt being gripped by the nip rolls is suddenly placed under a high tension between the nip rolls and the starting end of the reel because the peripheral speed at the starting end is greater by the percent of reel taper than the peripheral speed of the nip rolls. Since the belt is not carrying yarns, this increase in tension has no adverse effects. These means of preventing slippage are important because their application avoids the development of high tension areas in the yarns.

In Figure 3 a modification is shown whereby the load on the dryer is substantially reduced and undue stress on the advancing mechanism is avoided. Two belts, a purification belt 19 and a drying belt 20, are used for purification and drying, respectively. Belt 19 carries the yarn through the purification steps. After these steps are completed the belt leaves the reel and passes approximately 180° around a small roller 21 the axis of which is parallel to that of reel 10. The belt 19 then passes around another roller 22 which is situated close to the reel 10 and has an axis about 90° to that of roller 21. This passage of belt 19 causes a ¼ turn in the belt. The belt is directed to roller 13 and then back to the reel. Belt 19 is, then, always wet and never passes through the dryer 14. It is possible to use an absorber belt such as is described in my copending application Serial No. 702,130, now U. S. Patent No. 2,465,214, issued on March 22, 1949, or squeeze rollers to remove most of the liquid from the belt 19 and the yarns prior to further processing.

The dryer belt 20 coming off the reel at point 15 passes around roller 16 to the ¼ turn roller 23 which is situated so that it directs the dryer belt 20 as closely as possible to the off-coming purification belt. The dryer belt 20 passes over roller 24 the axis of which is parallel to roller 21. As the belt 19 passes over roller 21, the yarn is directed through transfer comb 25, which is desirable when very closely spaced multiple ends are being processed. Further, the wiping action of the comb advantageously removes a large percentage of moisture. From this comb the yarn

ends pass onto the dryer belt **20** as the belt **20** passes over roller **24**. The yarns then continue to advance on the reel and are dried as they pass through dryer **14**. Take-off and wind-up of yarns is then accomplished in the usual manner. By using the mechanism described above and illustrated in Figure 3 it is necessary to stretch the belts only ½ the amount needed when a single belt is employed. For example a 3% stretch is sufficient instead of a total of 6% stretch on one belt. At these lower stretch values the change in belt length is taken care of without undue stress on the reel device. Decreased wear and tear and lower dryer loads allow for considerable saving in processing time and costs.

Yarn advancing devices of the canted roller type may also be used as is shown in Figure 4. Rollers **26** and **27** are skewed or in a canted position and are driven through shafts **12** by a motor (not shown). The angle at which the rolls are skewed or canted determines the advancement of the belt **11**. Guide rolls **160** are used to direct the belt **11** back onto the front end of the top roll. The modification is shown in further detail in Figure 5, an end view.

The dryer **14** or **140** can be any dryer having the requisite capacity to dry the threads at the advancement speed being used. The dryer may be designed to dry by radiation or direct contact with the yarn carrying belt or a combination of these methods may be employed. Advantageously, dryers specially designed to relax the filaments during drying are obviated by the apparatus and process of this invention. Since the yarns rest in a relaxed state on the belt surface during advancement, shrinkage occurs freely and readily during drying independently of the dryer. As pointed out above, the take-off speed may be made less than the initial speed to permit greater shrinkage, if such is needed. Further, auxiliary means for drying may be employed. For example, an endless absorbent belt may be passed over the yarn and belt helices as is described in copending application Serial No. 702,130, now U. S. Patent No. 2,465,214, issued on March 22, 1949.

Figure 6 shows the adoption of the belt **28** to a curved contact dryer **30** which normally replaces dryer **14** or **140**. This dryer **30** may or may not contain grooves **33** shown in Figure 7. The belt **28** continuously rotates around the dryer **30** as is shown in Figure 6. The copending application of Conaway and Hitt, Serial No. 720,030, now U. S. Patent No. 2,495,053, issued January 17, 1950, describes these contact dryers. Belt **28** may be replaced by belt **11** or belt **20** coming from the advancing device. In Figure 6, for example, yarn **18** is taken from the belt of an advancing reel and passed onto the top of belt **20** as it passes over driven roller **29** over the contact dryer **30** and over idle roller **31**, and the yarn then passes to winder take-up means **32**. The belt **20** is then returned to roller **16** and it then continuously rotates around the reel **10** and the dryer **30**. Dryer **14** is not used in this modification. As shown in Figure 10, squeeze rolls **290** and **290***a* may be used preceding and additional squeeze rolls **310** and **310***a* following the contact dryer to reduce dryer loads and to relax the yarns over the dryer area. The yarn **18** is carried by belt **11**, **20** or **28** and the frictional drag caused by the yarn being drawn over normally stationary surfaces is eliminated. This is more clearly shown in Figure 7 which view is taken along lines **7—7** of Figure 6. This view shows also, as a possible construction of the dryer, heater elements **34** surrounded by insulation **35**. It is preferred to use belts made of heat conductive materials, such as metals and to use dryers having the grooved surfaces shown in Figure 7 since the belt is deflected as it passes through the grooves over the curved surface. Individual or multiple yarn ends may be dried in the manner described above. By use of the belt **11**, **20** or **28** on such contact dryers frictional drag on the yarns may be reduced and lower residual shrinkages obtained.

Of course, any of the reels described may be used with a contact dryer. In Figure 11, belt **128** carrying yarn **118** passes from one end of reel **110**, supported on axle **112**, over the surface of dryer **130** in contact with it and thence over roller **117**. The yarn leaves the belt at this point, and the belt proceeds to the other end of the reel after passing around additional rollers **116** and **113** in succession. The reel **110** may be any one of the reverse reels referred to herein.

It can be seen from the above description that the yarn sheet **18** is laid down upon the advancing belt **11** rather than directly upon the reel bars or carrying or drying means. The yarn **18** is placed on the belt, using a comb such as guide **250**, if desired, so that the ends comprise an advancing band which is spaced equidistant from each edge of the belt. The helices in band form remain in this position as the band advances. The band may be composed of a single yarn or a plurality of yarns, as shown in the figures, which come directly from spinnerets or spinning baths (not shown). As the belt **11** and the yarn band **18** advance, various processing solutions are employed by any convenient means (not shown) to subject the filaments to any of the yarn processing techniques necessary. For example, perforated pans such at **251** or **252** supplied by appropriate conduits and situated above the reel may be used to apply liquids to the yarn. As the treating liquid drips from the reel, it may be caught in appropriate vessels such as pans such as **253** or **254** placed under the respective treated areas. Thus, the reel may be adapted to most yarn processes.

It is preferred to perform all treating on one reel. This can readily be done as pointed out above, acidic liquids being initially applied to the yarns and water or neutralizing washes being applied before the yarns pass to the drier **14**, **140** or **30**. It is also possible to treat the yarn with only one treating liquid as it advances on a particular reel, passing the yarns to successive reels for successive treatments and finally for drying and then wind-up. The reels may, in any case, be used in any convenient arrangement. Any number of reels may be mounted in a horizontally or a vertically spaced relation. By using a plurality of reels and a plurality of yarns on each reel a very large poundage of yarn may be processed economically.

The yarn advancing mechanism of the present invention may be advantageously used for any purpose where yarn storing concurrent with yarn advancement is of value. For example, this reel is found of utility in the spinning and processing of viscose rayon or other regenerated cellulose yarn, for the processing of cellulose derivative yarn produced by either the wet or evaporative spinning processes and it is of value in the wet, melt or evaporative spinning of any yarn including synthetic polymer yarns to store and advance the yarn while the latter is heated to remove the last traces of solvent. It may be used

in the processing of yarn such as the application of finishes or sizes to a yarn and the subsequent drying thereof where such process involves the handling of considerable lengths of yarn in a relatively small space.

The belts 11, 20 and 28 are composed of a material which is resistant to the treating liquids used and which has an elasticity sufficient to cause the belt to remain in contact or stay taut on the reel and which will withstand the dryer temperatures. Materials which may be used in constructing the belt include, rubber, cotton, rayon, belt, sponge, chamois, metal and plastics such as nylon, polymerized tetrafluorethylene, interpolymers of vinylidene chloride and vinyl chloride, neoprene, or other plastics. Certain belts such as those prepared from polymerized tetrafluorethylene and metals have zero water absorption and can be used advantageously. The choice of material and the belt construction will vary with the different applications of the reels. Various woven or knitted fabrics may be used. In general, any material which may be advanced on an advancing reel and which presents a surface which will support a continuous film of liquid over its width and length and which will keep a yarn end in its respective position as it advances may be used in this invention.

Figure 8 shows a short section of a plain corrugated metal belt 36 made of an alloy predominately nickel and chromium or any of the various grades of stainless steel which are resistant to the purification solutions employed. This belt is expandible and may be joined simply as is shown at point 37 in Figure 9 by snapping one end in the corrugations of the other end. The surfaces of the metal or plastic surfaces may be roughened or ridged to prevent yarn slippage. The belting may be roughened or grooved longitudinally to prevent the yarn from slipping sideways. The grooves may be made to correspond to yarn denier and number of yarns. It is preferred to groove the top ridges only so that processing liquids are not so readily retained. Smooth, hard surfaced belts are not too satisfactory, because they do not readily support a continuous film of processing liquids, nor do they adequately keep the individual yarns in their respective positions. Metal or plastic belts such as polymerized tetrafluorethylene belts, keep the yarn in its respective position, especially well when grooved, and provide the further advantage that they do not absorb liquids. Accordingly, a substantial reduction in carrying out and mixing of the various processing liquids is obtained and the load of the dryer is materially reduced when grooved metal or plastic belts are used.

Various fabrics may be cemented in a continuous surface strip to one or both sides of the metal or plastic belts. Figure 9 shows a pile fabric 38 cemented on one side all the way around. It is also possible to use flat fabrics, sponge materials, natural or synthetic, and plastic materials in this manner. Figure 9 also shows the use of a material 39 having a pile surface and filling the spring indentations. Sponge and other materials may be used in this manner.

It is also possible to use a combination of any of these materials with a fabric belt. For example, a spongy material may be cemented to a cotton belt, the belt being then placed so that the spongy surface carries the yarn. Frequently, a piled fabric can be employed to advantage since the piled nature of the fabric assists materially in keeping the various yarn ends in place during advancement.

Generally, the belt approximates the width of the advancement cycle of the reel. For some reels, belts one-half inch in width are satisfactory while for other reels widths of 3 inches or more depending on diameter of the reel and the advancement cycle. The width of the belt is dependent on the number of yarn ends being processed, the width of the advancing cycle of the reel, the diameter of the reel, etc. The belt may be just wide enough to support a single thread or it may have widths measured in feet for use on reels of great size adapted to process warp sheets. The length of the belt will depend upon the reel length and upon the distance of advance desired. Likewise, the thickness of the belt is not critical and it is possible to use relatively thick belts. The metal belts described above may be very thin. For example, they may be as little as 0.002 inch in thickness. On the other hand belts of sponge-like materials may be an inch or more in thickness dependent upon the nature of the particular process or application involved.

The belt may be advanced on the reel in any manner. Each helix may be situated so that the band of yarns are closely spaced as shown in Figure 1. In this way, a film of liquid may be maintained at all times substantially over the whole length of the reel or purification area. The film is not broken where a belt wrap contacts adjacent belt wraps if the belt width is equal to the advancing cycle. Advancement of the belt may, upon choosing the proper width, be conducted so that a space is formed between successive wraps of the belt. This results in completely breaking the film between each wrap over the entire reel or area covered by the purification solutions. Further, the yarn bands may be relatively far apart or closely spaced. However, the belt maintains a film over the width of each wrap and it does so whether or not it is carrying yarn. This is an important and outstanding advantage of this invention, for the yarn is always being advanced in contact with a treating liquid and this is true regardless of the distance between adjacent yarns. Optimum treating and maximum efficiency in the use of the various liquids is thereby obtained. Further, the space required in the treatment of the yarn, as in washing it free of acid, is no more than that previously required on bare reel bars.

Thus, an important advantage of the process and apparatus of this invention lies in the ready maintenance of a film of liquid over the yarns. When the belt is not used, a yarn band having a minimum of 22 ends per inch (150 denier yarn) was required to support a film of water, the yarn speed being 3150 inches per minute. If the speed varied more than 2% or if as many as two yarns dropped out of the sheet, the film of liquid was broken. The use of a wetting agent resulted in more latitude which, however, still was not satisfactory. On the other hand, when the belt is used, a film is maintained regardless of the number of yarns running. Thus, individual yarns do not depend upon the others for maintenance of the film and if breakage of one or more yarns does occur the yarns still running continue to be properly processed. Further, the reel speed can be varied as much as 18% to 20% without resulting in the breaking of the liquid film. A still further advantage is that no wetting agents are required. The film of liquid extends all the way

around the reel whether the width of the belt is equal to or less than the advancement displacement per cycle. If the belt width is equal to the advancement cycle, the film is unbroken over the entire area subjected to liquid treatment. If the belt width is less than the advancement cycle, the film is broken between wraps but is maintained across each wrap of the belt as it passes around the reel.

Another important advantage of this invention is that the yarn may be advanced under very little tension and under tension considerably lower than that which obtains when the belt is not used. In a comparison it was found that when the yarn was advanced on bare reel bars it was necessary to maintain a tension of 25 to 35 grams on the yarn. This relatively high tension was required to keep the individual threads properly aligned and to avoid breakage through entanglement. When lower tensions were used, the liquid film or thread alignment could not be maintained. When similar yarn of the same denier is advanced using the apparatus and process of this invention, the threads could be advanced with tensions on them as low as 2 grams. Maintenance of the liquid film, when the belt is used, is not as critical on the yarn spinning-speed and thread tensions. The yarns may be laid on the belt **11** with any desired tension on them. It is preferred to exert some tension on the yarns as they are laid on the belt since better alignment control is maintained. Under initial tensions of 4 to 5 grams on 100 denier yarn it was found that the yarns maintained good alignment on the belt. Further, just prior to entering the dryer the tension on the yarns was so low that it could not be measured. This indicated that the belt in cooperation with the tapered advancing reel used allowed for changes in the length of the yarn commensurate with the changes in shrinkage or swelling occurring during the different processing stages. Thus, the yarn by the method and apparatus of this invention was processed in a substantially relaxed state under relatively little tension. Generally, the tension on the yarns **18** after they leave the squeeze rollers **17** shown in Figure 2 and pass to the wind-up means is about 20 grams per denier. This tension is required to insure proper separation of yarns and is not deleterious to the yarns since the purification and drying steps have been completed.

Further, when a yarn destined to be finished as 100 denier by package spinning and processing is processed on the bare reel bars the denier becomes about 91 to 93 denier, whereas under the same processing but using the belt, the resulting denier was 99. Correspondingly small losses in other physical properties of the yarn were noted when the belt was employed. By the process and apparatus of this invention it is possible to obtain yarn having a residual shrinkage comparable to that of yarn processed in skein form. For example, when the belt is used only in the purification area, residual shrinkages as low as 3.4% are obtained. The residual shrinkage decreases even further when the belt is used to carry the yarn through the dryer also. The values approach and in certain instances equal those obtained in the skein purification methods in which the yarn is in a relaxed state. When the yarns are processed and dried without the belt, that is, on the bare reel bars, the residual shrinkage in the yarns are materially higher being in the order of 6% to 7%.

Hitherto, in the drying of bucket cakes, different strains are set up in the cakes so that residual shrinkages vary from the inside, middle to outside of the package. High tension is advantageously avoided and yarn quality is markedly improved by use of the method and apparatus of this invention.

The apparatus and process of this invention may be applied to the processing of yarn of any denier. For example, yarns of 75, 100 and 150 denier have been advanced on the belt, processed and dried under low tensions and with attendant improvement in yarn quality and residual shrinkages. Yarns of 1100, 1650, and 2200 denier can be similarly processed. The advantages of the process and apparatus are attained with these yarns and with yarns of even lower or higher denier. The total tensions may be varied widely regardless of denier and they may be made considerably lower than those reached in the advancing of the particular yarn on the bare reel bars.

The yarns may be directed to the belt in a horizontal plane or they may approach the belt vertically, as, for example, from a point above the reel, as shown in the figures. The movable parts or advancing means of the particular reel employed place the belts **11** or **20** under tension, but the stress and strain in the belt are not imparted to the yarns. Further, assuming the delivery coming off the reel at a constant rate, the speed of squeeze rolls **17** may be made 6% to 10% lower than that rate so that the yarn may be relaxed while passing through the dryer **14** in Figure 2. The belt returns to the reel under tension, the yarns **18** being drawn from the rollers under any desired tension for winding at appropriate take-up positions. Thus, the yarn carried on the belt is under a much lower tension than when it is running in direct contact with the moving or carrying means of the reel. For example, yarn has been purified on the belt under 2 grams tension without the individual yarns getting out of alignment, while like yarn processed under the same conditions on the bare reel bars required 25 to 35 grams tension to hold proper alignment. Even under this lower tension, the yarn sheet does not become distorted, but remains on the belt as first laid down when starting on the reel. Further, it is protected by the belt against possible abrasion that may result from contact of the yarn with the carrying means of the reel. Tearing and scuffing are eliminated. Yarn of higher quality is produced. For example, yarn in direct contact with bars often has filaments of adjacent ends disarranged and overlapping at the contact points. These generally cause broken filaments especially if tucked under an adjacent wrap. This condition is eliminated by using the process and apparatus of this invention. Physical properties of the yarn are improved by use of the belt since there is less stretching of yarn during processing. Yarn having residual shrinkages of 3.5% and lower have been produced by use of the method and apparatus described herein as compared to 6% or more residual shrinkage obtained on the bare reel bars under the same processing conditions.

Still another advantage is that the belt prevents residues from forming on the yarn carrying means during drying. Very little or no treating liquid comes into contact with the movable parts of the reel. The belt may be continuously washed prior to its return to the reel (at any point between pins **13** and **16**, for example) so that it is always being used on the reel in a clean, fresh

state. If desired, it may also be dried prior to its return to the reel. In this way no residue is allowed to collect on it. The life of the reel is greatly increased and the number of mechanical failures is considerably reduced.

Since it is obvious that many changes and modifications may be made in the above described details without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited to the details described herein except as set forth in the appended claims.

I claim:

1. Apparatus for advancing filaments which comprises an advancing reel; means for driving said reel; an endless, absorbent and resilient belt helically wound on and helically travelling on said reel by virtue of its inner surface being in driving contact with said reel, its outer surface being free to carry said filaments; guides for directing said belt to and from said reel in an endless fashion; guides for directing said filaments to and from the outer surface of said belt; and means for removing said belt from said reel, said removal means being adapted to be driven at a speed lower than the speed of said reel.

2. Apparatus for advancing filaments which comprises an advancing reel; means for driving said reel; an endless, absorbent and resilient belt helically wound on and helically travelling on said reel by virtue of its inner surface being in driving contact with said reel, its outer surface being free to carry said filaments; guides for directing said belt to and from said reel in an endless fashion; guides for directing filaments to and from the outer surface of said belt; and squeeze rolls through which said belt carrying said filaments passes upon leaving said reel prior to the separation of said filaments from said belt and return of said belt to said reel.

3. Apparatus for advancing and processing filaments which comprises an advancing reel; means for driving said reel; an endless, absorbent and resilient belt helically wound on and helically travelling on said reel by virtue of its inner surface being in driving contact with said reel, its outer surface being free to carry said filaments and to receive a processing liquid for said filaments; guides for directing said belt to and from said reel in an endless fashion; guides for directing said filaments to and from the outer surface of said belt; an applicator for applying said liquid to said filaments as they are carried by said belt; a dryer for drying the resultant processed filaments as they are carried by said belt; and means for removing said belt from said reel, said removal means being adapted to be driven at a speed lower than the speed of said reel.

4. Apparatus for advancing and processing filaments which comprises an advancing reel; means for driving said reel; an endless, absorbent and resilient belt helically wound on and helically travelling on said reel by virtue of its inner surface being in driving contact with said reel, its outer surface being free to carry said filaments and to receive a processing liquid; guides for directing said belt to and from said reel in an endless fashion; guides for directing filaments to and from the outer surface of said belt; an applicator for applying a processing liquid to said filaments as they are carried by said belt; a dryer for drying the resultant processed filaments as they are carried by the said belt; and squeeze rolls through which said belt carrying said filaments passes upon leaving said reel prior to the separation of said belt and said filaments followed by the return of said belt to said reel.

5. Apparatus for advancing yarn which comprises an advancing reel; means for driving said reel; an endless, absorbent and resilient belt helically wound on and helically travelling on said reel by virtue of its inner surface being in driving contact with said reel, its outer surface being free to carry said filaments; guides for directing said belt to and from said reel in an endless fashion; and means for removing said belt from said reel, said removal means being adapted to be driven at a speed lower than the speed of said belt on the reel.

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