July 18, 1967 R. H. MARKS 3,331,222

METHOD FOR PRODUCING A FABRIC

Filed Nov. 23, 1964 4 Sheets-Sheet 1

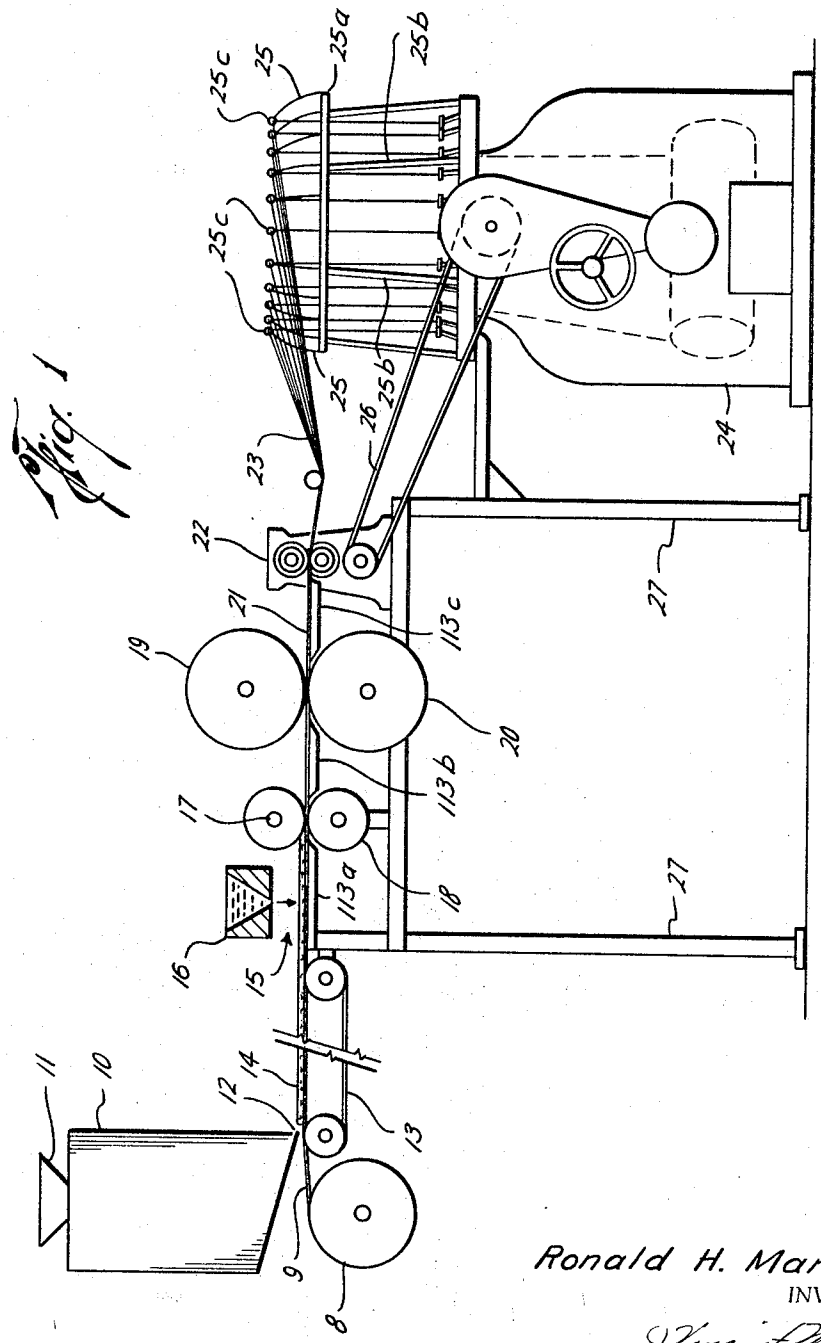


Fig. 1

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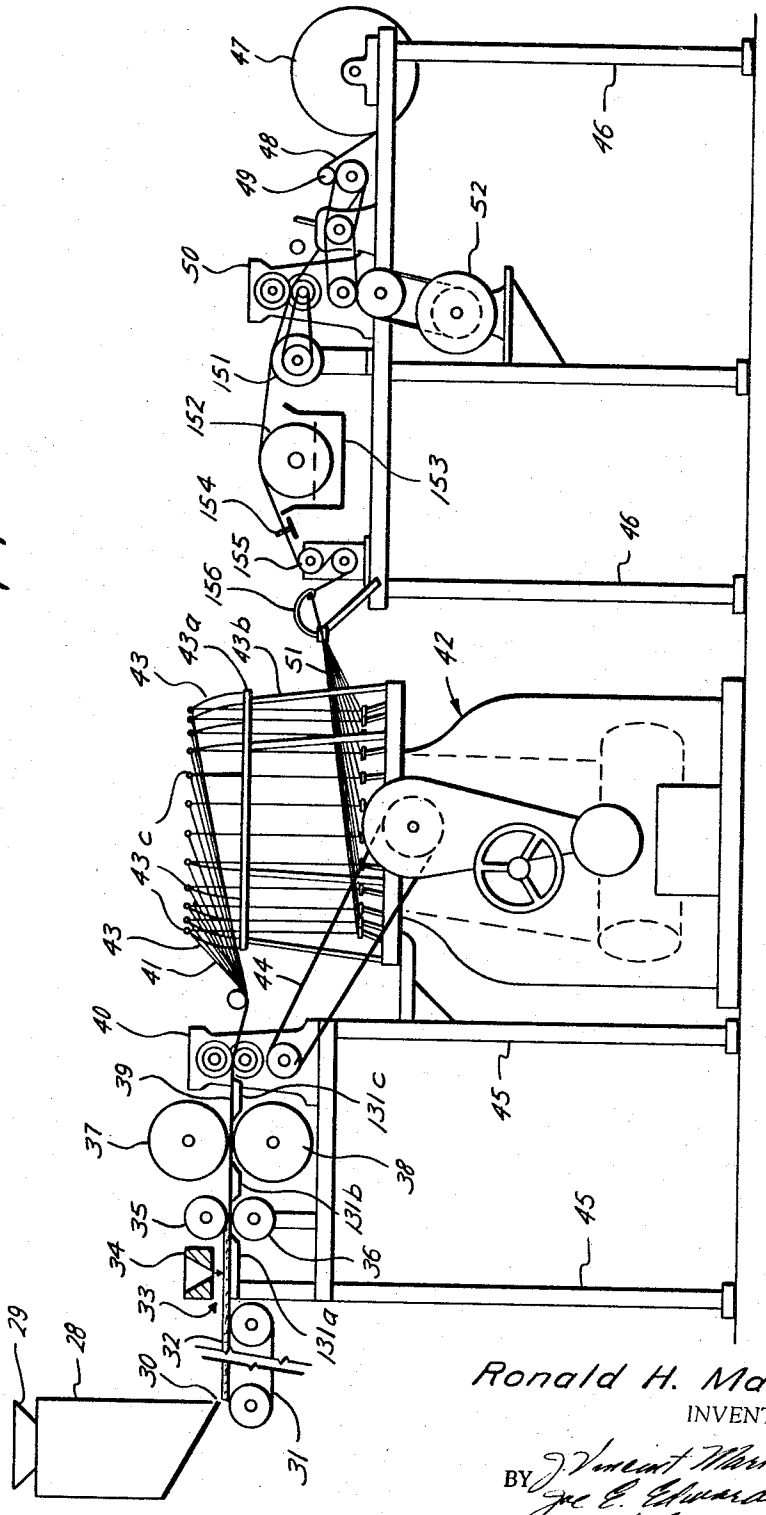
BY J. Vincent Martin
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July 18, 1967 R. H. MARKS 3,331,222

METHOD FOR PRODUCING A FABRIC

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Fig. 2



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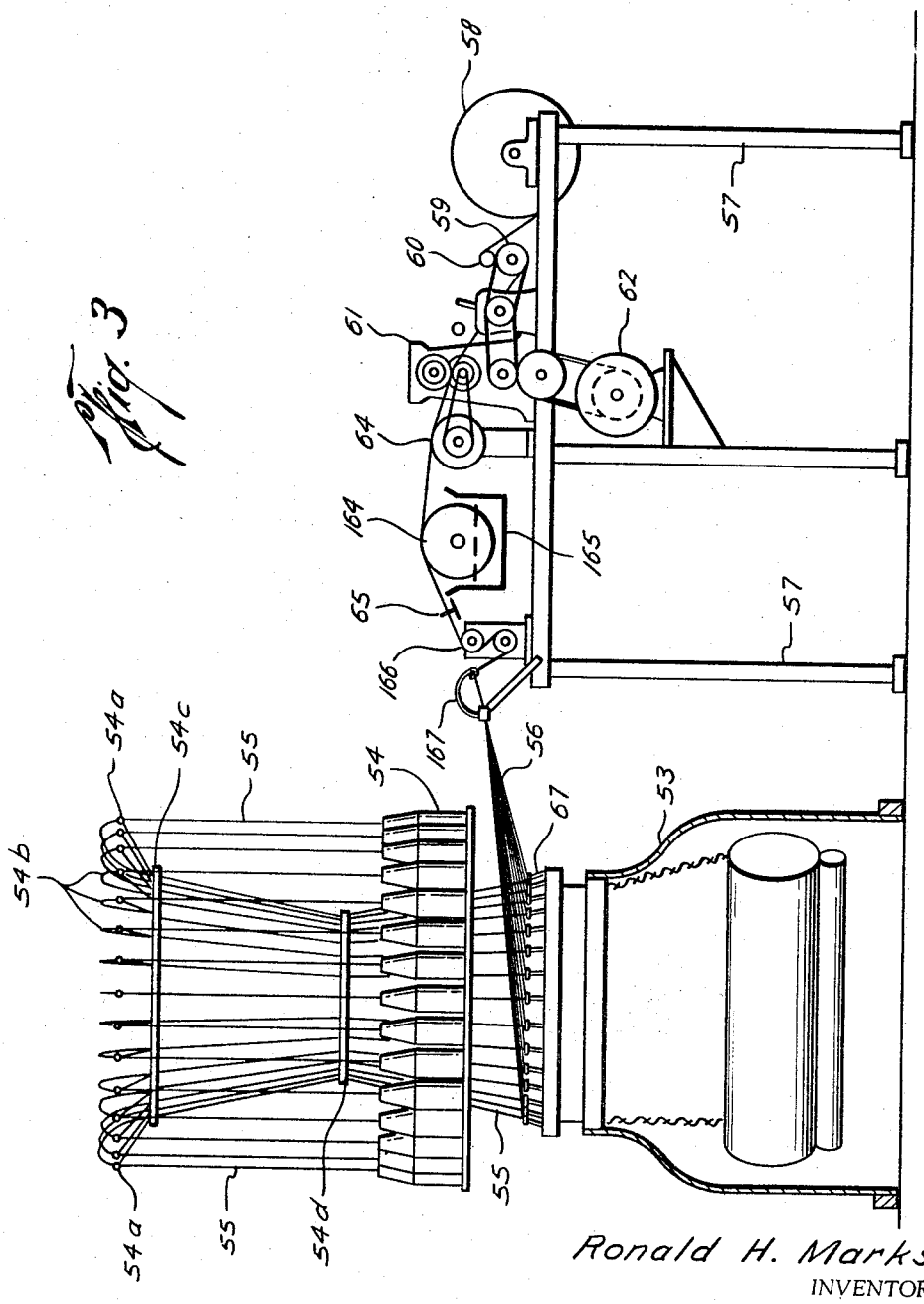
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METHOD FOR PRODUCING A FABRIC

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Fig. 3



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July 18, 1967 R. H. MARKS 3,331,222

METHOD FOR PRODUCING A FABRIC

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Fig. 4

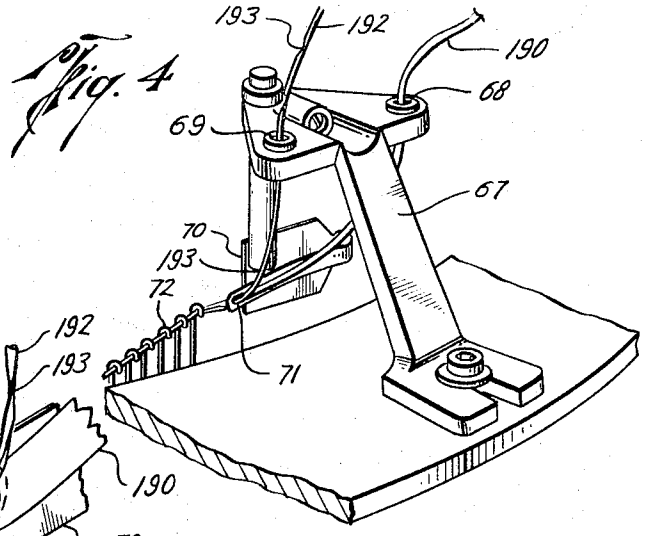


Fig. 5

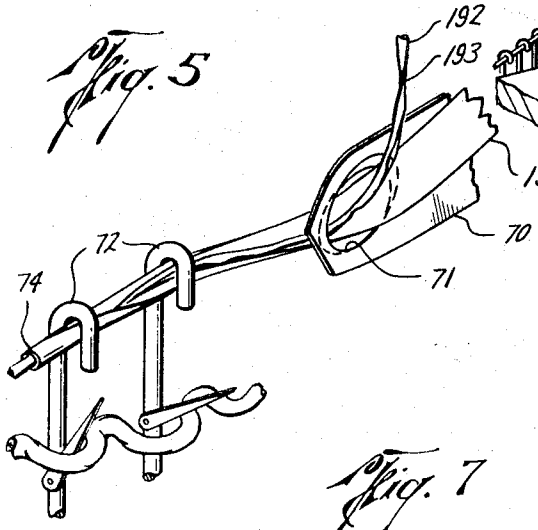


Fig. 6

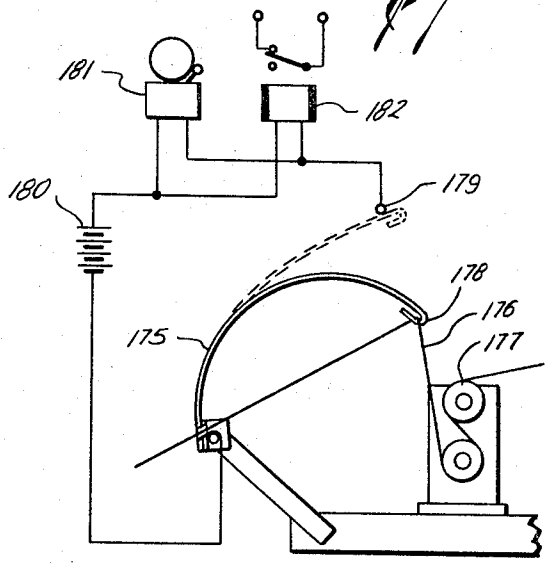


Fig. 7

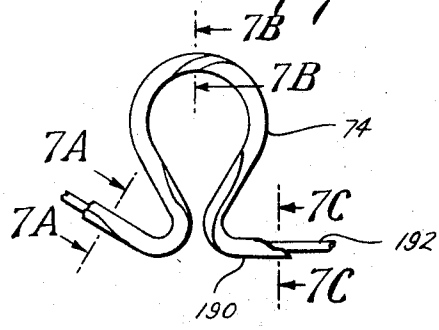


Fig. 7A

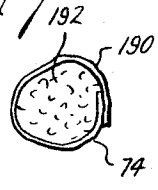


Fig. 7B

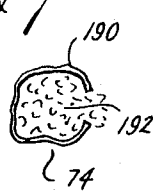
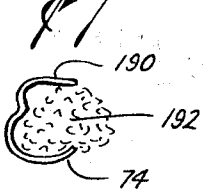


Fig. 7C



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United States Patent Office 3,331,222
Patented July 18, 1967

3,331,222
METHOD FOR PRODUCING A FABRIC

Ronald H. Marks, Dallas, Tex., assignor to American Can Company, New York, N.Y., a corporation of New Jersey

Filed Nov. 23, 1964, Ser. No. 413,261
12 Claims. (Cl. 66—202)

The present application is a continuation-in-part of my prior pending application Ser. No. 371,717 filed June 1, 1964, now abandoned.

The present invention relates to a method and an apparatus for the utilization of substandard fibers and some waste fibers, such as cotton motes and other fibers, whereby the fibers are processed into a useful form and the fabric produced thereby.

Mechanized agriculture, such as the picking of cotton with machines, has necessitated improvements in the techniques of cleaning fibers. The technical advances in cleaning fibers have resulted in improvement in the cleaned fibers, both in the higher grades and the lower grades. The residue fibers from the lower grade fibers, which in the case of cotton fibers are linters and motes, are short and exhibit little strength characteristics for utilization in normal textile manufacturing. The term cotton motes as used herein is intended to describe those substandard cotton fibers which may include immature fibers, discolored fibers, short fibers and particles of material other than fibers. These residue fibers are frequently off-color and even though they have been cleaned with the improved cleaning techniques they include particles of materials other than fibers, such as stems, leaves and bolls. Other fibers, such as rayon and synthetic materials, may be short, off-color or below standard grade. These short and below standard grade fibers are normally not capable of textile conversion when they are spun into a yarn as they do not have the uniform strength required for knitting and their general use has been as mass fibers for bedding and other similar products.

The term "substandard fibers" as used herein shall mean fibers which in the past have not been readily used in normal production of a fabric by knitting. Many of the substandard fibers, as herein defined, may be processed into a yarn, but such fibers will produce a yarn which does not have uniform tensile strength throughout its length and therefore is not readily used in knitting. The present invention also contemplates the use of yarns of commercial grade fibers in which the yarns produced, by reason of the incorporation of substandard fibers, impurities or improper yarn processing, do not have the uniform tensile strength required by normal production knitting. Such yarns may include substantial lengths having suitable tensile strength with intermittent weak sections. These weak sections make the yarns unsuitable for normal knitting.

It is therefore an object of the present invention to provide a method and apparatus for utilizing substandard fibers in the knitting of fabric.

Another object of the present invention is to provide a method and apparatus to knit elements of a material not suitable for normal knitting into a fabric.

Another object of the present invention is to provide a method and apparatus to combine such substandard fibers with other materials and knit the combination into a fabric.

A further object of the present invention is to provide a method and apparatus for producing a relatively inexpensive knitted fabric from such substandard fibers.

A still further object of the present invention is to provide a method and apparatus for combining substandard fibers with paper to form a relatively inexpensive knit fabric.

Another object of the present invention is to provide a method and apparatus for knitting a fabric in which each knitting station is fed two elements, at least one of said elements being unsuitable for knitting, and said elements are interengaged into a combination or composite element suitable for knitting.

Another object is to provide a knitted fabric including a plurality of strands which include two elements, one of which has a nonuniform tensile strength.

Another object of the present invention is to provide a method and apparatus utilizing yarns having nonuniform tensile strength in the knitting of fabric.

A still further object of the present invention is to provide a method and apparatus for jointly feeding substandard fibers and paper strips to a knitting machine wherein the paper strips are crimped on the fibers during knitting to provide a combination material element having substantially greater uniformity of tensile strength suitable for the knitting of a fabric.

Still another object of the present invention is to provide a method and apparatus for jointly feeding yarns having nonuniform tensile strength and paper strips to a knitting machine wherein the paper strips are crimped on the yarns during knitting to provide a combination or composite material element having substantially greater uniformity of tensile strength suitable for the knitting into a fabric.

Another object of the present invention is to provide a method and apparatus for producing a fabric from substandard fibers wherein the fibers are matted into a suitable form for feeding to a knitting machine and are combined with elements of sheet material fed to such knitting machine.

Another object of the present invention is to provide a method of compressing and bonding substandard fibers to a continuous sheet and thereafter dividing such sheet into elements and knitting a fabric from such elements.

Still another object of the present invention is to provide a method and apparatus for forming a continuous sheet of substandard fibers and dividing such sheet into elements and thereafter combining such elements with additional elements for knitting into a fabric.

Another object of the present invention is to provide a method and apparatus in which two types of elements may be knitted into a fabric where neither of the elements would have sufficient strength for knitting.

These and other objects of the present invention will be readily understood from the following explanation and description of the details of the system which are illustrated in the accompanying drawings wherein:

FIGURE 1 is a diagrammatic representation of an apparatus forming a fabric from a plurality of elements derived from a web of material to which a layer of substandard fibers has been bonded;

FIGURE 2 is another similar representation of another apparatus forming a fabric from a plurality of elements derived from matted substandard fibers and a plurality of elements derived from a web of material;

FIGURE 3 is another representation of an apparatus forming a fabric from a plurality of yarns having nonuniform tensile strength and a plurality of elements derived from a web of material;

FIGURE 4 is an enlarged view of the feeding mechanism used in the apparatus of FIGURE 3;

FIGURE 5 is an enlarged detail view of knitting needles receiving and combining a yarn having nonuniform tensile strength with a strip element;

FIGURE 6 is an illustration of the tension device for the strip elements of FIGURE 3 and the electric shutoff circuit associated therewith;

FIGURE 7 is a detailed view of one loop of the fabric produced by the method and apparatus of the present invention;

FIGURE 7A is a sectional view of the loop shown in FIGURE 7 taken along lines 7A—7A of FIGURE 7;

FIGURE 7B is a similar sectional view taken along lines 7B—7B of FIGURE 7; and

FIGURE 7C is another sectional view and is taken along lines 7C—7C of FIGURE 7.

Since the substandard fibers contemplated by the present invention have little use except as massed fibers or for yarns having nonuniform tensile strength, such fibers are relatively inexpensive. These fibers or their yarns do not have sufficiently uniform tensile strength to be utilized to form a fabric on ordinary knitting machines. They are utilized by the present invention in combination with elements of other materials wherein the fabric produced utilizes the strength which is available in such fibers. By proper selection of the other material the cost of the fabric produced will be limited so that the fabric produced will be inexpensive and disposable after a single use.

The material used in combination with the substandard fibers should be selected to provide the desired fabric. Such material should also provide sufficient strength and reinforcement for the substandard fibers to allow the fabric to be produced on standard knitting machines.

Such strong inexpensive material will also have many additional end product uses. Also, other fabrics may easily be produced by the method and apparatus of the present invention which utilize substandard fibers and paper or other suitable material.

In the form of the apparatus illustrated in FIGURE 1 the substandard fibers are delivered to a suitable distributing device **10** through the upper hopper **11**. Distributing device **10** may be any suitable means for receiving and processing the fibers whereby they are discharged from the lower portion of the device **10** through the outlet **12** as a bat of loosely piled random fibers indicated generally at **14** onto web **9** from roll **8** which may be of any slittable material, such as plastic film or paper. Web **9** and bat **14** are supported by endless belt conveyor **13**. Distributing device **10** may be a carding machine having means to assure that its discharge of fibers will have relatively uniform thickness and uniform width as required by the additional apparatus of the present invention hereinafter more fully explained.

The bat **14** of fibers is delivered to tray **113***a* by the endless belt **13** and through the treating zone **15** wherein the bat of fibers is subjected to a treating liquid. In the figure the treating liquid is shown to be dripping onto the bat **14** from the treating liquid applying means **16**. The means **16** is shown in the form of a trough having a lower slot through which the treating liquid may drip onto the bat **14**. Any suitable means, such as sprayers, submerged roller applicators or other devices, may be used for the application of the treating liquid to the bat **14** without departing from the spirit of the present invention.

Care should be taken in the selection of the means **16** to preserve the continuity of bat **14** during the application of such treating liquid. The fibers of bat **14** are loosely piled fibers and therefore will not have sufficient strength for some certain types of treating liquid applicators, particularly those which tend to exert a pull on bat **14** even though bat **14** is supported by web **9**. Treating liquid may be applied to the substandard fibers prior to their discharge onto web **9**.

In the use of treating liquid it is suggested that a suitable treating liquid, such as a starch, be applied to the bat **14** which will cause the individual fibers when later processed to have sufficient cohesiveness and adhesiveness to web **9** to provide the necessary tensile strength required by the remainder of the apparatus of the invention.

With the bat **14** and web **9** wet from the application of the treating liquid they are delivered to the light rolls **17** and **18**. On passing between the rolls **17** and **18**, bat **14** is substantially compressed and the web of material discharged from rolls **17** and **18** will have substantially less thickness than the original combined thickness of bat **14** and web **9**. This web of material will, because of the treating liquid, retain its compressed condition on discharge from the rolls **17** and **18** due to the at least partial bonding between the fibers and to the web **9** by the treating liquid. The web of material from the rolls **17** and **18** is delivered on tray **113***b* to the heavy rolls **19** and **20**. The web of material is further compressed by rolls **19** and **20** into a substantially continuous bonded flat sheet or web of material including the compressed fibers and the web **9**.

It should be noted that depending on the type of treating liquid applied to the bat **14**, one or more of the rolls **17**, **18**, **19** and **20** may be heated to effect a partial setting of the treating liquid during the compression of the fibers into the web or sheet of material discharged from such rolls. This heating may be applied to the web separately at a position between the two sets of rolls whereby the treating liquid will be sufficiently set that the sheet or web of material will maintain its compressed condition on discharge from the rolls **19** and **20**.

The web **21** of compressed fiber material and web **9** discharged from the rolls **19** and **20** is delivered on tray **113***c* to the slitting device **22** wherein the web **21** is divided into a plurality of elements **23**. These elements are suitably separated and guided to the knitting machine **24**. As shown, knitting machine **24** is of the rotating cylinder type wherein the flexible feed guides **25** are stationary and the cylinder and knitting needles rotate within the machine to form a fabric from the elements delivered to the knitting machine.

The feed guides **25** on knitting machine **24** are resilient or flexible wires which are suitably secured to the support ring **25***a*. Legs **25***b* extend upwardly from machine **24** to maintain support ring **25***a* and feed guides **25** in proper position above machine **24**. A loop **25***c* is provided in the end of each of feed guides **25** through which the elements **23** pass. Feed guides **25**, because of their flexibility, will assist in the maintenance of proper tension in elements **23** during knitting. It is further suggested that when the material of web **9** is paper, as contemplated in some uses of the present invention, the paper portion of the elements retain a degree of dampness for feeding to the knitting machine **24**.

A belt or chain drive connection **26** is shown connecting from the knitting machine **24** to the slitting device **22** whereby the feed of elements **23** to a knitting machine **24** will be synchronized with the knitting speed of the knitting machine **24**. It should be noted that the speed of rolls **17**, **18**, **19** and **20**, the speed of conveyor **13** and the feed from the distributing device **10** onto the conveyor **13** should also be suitably synchronized with the speed of the knitting machine whereby the process of forming and knitting the elements **23** will be continuous.

It is further desired that a minimum amount of tension be maintained in the elements **23** because of their relatively limited tensile strength. However, it is further necessary that the elements **23** not be fed to the knitting machine at a rate faster than they are utilized by the knitting machine and therefore synchronization in timing of all parts of the system for the continuous formation of the fabric produced by the knitting machine is desired. This synchronization in the timing of the components of the apparatus may be accomplished by any suitable means including the pre-setting of the speed of each of the

components or the interconnection of the components through suitable belting, gearing or transmissions whereby the formation of the fabric may be continuous at varying speeds. The components of the equipment hereinbefore described are provided with suitable supporting structure **27**, a part of which, the support for roll **8**, endless belt **13** and distributing device **10** are not shown in the drawing.

The elements **23** which are fed to knitting machine **24** are combinations of strips of web **9** with fibers which originally form bat **14** being at least partially bonded to the web strips and on which the fibers are compressed and partially bonded to each other. The inclusion of web **9** will provide sufficient tensile strength to elements **23** whereby the substandard fibers may be incorporated therewith into the knitted fabric. Thus, such substandard fibers may be used in the knitted fabric wherein they will provide substantial body to the fabric product.

The material used for web **9** may be of any suitable material which is desired in the fabric to be produced. It has been found that a paper material when combined with substandard fibers, such as cotton motes, and knitted into a fabric, in accordance with the present invention, will result in a relatively strong fabric which will have a relatively low cost. Such fabrics may be readily used in baling cotton in place of jute or other materials presently being used.

In FIGURE 2 the drawing of the apparatus illustrated to the left of the drawing is substantially the same as the apparatus of FIGURE 1 with the exception that the roll **8** and the web **9** are not used. The apparatus to the right of the drawing is substantially the apparatus as shown in my prior co-pending application, Ser. No. 299,358, filed Aug. 1, 1963 now Patent No. 3,214,943. In the form of apparatus illustrated in FIGURE 2, the substandard fibers are delivered to a suitable distributing device **28** through the upper hopper **29**. Distributing device **28** may be a suitable means for receiving the fibers and processing the fibers whereby they are discharged from the lower portion of the device **28**, out through the outlet **30**, and onto the endless belt **31** as a bat of loosely piled, random fibers, indicated generally at **32**. Distributing device **28** may be a carding machine having means to assure that this discharge of fibers will have relatively uniform thickness and uniform width as required by the additional apparatus of this form of the present invention hereinafter more fully explained.

The bat **32** of fibers is delivered by the endless belt **31** onto supporting tray **131***a* and through treating zone **33** wherein the bat of fibers is subjected to a treating liquid. In the figure the treating liquid is shown to be dripping onto the bat **32** from the treating liquid applying means **34**. The means **34** is shown in the form of a trough having a lower slot through which the treating liquid may drip onto the bat **32**. Any suitable means, such as sprayers, submerged roller applicators, or other devices, may be used for the application of treating liquid to the bat **32** without departing from the spirit of the present invention.

Particular care should be taken in the selection of the treating means **34** to preserve the continuity of the bat **32** during the application of such treating liquid. The fibers of bat **32** being loosely piled fibers and unsupported by a continuous web, such as the web **9** shown in FIGURE 1, may not have sufficient strength for some types of treating liquid applicators, particularly those which tend to exert a pull on bat **32** and those which do not provide adequate support for bat **32**.

The treating liquid to be used in the treating liquid applying means **34** should be similar to that used in reference to FIGURE 1. Such liquid should provide sufficient cohesiveness to provide the necessary tensile strength to the bat **32** which is required by the remainder of the apparatus of the invention illustrated in FIGURE 2 through which the bat **32** is processed.

With the bat **32** wet from the application of the treating liquid, it is delivered on tray **131***a* to the light rolls **35** and **36**. On passing between rolls **35** and **36**, bat **32** is substantially compressed and the web of material discharged therefrom will have substantially reduced thickness as compared to the original thickness of bat **32**. This web of material will, because of the treating liquid, retain its compressed condition on discharge from the rolls **35** and **36** due to the at least partial bonding between the fibers of bat **32** by the treating liquid. The web of material from the rolls **35** and **36** is thereafter delivered on tray **131***b* to the heavy rolls **37** and **38**. The web of material is further compressed by rolls **35** and **36** into a substantially continuous bonded flat sheet or web of compressed fibers.

As previously stated in relation to the apparatus at FIGURE 1, the rolls **35**, **36**, **37** and **38** may be heated to effect a partial setting of the treating liquid during the compression of the fibers. Such heating may also be applied to the web separately at a position between the two sets of rolls whereby the treating liquid will be sufficiently set that the sheet or web of material discharged therefrom will maintain its compressed condition on discharge from rolls **37** and **38**.

The web **39** of compressed fiber material discharged from rolls **37** and **38** is delivered on tray **131***c* to the slitting device **40** wherein the web **39** is divided into a plurality of elements **41**. These elements **41** are suitably separated and guided to the knitting machine **42**. As shown, knitting machine **42** is of the rotary type wherein the flexible feed guides **43** are stationary and the cylinder and knitting needles rotate within the machine to form a fabric from the elements delivered to the knitting machine.

The feed guides **43** on knitting machine **42** are resilient or flexible wires which are suitably secured to the support ring **43***a*. Legs **43***b* extend upwardly from machine **42** to maintain support ring **43***a* and feed guides **43** in proper position above machine **24**. A loop **43***c* is provided in the end of each of feed guides **43** through which the elements **41** pass. Feed guides **43** because of their flexibility will assist in the maintenance of proper tension in elements **41** during the knitting.

The belt or chain drive connection **44** is shown connecting the knitting machine **42** to the slitting device **40** whereby the feed of the elements **41** to the knitting machine **42** will be synchronized with the speed of the knitting machine **42**. It should be noted that the speed of rolls **35**, **36**, **37** and **38**, the speed of conveyor **31** and the feed from the distributing device **28** onto the conveyor **31** should also be suitably synchronized with the speed of the knitting machine whereby the process of forming and knitting the elements **41** will be continuous.

It is further desired that a minimum amount of tension be maintained in the elements **41** and therefore coordination in the timing of all parts of the system for forming the fabric is desired. Such synchronization and timing as suggested in relation to the device of FIGURE 1 may be suitably used.

The components of the equipment hereinbefore described are provided with suitable supporting structure **45**. The part of structure **45** which provides support for endless belt **31** and distributing device **28** is not shown in FIGURE 2.

The apparatus in FIGURE 2 to the right of knitting machine **42** includes supporting structure **46** providing support for the rotatively mounted roll **47** of web material. The web **48** unwinds from the roll **47** and extends through the tension adjuster **49** and slitting device **50** wherein the elements **51** are formed from the web **48** without the severing of the connection of the elements **51** to the web **48**.

The elements **51** from slitting device **50** are conducted over guide roll **151** and also over treating roll **152**. Treating roll **152** is shown to be partially submerged in the

liquid contained in treating tank **153** and is used to supply sufficient treating liquid to the elements **51** to render them amenable to the knitting operation. When elements **51** are paper, a slight wetting will add substantially to the flexibility of such paper strips. Elements **51** extend from treating roll **152** through comb **154**, tension adjuster **155** and flexible feed guides **156** to the individual knitting stations on knitting machine **42**. Since the rupture of any of the elements **51** will necessitate a stopping of the knitting, the feed guides **156** have been provided to not only compensate for any variation in tension of the elements **51** but also to provide an automatic shutdown for the whole apparatus, as hereinafter more fully explained with reference to the apparatus details of FIGURE 6. At the knitting machine **42** the elements **51** are combined with the elements **41**, as hereinafter more fully described.

A suitable drive mechanism **52** is provided to control the feeding of the elements **51** to the knitting machine **42**. It is necessary that the feeding speed of the elements **51** to the knitting machine **42** be synchronized with the speed of the knitting machine whereby proper tension is maintained in the elements **51**.

A typical example of the method and apparatus, illustrated in FIGURE 2, would be the feeding to a knitting machine of the elements **41** formed from substandard fibers in contiguous relationship with the elements **51** formed from a web **48** from a roll **47** of paper material. It has been found to be desirable to combine paper elements with the substandard fibers since the paper will at least partially engage the substandard fiber elements. With both elements **41** and **51** being in the form of relatively narrow strips of material, the individual elements will, however, gain strength through their combination by engagement with the knitting needles (hereinafter more fully explained) and when combined in a fabric will have the desired characteristics.

The elements **51** will be simultaneously fed to the knitting machine **42** in contiguous relationship with the elements **41** and will greatly assist the feeding of the elements **41** to the knitting machine. It is also suggested that material other than paper may be utilized to form the elements **51** which are to be combined and knitted with the elements **41** to form a fabric, and any suitable material desired in the end product which combines with the fiber elements as hereinafter explained may be used in accordance with the principles of the present invention.

In FIGURE 3, an apparatus is illustrated including a knitting machine **53** which is fed by strip elements from an apparatus, such as is illustrated in the right side of FIGURE 2 and as clearly described in my aforementioned prior co-pending application, and also is fed by yarn having nonuniform tensile strength.

The spools **54** of such yarn **55** are concurrently fed to the individual knitting stations of the knitting machine **53** with the elements **56** from the apparatus illustrated to the right of the knitting machine **53**.

The yarn **55** passes from the spools **54** upwardly through the loop **54***a* in flexible feed guides **54***b*, then downwardly inside of support ring **54***c* and guide ring **54***d* to the individual knitting stations. Support ring **54***c* and guide ring **54***d* are each suitably supported from machine **53** but such supports are not shown. Flexible guides **54***b* are suitably secured to support ring **54***c*.

The element-forming apparatus of FIGURE 3, as shown, is substantially identical to that apparatus previously described and includes the support structure **57** on which the roll **58** supplying the web **59** is rotatively mounted, the tension adjuster **60**, the slitting device **61**, the drive mechanism **62** and the suitable element guiding means, such as the roll **64**, and the comb **65**.

The web **59** is withdrawn from the roll **58** and fed through the tension adjuster **60** to the slitting device **61** wherein the web is divided into a plurality of elements **56**. The elements **56** are led over guide roller **64** and across treating roller **164** which is positioned in treating tank **165** at least partially submerged in the liquid contained therein to apply a suitable amount of such liquid to the elements **56**. These elements **56** are then separated by the comb **65** and fed through the tension adjuster **166** and the flexible feed guides **167** to the knitting stations on knitting machine **53**. The detail structure of feed guides **167** is hereinafter more fully explained with reference to FIGURE 6.

It should be understood that spools **54** of yarn **55** may readily be replaced by cans supplying roving of substandard fibers to the knitting machine **53**. In either case the yarn or roving will be assisted in feeding to the knitting machine by combination with the elements **56** prior to engagement into the fabric by the knitting needles of the machine **53** whereby the yarn **55** or roving will be subjected to a very limited amount of tension, and such tension will be only that necessary to cause the yarn to move from the spools, through the yarn guides **66** and to the feeding mechanism **67** wherein the yarn will be fed with the elements **56** to the knitting needles.

If desired, the yarn **55** or roving used in the apparatus illustrated in FIGURE 3 have been subjected to a treating liquid to provide some cohesiveness of the fibers whereby the yarn or roving will withstand the necessary pull to be delivered to the feeding mechanisms **67** of the knitting machine **53**.

Where a treating liquid is applied to the substandard fibers which is not desired in the end product, a liquid should be used, such as starch, which can be readily washed from the fabric produced without substantially reducing the strength of the fabric. The fabric formed by any of the three forms of apparatus illustrated in the figures will include substandard fiber elements and the strip elements. The strip elements will be fed with the substandard fiber elements to the knitting machine and will, when originally engaged by the knitting needles, be crimped to at least partially engage such fiber elements. With such engagement the combined elements will be knitted into a fabric which will appear to have a plurality of composite elements rather than a plurality of individual elements.

It is generally preferred in the process of the present invention that the additional elements used with the fiber elements or yarn be in the form of continuous strips. In such form the strips will, when engaged by the needles of a knitting machine, have a tendency to fold. Such folding of the strips will implement the inter-engagement between the strips and the substandard fiber elements to assist the drawing of the substandard fiber elements into the fabric and to form composite elements in the fabric produced.

Referring to FIGURES 4 and 5, it can be seen that strip element **190** and yarn **192** are fed to separate eyelet guides **68** and **69**, respectively, provided in the upper portion of feeding mechanism **67**. The bracket **70** is secured in feeding mechanism **67** and is provided with an aperture **71** through which both yarn **192** and strip element **190** in contiguous relationship to each other are fed to the needles **72**. It should be noted that feeding mechanism **67** is secured to the stationary portion of the knitting machine **53** and that the needles **72** move around the interior thereof so that they continually move past the individual brackets **70** and engage the yarn **192** and strips **190** which are fed through the aperture **71** of the brackets **70**. It should be noted that the yarn **192** is illustrated in both FIGURES 4 and 5 as having thinned or weakened sections **193**.

As shown in FIGURE 5, the element **192** and element **190** are guided through the aperture **71** so that both elements are directed beneath the hook portions of the needles **72**. Preferably the strip element **190** is guided against the shank portion of the needles, with the yarn element **192** adjacent said strip element; however, by reason of the speed of operation of the knitting machine

and the attendant vibration, portions of the yarn may engage the shank portions of said hooks; however, so long as the combined elements are positioned beneath the hook portions of the needles, said needles will function to cause at least partial interengagement of the elements as the needles reciprocate to perform the knitting operation. In passing through aperture **71** the strips **190** and yarn **192** will move in contiguous relationship, and when engaged by the hooks of needles **72** will be at least partially engaged by folding and crimping of strips **190**. This engagement produces combination element **74** or core yarn. When element **74** is pulled through the previously formed loops, this engagement is sufficient to make element **74** sufficiently strong to withstand such action and the knitting action of pulling element **74** through the loops will consolidate the engagement between strips **190** and yarn **192**. Thus, the action of the needles simultaneously forms a core yarn by the interengagement of the elements of different materials and also knits the core yarns into a fabric. As used herein, core yarn or combination or composite element means that element which is formed from at least two different materials by the crimping action of the needles.

It should be noted that while FIGURES 4, 5 and 7 illustrate that the strip element **190** has been crimped into engagement with yarn **192** in a position completely surrounding yarn **192**, the engagement of yarn **192** by strip **190** will not always take this position but may just engage a portion of yarn **192**. However, in accordance with the present invention there will always be at least a partial inter-engagement or interconnection between yarn **192** and strip **190** so that the combination element **74** which ultimately appears in the fabric will be a composite of the two components. In forming combination element **74**, the weakness of yarn **192** will be strengthened by the available strength of the strip **190** to prevent the rupture of yarn **192** during that portion of the knitting operation when the greatest strain is placed upon the yarn, i.e., during the pulling of the combination element **74** through the loops of the previously formed fabric. FIGURE 7 illustrates one loop of the fabric formed by the knitting of the combination elements **74** being composed of the individual yarn **192** and strips **190**.

The aforementioned inter-engagement between the yarn **192** and the strip **190** is a random positioning. This is illustrated by the sectional views of FIGURES 7A, 7B and 7C. As shown in some portions of the fabric formed, the strip **190** may completely surround the yarn as shown in FIGURES 7 and 7A. In other portions of the fabric there will be only a partial surrounding of the yarn **192** by the strip **190** as illustrated in FIGURES 7B, while other portions may only have a partial condensing or folding of the strip **190** onto a portion of the yarn **192** as illustrated in FIGURE 7C. Such inter-engagement or interconnection is sufficient to form a core yarn or composite strand which is capable of being knitted into a fabric with other such composite strands by the needles.

The details of flexible strip guides **175**, similar to guides **156** illustrated in FIGURE 2 and guides **167** illustrated in FIGURE 3, are shown in FIGURE 6. The strips **176** feeding from the tension adjuster **177** are delivered through the hook **178** of guides **175**. The hook **178** is positioned at the outer end of the guides **175** and the inner end of guides **175** is secured to the frame of the supporting structure. The flexibility of guides **175** will maintain a substantially constant tension in the strips **176** during all normal operations. The guides **175** further provide a shutoff device when one of the strips **176** ruptures. Upon rupture of one of the strips **176**, the guide **175** will spring upward into engagement with bar **179**, thereby making a connection in the shutoff circuit. This circuit is provided with a battery or other suitable power source **180** having one terminal connection to the fixed end of guides **175** and the other terminal connecting to one terminal each of the alarm **181** and switch **182**. The other terminals of alarm **181** and switch **182** are connected to the bar **179**. When one of the strips **176** ruptures, its flexible guide **175** will spring upwardly into contact with the bar **179**, thereby completing the circuit, actuating the alarm **181**, and energizing the solenoid to open the switch **182**. The switch **182** should be connected to the main circuit (not shown) for the whole apparatus whereby when one of the strips **176** ruptures the whole apparatus will immediately be shut down until the ruptured strip can be rethreaded to the knitting machine.

With the contiguous feeding of two types of elements to each knitting station of a knitting machine and with the engagement between such types of elements resulting from the action of the hooks of knitting needles, it is possible to produce a fabric from two types of elements, neither of which would have sufficient strength for knitting by itself. Thus, where cotton motes and paper are to be used for knitting, the paper elements may be relatively inexpensive and thereby allow the production of a fabric which is sufficiently inexpensive to be disposable after a single use.

Many other combinations of types of elements may be knit into a fabric by the method and apparatus of the present invention. Plastic materials may be combined with paper or with substandard fibers and knit into a fabric. A rayon yarn not suitable for knitting may be knit with elements of paper by the method and apparatus of the present invention to form a fabric.

From the foregoing it may be seen that the present invention has provided a method and apparatus for knitting a fabric from substandard fibers, which fabic is relatively inexpensive and utilizes additional material such as paper in the combination with the substandard fibers. Such method and apparatus also allow the production of a fabric from random piled substandard fibers by suitably treating, compressing, the fibers into a web, slitting the web, and combining the fiber strips with elements from a web of material to be knit into the desired fabric. The method and apparatus of the present invention also combine a yarn having nonuniform tensile strength with strips whereby a combination element results in the fabric and the combination element is formed by at least partial engagement of the yarn by the strips with the strips being crimped or compressed to form such engagement.

Further, the method and apparatus of the present invention also allow the use of two types of elements in knitting wherein either one or both of the types of elements may not have sufficient strength to be knit into a fabric. In the present invention, the fabric produced includes the knitted dual strands each of which includes a substandard element and a second element.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. The method of producing a fabric from yarn elements and strip elements,

said yarn elements having non-uniform tensile strength and being incapable of passing through a knitting operation without interruption of the knitting operation due to rupture of said yarn elements,

said strip elements being amenable to knitting,

said method comprising, feeding at least one of said yarn elements to each knitting station of a knitting machine,

simultaneously feeding at least one strip element to each knitting station of the knitting machine,

the strip and yarn elements fed to each of said knitting stations being fed in contiguous relationship to each other to the needles of said knitting machine so that said needles engage both elements to deform said strip elements substantially about said yarn elements to form them into a composite strand which is

capable of being knitted with other composite strands into a fabric by said needles, and

knitting said composite strands on said knitting machine to produce a fabric.

2. The method of producing a fabric according to claim 1 wherein,

said yarn elements are at least partially adhesively bonded to said strip elements.

3. The method of producing a fabric according to claim 1 wherein,

said yarn elements are fed to said knitting machine to form a plurality of sources of substandard fiber yarn.

4. The method of feeding elements of two different materials to a knitting machine, the elements of one material being a strip and the elements of the other material being a yarn, including

feeding at least one of each of said elements of the two materials to each knitting station of the knitting machine, and

guiding said elements in contiguous relationship to the needles of the knitting machine to position a portion of the strip element between the needles and the yarn element whereby engagement by and pulling of the needles deform the strip element into at least partial engagement with the yarn element to form a core yarn during the knitting operation.

5. The method of feeding elements to a knitting machine according to cliam 4, wherein

said yarn elements are composed of a plurality of substandard fibers.

6. The method of feeding elements of two different materials to a knitting machine, the elements of one material being a strip and the elements of the other material being a yarn, including

feeding at least one of each of said elements of the two materials to each knitting station of the knitting machine, and

guiding said elements in contiguous relationship to each other to the needles of the knitting machine to direct the strip element against the shank of the needles whereby engagement by and movement of the needles deform the strip element into at least partial engagement with the yarn element to form a core yarn.

7. The method of feeding elements according to claim 6, with the additional steps of

moving the needles in a downward direction relative to the elements,

said downward movement of said needles pulling said core yarn through a previously formed loop to further consolidate the previously formed core yarn.

8. The method of producing a fabric on a knitting machine from elements of two materials, the elements of one material being in strip form and the elements of the other material being in yarn form, including

feeding at least one of each of said elements to each knitting station of the knitting machine,

guiding said elements at each knitting station in contiguous relationship to each other to the needles of the knitting machine with the strip element being directed against the shank of the needles, and

knitting a fabric from a core yarn which is simultaneously formed during the knitting operation by reason of the needles engaging the contiguous elements to deform the strip element into at least partial engagement with said yarn element to produce said core yarn.

9. The method of producing a fabric from two different materials on a knitting machine, including

dividing a web of compressed, adhesively bonded substandard fibers into a plurality of yarn elements,

producing a plurality of strip elements of a material having characteristics which render the strip elements amenable to knitting,

feeding one of said yarn elements and one of said strip elements to each knitting station of a knitting machine,

guiding said elements at each knitting station in contiguous relationship to each other to the needles of the knitting machine to direct the strip element into at least partial contact with the shank of the needles whereby movement of the needles deforms the strip element into at least partial engagement with the yarn element to form a core yarn, and

knitting said core yarns into a fabric.

10. The method of producing a fabric on a knitting machine in accordance with claim 9, including the additional steps of,

feeding a continuous bat of substandard fibers to a treating zone wherein said bat comprises a pile of loose, random fibers of a definite width and a substantially uniform thickness,

impregnating said bat with a treating liquid in the treating zone, and

compressing said bat of treated fibers leaving the treating zone into a relatively thin web of material wherein the fibers are at least partially bonded together by the treating liquid,

the foregoing steps being performed prior to the step of dividing said web into the yarn elements.

11. The method of producing a fabric from elements of two materials,

the element of one material being initially a flat strip,

the elements of the first material having insufficient or non-uniform tensile strength which prevents the elements from passing through a knitting operation without interruption of the knitting operation due to rupture of said elements,

the elements of the second material having characteristics which render them amenable to knitting,

said method comprising,

feeding one element of the first material to each knitting station of a knitting machine, and

simultaneously feeding one element of said second material to each knitting station of the knitting machine,

the two elements fed to each of said knitting stations being fed in contiguous relationship to each other to the needles of said knitting machine so that in performing the knitting operation, said needles engage both elements and deform said initially flat strip element substantially about the other element to thereby connect the elements to each other with sufficient attachment to form a composite strand which is capable of being knitted without rupture with other composite strands into a fabric by said needles.

12. The method of producing a fabric from elements of two materials,

the elements of both materials having insufficient or non-uniform tensile strength which prevents the element from passing through a knitting operation without interruption of the knitting operation due to rupture of said elements,

the elements of one material being intially a flat strip,

said method comprising,

feeding at least one element of each of said materials to each knitting station of a knitting machine,

the elements fed to each of said knitting stations being fed in contiguous relationship to each other to the needles of said knitting machine so that in performing the knitting operation, said needles engage both elements and deform said initially flat strip element substantially about the other element to thereby connect the elements to each other with sufficient attachment to form a composite strand which is capable of being knitted with other composite strands into a fabric by said needles.

(References on following page)

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References Cited

UNITED STATES PATENTS

2,049,845	8/1936	Lepine	66—125
2,156,549	5/1939	Smith	66—202
2,169,886	8/1939	Shaw	28—1
2,596,246	5/1952	Johnson et al.	28—1

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2,678,552	5/1954	Adams	66—202
2,921,455	1/1960	Furge	66—125
3,193,904	7/1965	Evans et al.	28—1

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