United States Patent

[11] 3,542,267

[72] Inventors **Saburo Ida;**
Yoshimitsu Tsutsui; Shigeo Tsutsui,
Nagoya-shi, Japan

[21] Appl. No. **703,304**
[22] Filed **Feb. 6, 1968**
[45] Patented **Nov. 24, 1970**
[73] Assignee **Mitsubishi Jukogyo Kabushiki Kaisha**
Tokyo, Japan
[32] Priority **Feb. 9, 1967**
[33] **Japan**
[31] **No. 42/8,453**

[54] **METHOD AND DEVICE FOR SPLITTING YARN**
15 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **225/3;**
28/1; 83/175; 225/97
[51] **Int. Cl.** **B26f 3/00**
[50] **Field of Search** 83/18,175;
19/.62, .64; 57/31; 225/3, 97, 93; 28/1(F)

[56] **References Cited**
UNITED STATES PATENTS

2,247,529	7/1941	Taylor et al.	19/.62X

Primary Examiner—James M. Meister
Attorney—McGlew and Toren

ABSTRACT: An apparatus for splitting fibrous yarn from film and yarn material such as polypropylene, polyester polyethylene and the like, includes two spaced sets of feed rollers each defining a nip between which the yarn is fed in the form of a tape. The forward roller set is driven at a faster speed than the rear set in order to provide a tensioning of the yarn. A feature of the construction is that two sets of splitting rollers are arranged for selective orientation with the tape. In one embodiment, after one splitting roller is positioned in a direction toward the tape, it may be engaged tightly by the tape by deflecting a guide roller in a direction to press the tape into engagement with the splitting roller. In the one embodiment, the splitting rollers are carried at respective ends of a rotatable arm which may be rotated to position a selected one of the splitting rollers into association with the tape which is being processed while the other one may be positioned in a standby position in readiness for use, if desired. In the other embodiment, the splitting rollers are located in spaced relationship and the yarn is deflected to one or both of the rollers as desired.

The apparatus also includes a supporting bar which may be moved outwardly under the tape to pick up any tape which has become cut away so that it may be replaced manually into engagement with the guide rollers and feeding rollers.

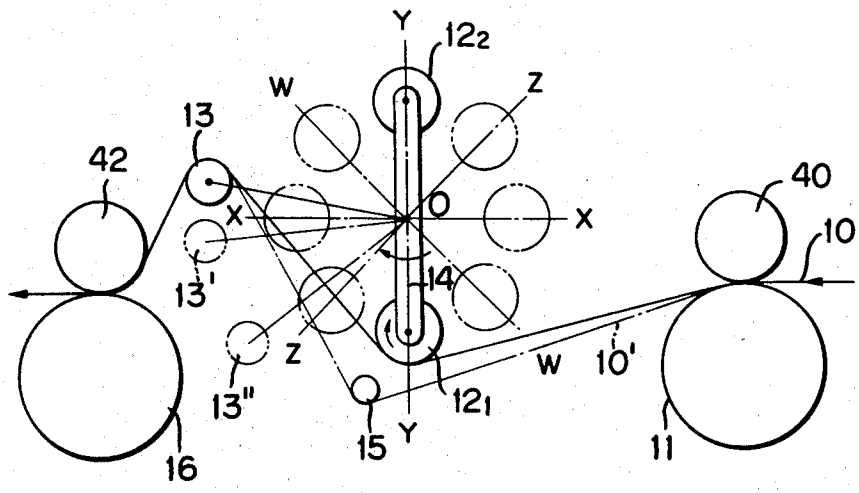


FIG. 1

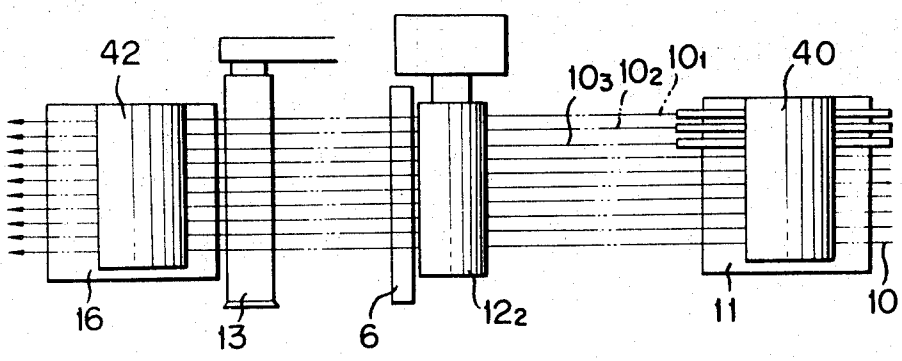
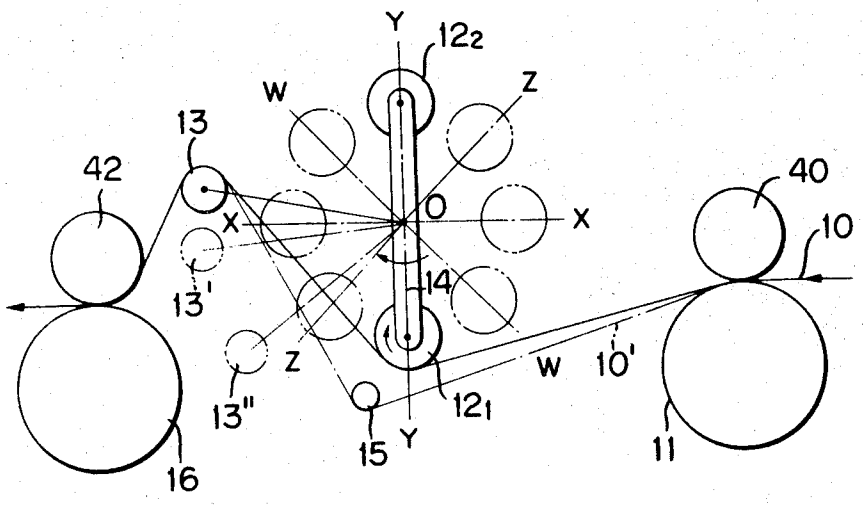
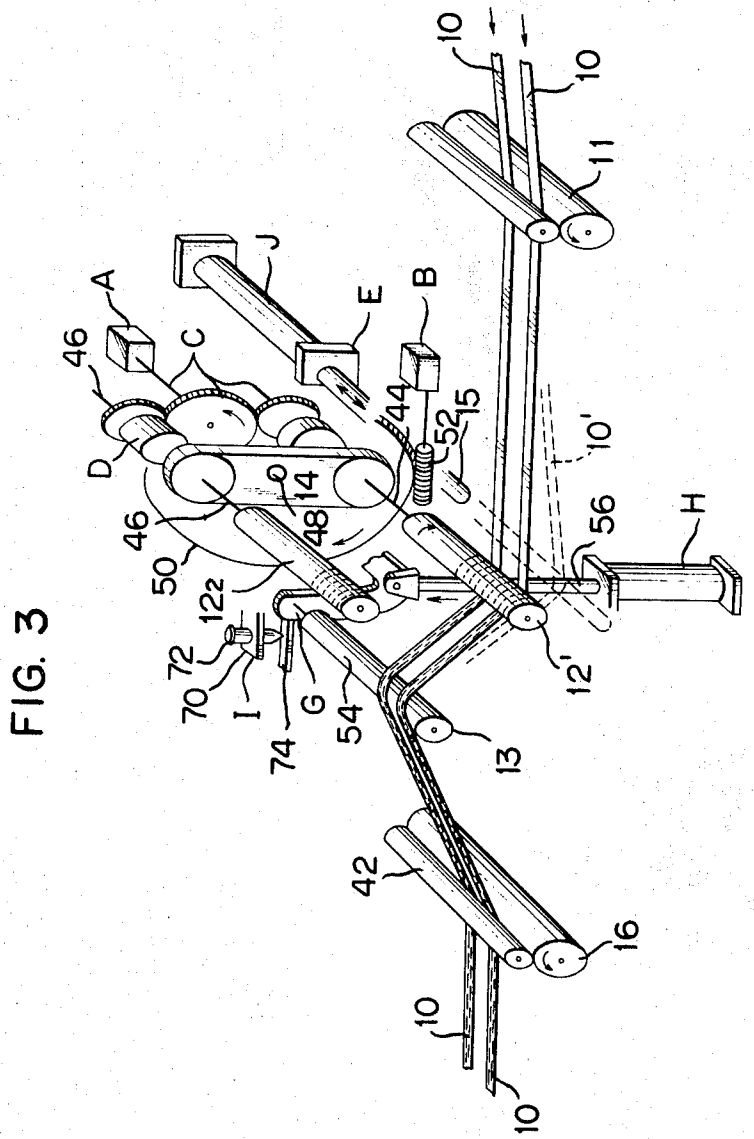


FIG. 2



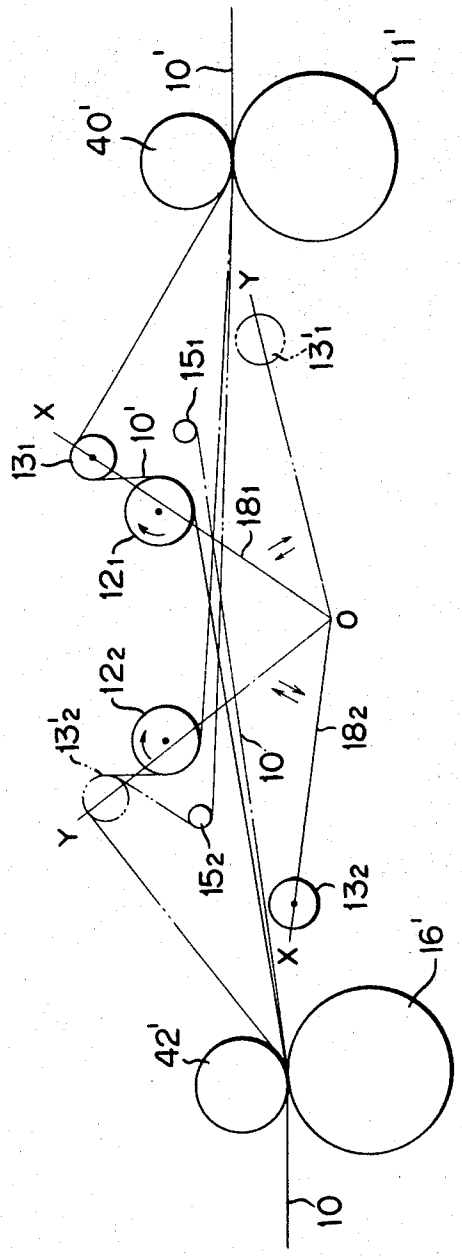
INVENTOR.
SABURO IDA
YOSHIMITSU TSUTSUI
SHIGEO TSUTSUI
By Marklew and Torrey
Attorneys

FIG. 3



INVENTOR.
SABURO IDA
YOSHIMITSU TSUTSUI
SHIGEO TSUTSUI
BY Mailglew and Torrey
Attorneys

FIG. 4



INVENTOR.
SABURO IDA
YOSHIMITSU TSUTSUI
SHIGEO TSUTSUI
By Marglew and Toren
attorneys

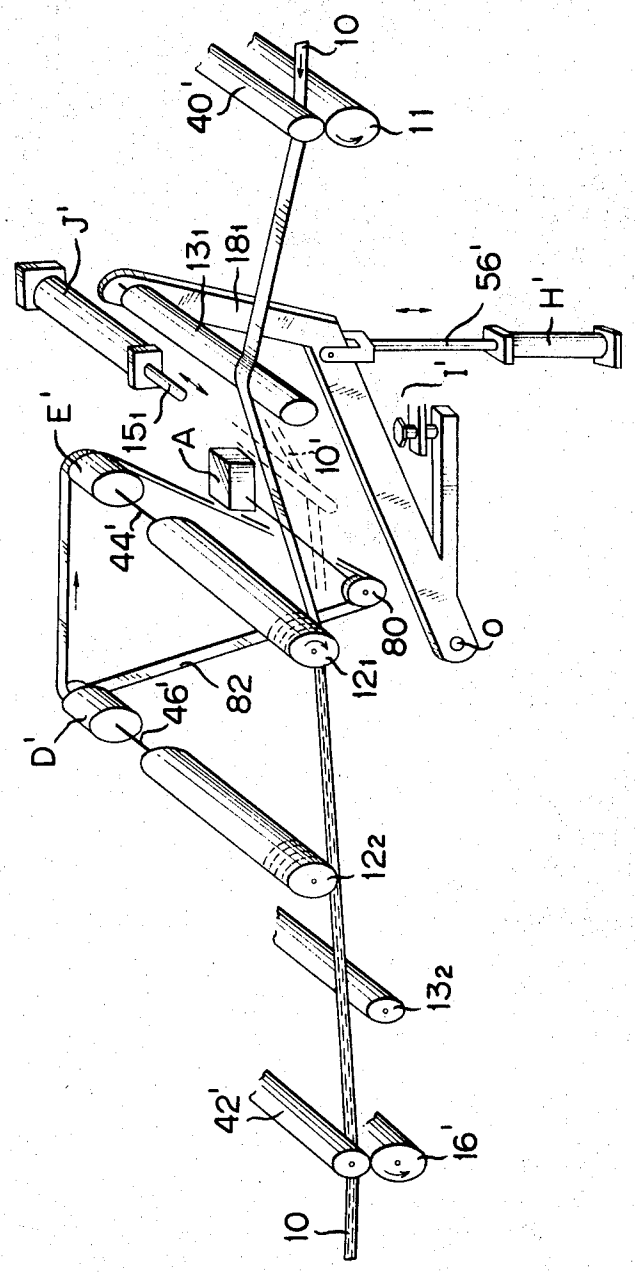


FIG. 5

INVENTORS
SABURO IDA
YOSHIMITSU TSUTSUI
SHIGEO TSUTSUI
By Marlow and Tuttle
attorneys

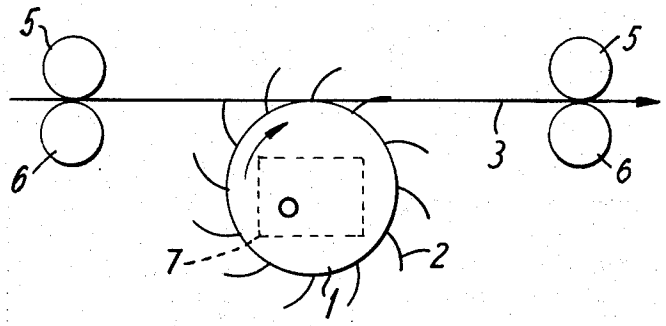


FIG. 6

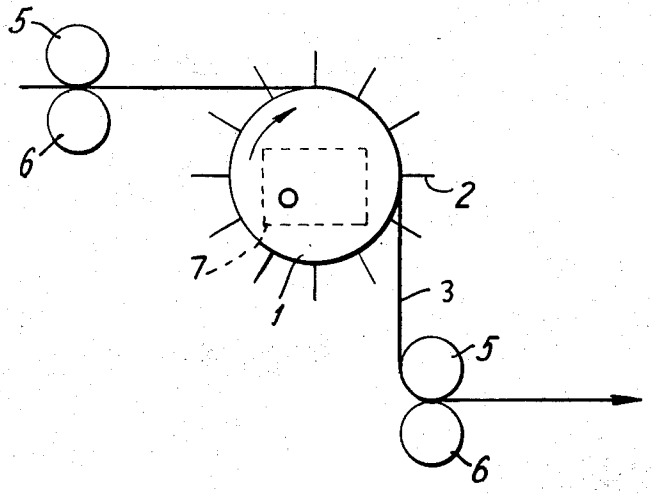


FIG. 7

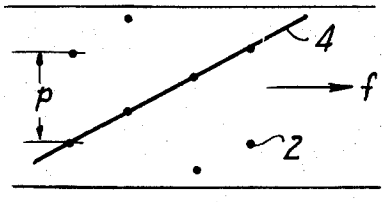


FIG. 8

INVENTORS
SABURO IDA
YOSHIMITSU TSUTSUI
BY SHIGEO TSUTSUI

McGlew & Toren
ATTORNEYS

METHOD AND DEVICE FOR SPLITTING YARN

SUMMARY OF THE INVENTION

This invention relates in general to apparatus and method for mechanically splitting fibers such as polypropylene, polyester, polyethylene and the like, and in particular to a new and useful apparatus and method for feeding thermoplastic yarns under tension into association with splitting cutters and wherein a plurality of such cutters are mounted on a rotatable head which may be selectively positioned to orient only one selected cutter into association with the yarn at a given time.

The present invention relates to apparatus which may be used in a method of making fibrous yarns from film and yarn material such as polypropylene, polyester, polyethylene and the like. In conventional apparatus of this kind, a splitting step is taken after a drafting step, in which it is possible to operate on a large number of tapes concurrently. For such operation, it is necessary to employ splitting cutters comparable to the number of tapes or yarns which are to be processed. The disadvantage in the known apparatus is that the tape or yarn which is treated becomes creased and deformed and even its physical properties are changed. In addition, the apparatus is not capable of continued operation in the event of a breakdown of one of the cutting parts or of a severance of the tape.

The present invention is an improvement over the prior art, particularly in respect to the provision of an inexpensive device for splitting the yarn under tension and which employs a plurality of cutters which may be selectively oriented in an operating position. The advantage of the arrangement is that whenever a cutter is broken or encounters undue wearing condition, it may be rapidly replaced by immediately shifting another cutter into position. In addition, the apparatus is arranged so that the operation may be carried out even when one of the tapes becomes broken or severed by simply stopping the cutting momentarily while the severed tape is entrained on a movable holding bar which is moved outwardly below the tapes to hold the tape temporarily until it can be trained backwardly over the guide rollers.

Accordingly it is an object of the invention to provide an improved device and method for splitting fibrous yarn of synthetic material which includes a plurality of cutters which may be selectively positioned in an operative position for splitting the yarn.

A further object of the invention is to provide a device for splitting yarns which includes spaced feeding rollers arranged in sets forming nips between which the yarn is fed, one roller set being fed at a faster speed than the other in order to tension the yarn; and wherein the yarn may be directed by a deflecting guide roller over a splitting roller which is positioned so that it is oriented against the yarn to force it to engage over the splitting roller.

A further object of the invention is to provide a splitting device which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a top plan view of a splitting machine constructed in accordance with the invention;

FIG. 2 is a somewhat schematic side elevational view of the apparatus indicated in FIG. 1;

FIG. 3 is a front side perspective view of the apparatus indicated in FIG. 2;

FIG. 4 is a side elevational view of another embodiment of the apparatus;

FIG. 5 is a front side perspective view of the apparatus indicated in FIG. 3;

FIG. 6 is a side elevational view of an illustrative example of a splitting drum or roller with the film or yarn extending in straight engagement therewith;

Fig. 7 is a view similar to FIG. 6 showing films or yarn extending over the splitting drum with an increased angle of engagement; and

FIG. 8 indicates one arrangement of the splitting projections set on the peripheral surface of a splitting drum.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, the invention embodied therein in FIGS. 1—3 comprises a yarn splitting device which includes a rear set of feed rollers **40** and **11** forming a nip between which a plurality of laterally spaced tapes of yarn material **10** is fed. In addition, a forward set of feed rollers **42** and **16** forms a nip between which the tapes are directed. The forward set of rollers **42** and **16** are rotated at a faster speed than the rear set **11** and **40** so that the tape between the roller sets is maintained under tension. The tapes **10** which are fed in the direction of the arrow from the right to the left indicated in the drawings is maintained under a tension which can be controlled by running the forward set of rollers **42** and **16** at a speed which is 2—3 percent greater than the speed of the rear set **11** and **40**.

In accordance with a feature of the invention, the tapes **10** may be positioned in operating engagement with one or all of a plurality of cutting disks or splitting rollers or drums, in this instance two separate splitting rollers 12_1 and 12_2. The rollers 12_1 and 12_2 are mounted on respective shafts **44** and **46** which are carried at respective ends of a rotatable arm **14** which is affixed to a shaft **48** for rotation therewith. The shaft **48** carries a gear wheel **50** which may be selectively rotated through a worm **52** by means of a positioning motor B (FIG. 3). In addition, shafts **44** and **46** are driven by variable speed driving motor A through a gear train C and clutches D and E.

During operation, the arm **14** is advantageously located along a vertical axis Y–Y in order to position a selected one of the cutters 12_1 or 12_2 in a position facing the tape **10**. With the arm **14** thus positioned, deflecting means in the form of a guide roller **13** is shifted in an upward direction, as indicated in FIG. 3, to engage the tapes **10** from below and to cause them to engage around a portion of the periphery of the operating splitting roller 12_1. For this purpose the guide roller **13** can freely rotate around its axis and is mounted on a shaft or spindle **54** which is carried on a lever G which has an end which is pivotally supported on a fixed frame (not shown) and an intermediate portion which is pivoted to a rod **56** which may be reciprocated under the control of a fluid cylinder H in order to cause the desired shifting of the roller **13** towards or away from the tapes **10**. The possible positions of the guide roller **13** are indicated at **13'** and **13''** in FIG. 2. The rollers 12_1 and 12_2 may be oriented in any one of the dotted line positions shown by shifting the supporting arm **14** so that it alines with any one of the axes X–X, W–W, Y–Y, or Z–Z. The center lines of the tensioned tape between the forward roller set **16** and **42** and the rear roller set **11** and **40** is designated by 10_1, 10_2 and 10_3. The guide roller **13** may be positioned by shifting the rod **56** in order to effect a suitable angle of tape contact with respect to the cutter.

The splitting rollers 12_1 and 12_2 may be of a type indicated in FIGS. **6**, **7** and **8** in respect to a splitting drum or roller **1** having splitting projections **2** on its peripheral surface driven by suitable means **7** such as an electric motor.

As shown, the drum **1** is in contact with at least one film or yarn **3**, for example, of polypropylene and of 1000 denier, and is driven by an appropriate means to rotate at a peripheral speed either equal to or more or less differing from the traveling speed of the film or yarn **3**. Each of the projections **2** is of a needle or the like form straight or curved in an involute and preferably is set to slope with its pointed end extending in the

direction of the axis of rotation of the drum. The projections 2 are arranged on the peripheral surface of the splitting drum 1 along predetermined lines of lead 4 which proceed in the direction of the axis of rotation of the drum as the latter is driven to rotate. The spacing pitch p between two alined projections 2 arranged on adjacent lines of lead 4 is determined in accordance with the desired splitting pattern or split configuration.

Film or yarn 3, which runs in contact with the splitting drum 1, may be arranged to extend in a straight line, as shown in FIG. 6, or to extend around the drum surface at an increased angle of engagement, as shown in FIG. 7. In the case of FIG. 6 the arrangement is made to allow the distance between the axis O of the splitting drum 1 and the film or yarn 3 to be freely varied as required between a minimum corresponding to the radius of a drum 1 and the maximum workable radial distance of the projections 2 plus the drum radius. In the case of FIG. 7, the distance between the drum axis and film or yarn extending around the drum surface is fixed but the angle of engagement therebetween is variable, as will be apparent from the following description.

Provided in front of and behind the splitting drum 1 are respective sets of nipping rolls 5 and 6 which serve to drive the film or yarn 3 under a predetermined tension, to maintain the film or yarn being split in a contact position relative to the projections 2, and to drive the film or yarn 3 along a predetermined path. In FIG. 8, the arrow f indicates the direction of travel of film or yarn 3.

According to a feature of the invention, the splitting operation can be restarted after the tape is trained over the guide rollers without winding the tape or yarn directly around the splitting cutter in the event that the tape or yarn becomes broken or entangled with the splitting cutter. For this purpose, a yarn or tape engaging bar 15 is disposed below the splitting cutter 12_1 during the operation. The bar is positioned in a position below the tape 10 by actuating a fluid cylinder J with a suitable fluid to cause the outward movement of the bar 15 from the solid line position indicated in FIG. 3 to the dotted line position at which it will be below the tape in a position to support any tape which breaks off. The bar is movable in its cylinder J at directions at right angles to the movement of the tape 10 but it need not rotate about its own axis.

After the tape is operated on by a splitting roller 12_1 or 12_2, whichever is positioned in the operating position, it is moved over the guide roller 13 and passed through the forward feed rollers 42 and 16. The guide roller 13 is initially adjusted by actuating the cylinder H and thereafter it is held at a given winding angle by a winding angle adjusting apparatus I. The apparatus I includes a fixed plate member 70 and a threaded adjusting screw 72 which bears against an angle portion 74 of the lever G.

During the startup of the device, the arm 14 is held in a position X–X, as indicated in FIG. 2, and the guide roller 13 is positioned at the position 13''. Thereafter, the tape or yarn 10 which discharges from the roller group 11 and 40 is disposed so as to engage directly with the nip roller group 16 and 42 without contacting the splitting cutter 12_1 or 12_2. In this condition, the tape or yarn 10 is, as indicated in FIG. 1, uniformly arranged in parallel with respect to each other so that they may be fed away from the apparatus out through the nip of the rollers 16 and 42 in parallel relationship after they are split.

Thereafter, the arm 14 is rotated to the position indicated by the line Y–Y and held in this position during the splitting operation. The guide roller 13 is then swing so as to provide a suitable contact angle of the tape 10 which respect to the splitting cutter 12_1, and when this is done, it is held in this position. The tapes are then fed under tension by the forward and rear sets of the feed rollers 42—16 and 40—11, respectively, so that the splitting operation is carried out.

While breakage of the tape and the entanglement of the cutters 12_1 and 12_2 may occur, it is possible to reguide the broken or entangled tape over the guide roller 13 and between the nip of the forward rollers 16 and 42 so that the apparatus can be restarted. When this occurs, the arm 14 may be rotated through 180°, so that the tape which is not broken is engaged by the cutter 12_2. It can be seen from the drawings that the rotational speed of each cutter varies slightly in accordance with the contact angle of the tape or yarn with respect to the cutter, but variations can be minimized by the correct location of the guide roller and the position of the tape in respect to each individual cutter. In addition, the mechanism may be operated so that the tape is contacted first by the cutter 12_1 and then by the cutter 12_2 for a suitable period of time so that any variation in contact angle or speed may be suitable compensated.

Any tape which becomes entangled or is cut off, will fall down on the engaging bar 15 and may be manually returned to the guide roller and the forward feeding rollers 16 and 42 so that the splitting operation can be restarted.

Because one of the cutting rollers 12_1 or 12_2 is always in an idle position, it is possible to work on this idle roller, for example, to replace its cutting knives, even when the other roller is operating.

In the embodiment illustrated in FIGS. 4 and 5, similar parts are similarly designated but with primes added. In this embodiment, two splitting rollers are provided which are respectively mounted on fixed spaced journals which are located between the forward feeding rollers 16' and 42' and the rear feeding rollers 11' and 40'. In this embodiment, two sets of guide rollers 13_1 and 13_2 are arranged adjacent the respective outboard sides of the splitting rollers 12_1 and 12_2, respectively. Each guide roller freely rotating around its axis is carried on a supporting lever 18_1 which is pivoted about the center O. The position of the guide lever 18_1 is controlled by a fluid cylinder H' which acts to move a piston rod 56' to shift the associated guide lever about its pivot. Each guide roller 13_1 and 13_2 is mounted so that it may be movable through the path of the tape 10' in order to tension the tape either between the rear feed rollers 11' and 40' and the associated cutter 12_1 or the forward feed rollers 16' and 42' and the associated cutting roller 12_2. The apparatus also includes a fine adjustment mechanism I' to provide for minor variations of position of the lever 18_1 and to avoid any play in its mounting. Yarn engaging bars 15_1 are provided in the same manner as in the other embodiment, and they are operated by fluid cylinder J'. A single motor A is employed which drives a pulley 80 and a belt 82 to rotate input shafts of clutches D' and E' to drive associated shafts 44' and 46' of rollers 12_1 and 12_2. The motor A is advantageously a variable speed motor.

In the embodiment illustrated in FIGS. 4 and 5, when the tape 10 is set for the first time, the tape or yarn engaging bars 15_1 and 15_2 are moved backwardly in a retracted position shown in solid lines in FIG. 5. The arms 18_1 and 18_2 are held in a position indicated by the axis lines O–Y and O–X, respectively, indicated in FIG. 4. In this condition, all of the tapes 10 which exit through the nip of the rollers 11' and 40' are directed through substantially a straight line to the nips of the rollers 42' and 16'. The arm 18_1 is then rotated to the position O–X while the arm 18_2, which is not shown in FIG. 5 but only shown in FIG. 4, is maintained in its initial position unchanged. Under this arrangement, a contact of the yarn with the cutter 12_1 will be attained and the splitting operation will be carried out by this cutter.

When a breakage or entanglement of the tape or yarn occurs during the operation, the broken tape is cut off in the proximity of the discharge side of the nip rollers 11' and 40' and then the supply to the splitting cutter 12_1 is cut off. Thereafter, the splitting operation is transferred to the splitting roller 12_2 by shifting the arm 18_1 back to the position O–Y and by shifting the arm 18_2 to the position O–Y at which the tape will be guided around the cutting roller 12_2. When this is done, the splitting roller 12_1 can be fully examined and any broken parts removed or replaced.

In those instances where it is desired to effect a double splitting operation, both of the arms 18_1 and 18_2 may be oriented in an upward position in which they guide the tape around their associated splitting rollers 12_1 and 12_2.

In accordance with the preferred method of the invention for splitting yarns using at least two splitting rollers, the yarn is fed between the two feed roller groups which are arranged on each side of the splitting rollers in a manner such that the yarn is tensioned. Thereafter, the yarn is deflected by a guide roller into association with at least one of the splitting rollers. However, in a case where double splitting is desired, the yarn may be deflected into association with both splitting rollers at one time. If the yarn becomes entangled with one of the splitting rollers or if it breaks, then the other splitting roller may be immediately employed by deflecting the yarn into association with it. In the embodiment of FIGS. 1—3, it is necessary to shift the position of the splitting rollers so that the idle roller becomes effective. In the embodiment illustrated in FIGS. 4 and 5, shifting from one splitting roller to the other may be effected by merely displacing the associated guide roller to cause the yarn to bear against whichever roller is desired for operation.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

We claim:

1. A method for splitting yarns using at least two alternately acting splitting rollers, and using two sets of feed rollers arranged on each side of the splitting rollers, comprising feeding the yarn between the two feed roller groups arranged on each side of the splitting rollers in a manner to tension the yarn between the feed roller groups, and shifting the yarn so that it bears around one of the splitting rollers in operative contact therewith.

2. A method according to claim 1, wherein the splitting rollers are mounted on a rotatable supporting arm comprising rotating the arm so that one of the splitting rollers is initially positioned toward the yarn to be split, and thereafter shifting the yarn into association with this splitting roller.

3. A method according to claim 1, wherein there are at least two splitting rollers arranged at fixed spaced locations and wherein the yarn is shifted on the side adjacent one of the splitting rollers to engage it when that splitting roller is to be employed to split the yarn.

4. A method for splitting yarns using at least two splitting rollers, and using two sets of feed rollers arranged on each side of the splitting rollers, comprising feeding the yarn between the two feed roller groups arranged on each side of the splitting rollers in a manner to tension the yarn between the feed roller groups, shifting the yarn so that it bears around at least one of the splitting rollers in operative contact therewith, and wherein any broken yarn is collected below the associated splitting roller and is retained between the feed roller groups and then all of the yarns are deflected into association with the other of the splitting rollers.

5. A device for splitting yarns comprising means for feeding a plurality of laterally spaced yarn widths through a feedpath, a plurality of splitting rollers of a length equivalent to the combined widths of the yarn being fed arranged in alinement with the yarns in the feedpath, and deflecting means for deflecting said yarns to cause them to engage around a respective one of said splitting rollers to be operatively associated therewith for the splitting operation.

6. A device according to claim 5, wherein said feeding means comprises means for feeding said yarn widths under tension.

7. A device for splitting yarns comprising means for feeding a plurality of laterally spaced yarn widths through a feedpath, a plurality of spaced apart splitting rollers of a length equivalent to the combined widths of the yarn being fed arranged in alinement with the yarn in the feedpath, shifting means for shifting said yarns to cause them to engage around only a respective one of said splitting rollers to be operatively associated therewith for the splitting operation, and a rotatable arm adjacent the feedpath, said arm carrying a splitting roller at each end, said arm being rotatable to position a selected one of said splitting rollers in engagement with the yarn widths.

8. A device according to claim 7, wherein said shifting means comprises a guide roller, and means mounting said guide roller to move said guide roller through a path intercepting the yarn widths to cause the yarns to bear around a portion of the periphery of an adjacent splitting roller.

9. A device according to claim 5, including laterally spaced fixed journal means mounting said splitting rollers at spaced locations along the feedpath, said deflecting means comprising means movable through the feedpath to deflect the yarn widths at a location adjacent each one of said splitting rollers.

10. A device according to claim 9, wherein said deflecting means comprises a guide roller arranged on the outer side of each of said splitting rollers, and lever means mounting said guide rollers to shift said guide rollers through the feedpath of the yarn widths and to cause the yarn widths to bear under tension around a portion of the periphery of the adjacent splitting roller.

11. A device for splitting yarns comprising means for feeding a plurality of laterally spaced yarn widths through a feedpath, a plurality of spaced apart splitting rollers of a length equivalent to the combined widths of the yarn being fed arranged in alinement with the yarns in the feedpath, shifting means for shifting said yarns to cause them to engage around only a respective one of said splitting rollers to be operatively associated therewith for the splitting operation, a supporting bar movable at right angles to the feedpath, and means for displacing said bar to position the bar directly below the yarn widths being fed so as to support the tapes in the event that they break off.

12. A device according to claim 5, wherein said deflecting means comprises a rotatable guide roller disposed on the opposite side of said yarn widths from said splitting rollers, and lever means carrying said guide roller being deflectable to move said guide roller through a path intercepting the yarn widths to deflect them over a portion of the surface of at least one of said splitting rollers.

13. A device for splitting yarns comprising means for feeding a plurality of laterally spaced yarn widths through a feedpath, a plurality of spaced apart splitting rollers of a length equivalent to the combined widths of the yarn being fed arranged in alinement with the yarns in the feedpath, shifting means for shifting said yarns to cause them to engage around only a respective one of said splitting rollers to be operatively associated therewith for the splitting operation, said shifting means comprising a rotatable guide roller disposed on the opposite side of said yarn widths from said splitting rollers, and lever means carrying said guide roller being deflectable to move said guide roller through the path intersecting the yarn widths to deflect them over a portion of the surface of at least one of said splitting rollers, a rotatable arm, said splitting rollers being carried at respective ends of said arm, a driving motor for said splitting rollers, and gear and clutch means connected between said motor and said splitting rollers to rotate said rollers at selected speeds.

14. A device according to claim 12, including a gear shaft supporting said arm for rotation therewith, and worm and gear means connected to said gear shaft to rotate said gear shaft for selectively positioning said arm.

15. A device for splitting yarns comprising means for feeding at least one yarn width through a feedpath, a plurality of spaced apart splitting rollers arranged in alinement with the yarn in the feedpath, and shifting means for shifting said yarn to cause it to engage around only one of said splitting rollers for operative association therewith for splitting the yarn.