Oct. 12, 1948. S. W. ALDERFER 2,451,016

ELASTIC THREAD AND PROCESS OF MAKING SAME

Filed Oct. 18, 1945

Fig. 1.

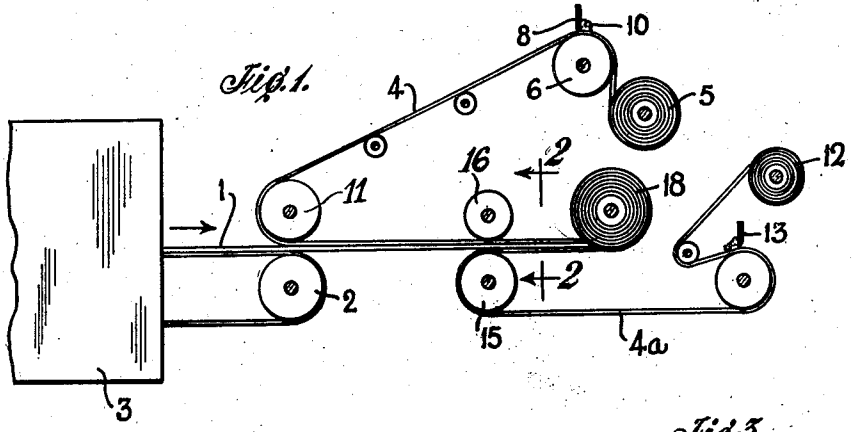


Fig. 2.

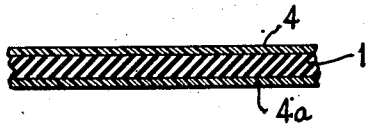
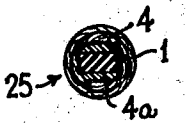


Fig. 3.



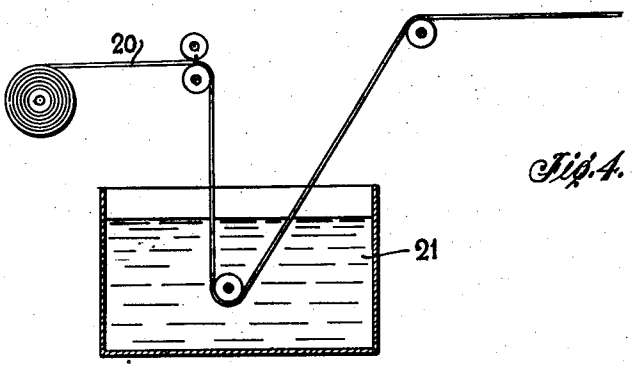


Fig. 4.

Fig. 5.



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Patented Oct. 12, 1948 2,451,016

UNITED STATES PATENT OFFICE

2,451,016

ELASTIC THREAD AND PROCESS OF MAKING SAME

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Application October 18, 1945, Serial No. 623,026

15 Claims. (Cl. 154—91)

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The present invention relates to new and useful improvements in the art of manufacturing elastic thread and particularly to a method of making very fine and delicate elastic threads. The base for these threads is rubber or rubber-like materials which have been perfected as substitutes for natural rubbers. When, therefore, the term "rubber" is employed in the specification or claims, it is intended to cover either a natural rubber or a synthetic material having the elastic properties of rubber and suitable for the purposes.

The principal use for the delicate elastic threads made by the process set forth herein is in the manufacture of garments such as hosiery tops, girdles, bathing suits or wherever it is desirable to use fabrics with mild tensions. The difficulties heretofore encountered in the manufacture of elastic thread responding to the requirements stated have been both in the manufacture of the thread and also in the subsequent weaving, knitting or braiding operations. With methods heretofore employed in the manufacture of extremely fine threads, if the threads become too delicate they are difficult to cut or form, and frequently break either during the forming operation or during spooling. It is also difficult to obtain a uniform tension on threads of very fine gauge such, for example, as a few thousandths inch in diameter.

When the thread is transferred to a loom, knitting or braiding machine, it is also subject to frequent breakage and as it stretches easily under very slight tension, it is difficult to regulate the tension on the various instrumentalities through which the thread passes so that the machines can operate efficiently.

It is, therefore, the purpose of the present invention to devise a method of manufacturing an elastic thread from rubber or rubber-like materials which will obviate the objections and difficulties which have been enumerated, and to provide a new type of elastic thread which may be employed in all kinds of textile machinery with the same facility as a non-elastic thread.

It is also an object of the invention to provide a rubber thread having a uniform stretch or elongation. Many elastic threads, and particularly fine threads, have light or heavy spots so that the thread stretches unevenly. The thread of the present invention has uniform stretch characteristics throughout.

This present invention is in the nature of an improvement upon the advances in this art described in my prior copending application Serial No. 543,132, filed July 1, 1944, now Patent No. 2,427,344, dated September 16, 1947.

The description and drawings herein are somewhat detailed in order to give a full and complete disclosure of the best known and preferred embodiments of the invention, but it will be understood that exact conformity therewith is not required, and the invention may be adapted and modified as may appear desirable or advisable. In the drawings are shown, in diagrammatic form, mechanical arrangements by which the thread may be made, but, again, these are merely for the purpose of showing certain procedures which may be employed and are not intended to illustrate all the various modifications which are adaptable for the process.

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Fig. 1 is a diagrammatic showing of a mechanical installation which may be employed.

Fig. 2 is an enlarged cross-section on the line 2—2 of Fig. 1 through the composite sheet. This view may also be deemed as a longitudinal section through the finished thread.

Fig. 3 is an enlarged cross-section through a covered thread before the plastic backing material referred to herein is removed.

Fig 4 is a view showing a simple dipping device for adapting the invention to previously formed threads. These may be either of the rolled, extruded or cut type.

Fig. 5 is a cross-section through the thread of Fig. 4, a round thread having been selected for the showing.

Briefly stated, the invention comprises the steps of uniting the rubber preferably when it is unvulcanized, with a stretchable plastic backing material having certain properties which are utilized to carry out the purposes of the invention. The properties of the plastic material to be selected which adapt it to the invention, are its ability to elongate permanently to a desired or predetermined degree, and this may be a degree which is the limit to which it can be stretched. This property having a permanent degree of elongation is frequently referred to as "orientation" by which is meant that the molecules of the material have rearranged themselves in alignment with the direction of pull. The material in this state is non-elastic and has little or no tendency to return to its former condition when the pull is relaxed. When material of this type is oriented, it usually has an increased tensile strength.

A second property which is essential to the uses for which the invention is adapted is that the backing material should be what may be termed a fugitive material, which is to say, that it is completely eliminated in the subsequent steps after the thread is completed or the product is fabricated. To achieve this result the backing soluble in liquids which are not deleterious to the finished product. Elastic threads used in the manufacture of garments may be covered with cotton, rayon, nylon, silk, or other textile materials, although this is not essential in practical applications of the invention. One of the advantages of the present invention is that the two layers or sheath of plastic material protects the

rubber content of the thread and the thread will pass through any guides or tensioning devices with a minimum of friction and without injury to the rubber.

In order to release the elastic material so that its dormant elastic properties may be utilized, the plastic backing material should be eliminated after the thread is covered or the fabric is completed. This ordinarily requires that the thread or fabric be treated with a solvent for the backing material and that the solvent should have no deleterious effect upon the textile materials. As all garments are washed after manufacture, the preferred types of plastics to be used as the backing material should be water soluble so that the backing material may be eliminated from the finished product with the least trouble and without injury to the product. It is not intended, however, to limit the invention to the use of water-soluble plastics, if it may be discovered that other plastics soluble in other non-deleterious solvents may be employed to release the elastic material from its backing after fabrication of the product.

A third desirable property of the plastic backing is that it should be able to withstand the temperatures which are employed in the vulcanization of the rubber or rubber-like material.

A number of plastic materials commonly of the type known as synthetic resins have been developed in recent years which will answer these requirements, and it is not wished or intended to limit the invention in any manner to one material or group of materials. It has been found, however, that polyvinyl alcohol and its derivatives give the best results and are the most readily workable material for the process. This material is capable of definite and fixed orientation and when stretched may reach a point where there is no further ability to stretch and little or no tendency to return to its former condition. It is also water soluble and is not affected by the heat employed in vulcanizing the rubber.

Rubber hydrochloride film may be used in place of polyvinyl alcohol, in which case toluene would be used as the solvent. Polyvinyl chlorides or their copolymers may be used, in which case any suitable solvent may be used, such as toluene. If an acetate film is employed, butyl acetate or any other acetate would be used.

For the rubber or rubber-like constituent of the thread, it is preferred to employ a natural or artificial dispersion of rubber, natural latex being admirably suited for the purpose. This, however, is not intended to exclude the employment of sheets of rubber calendered from pre-coagulated rubbers. The rubber which is employed will contain the usual compounding and vulcanizing ingredients.

Referring now to Fig. 1 of the drawings: In this particular procedure for carrying out the process, the rubber sheet is made from a natural latex or an artificial water dispersion of rubber or rubber-like material, by spreading a layer 1 thereof on an endless belt 2 which passes through a drying oven 3. The water is evaporated, which leaves a sheet of rubber of any desired thickness on the belt as it issues from the oven.

The sheet of rubber 1, preferably before it leaves the belt 2, is united to a layer of the plastic backing. As stated above, this is preferably a sheet of polyvinyl alcohol coextensive with the rubber sheet. The sheet of polyvinyl alcohol or other backing material 4 is supplied from a roll 5 and is preferably led over a roll 6 where it receives a relatively thin coating of a suitable adhesive cement. As exemplary of this step a doctor bar 8 may be placed in the position shown in the drawing with a bank 10 of the cement behind it. A sufficient period is allowed to cause the cement spread upon the layer 4 to reach the proper state of tackiness. The layer then reaches the roll 11 where it is laid over the rubber sheet.

A second layer of the backing material 4a is supplied from a roll 12, receives its coating of cement at 13 and is led over the roll 15 and applied to the opposite side of the rubber sheet. At this point or at a later point, pressure is applied to the composite sheet to adhere the elements firmly together. A pressure roller 16 is shown for this purpose. The composite sheet is then rolled up as at 18.

The subsequent steps may vary in order or timing, but the essential elements of the process are to laminate the rubber and the backing strips, cure the rubber, orient the backing layer by stretching it to the desired point of its orientation, and to slit the sheet into strips which form the threads. The simplest embodiment of the invention is to cure the rubber and then slit the composite sheet into narrow ribbons and stretch or elongate to the desired degree. As a variation the composite sheet may first be slit and the rubber cured thereafter. The stretching of the composite sheet of rubber will elongate the rubber, and thus place it under the desired tension which, of course, is dormant as long as the backing layers are present. The elongation of the rubber reduces the gauge of the thread and it is thus possible to make elastic threads of extreme fineness depending upon the factors of original thickness of the rubber layer and the stretch factor employed. The presence of the backing layer which elongates uniformly causes a uniform elongation of the rubber element. The degree of stretch may be fixed by the extent to which the backing layer is elongated before it reaches the limit of orientation. To reach any degree of elongation before complete orientation, the layers of backing material may be pre-stretched before application to the rubber sheet. Thus, by using a polyvinyl alcohol sheet which has the capability of stretch $6x$ the rubber may also be stretched $6x$, but if only a $2x$ stretch is desired in the rubber, the polyvinyl alcohol sheet may be stretched $3x$ before it is applied to the rubber.

A further variation is to slit the composite sheet before vulcanization to form the ribbons, stretch the ribbons, for example, $3x$ and then respool the ribbons. The ribbons may then be placed in a curing oven to cure the rubber. The thread may then be stretched, for example $2x$ to bring the rubber to the desired stretch and tension. In this process it may also be desirable to relax the tension imparted to the uncured rubber in the initial stretching. This may be done by compounding the rubber with what is known in the art as a delayed accelerator. This permits the rubber molecules themselves to relax before the cure is set up and they will reassume somewhat their original form before being finally cured. This variation of the process is particularly desirable where a very fine, light tension, elastic thread is to be the product. In this variation of the process the backing sheets have been stretched six times and the rubber only twice, yet a very fine rubber thread is obtained because the initial stretching has attenuated the layer of rubber before it is set up in the cure.

One of the purposes in providing two backing

layers, one on either side of the rubber, is to prevent the curling of the composite thread when released from any holding device, such, for example, as when unspooled. In the process of my prior application where only one layer of the backing material was employed, the tension in the rubber element of the composite thread and the tendency to contract as soon as all restraining forces are relieved, caused the thread to curl the instant that it was free. This made the composite thread difficult to handle in the spooling and weaving or knitting operations. By sandwiching the rubber between two layers of the backing material, the rubber cannot cause the thread to curl or twist, as the rubber is encased between two layers which are of the same fixed length and form a sheath to prevent the thread from curling. As noted above, the sheath of rubber also facilitates the weaving or knitting operations because it protects the rubber from injury by the machinery.

A somewhat similar, but less desirable method of preventing the thread from curling is to encase the rubber thread completely in a jacket of the backing material, and the subsequent steps of stretching and orienting are carried on with a thread of this form. In Fig. 4 this variation of the process is shown where a rubber thread 20 is led through a bath 21 of polyvinyl alcohol giving a composite thread of the form shown in Fig. 5.

After the thread is completed and stretched to the desired degree, it may be covered by the ordinary covering process with the chosen textile material. A thread made in accordance with the process described in connection with Fig. 1 is shown in Fig. 3 with two layers of covering 25 thereon. It is not essential that the thread be covered at this stage, however, as frequently a bare elastic thread may be woven directly in the fabric. In any event, the layers of backing material keep the rubber under tension and protected during covering and weaving or knitting.

Either after the thread is covered or after the product is completely fabricated, the fugitive backing layer or layers are removed, and, as indicated above, this is preferably by washing in which case the water dissolves the backing and the rubber element is now fully released from any restraint and becomes the elastic element of the product. It will be seen that up to the time that the backing is eliminated the thread is non-stretchable and consequently it can be handled exactly as any non-stretchable thread. This greatly facilitates all of the manufacturing operations and makes it possible to achieve a very fine thread with a uniform degree of elasticity throughout.

If desired for any reason to have a bare elastic thread, the fugitive backing may be eliminated before covering.

Other variations and modifications of the process will suggest themselves to those skilled in the art.

What is claimed is:

1. A process of making elastic threads comprising the steps of placing a sheet of uncured rubber between two layers of a fugitive backing material, said material having the property of permanently elongating when stretched to a predetermined degree, curing the rubber, slitting the composite sheet thus formed into ribbons, stretching the ribbons, and thereafter removing the backing.

2. A process of making elastic thread comprising the steps of attaching two sheets of a fugitive backing material to the surfaces of an uncured rubber sheet, said backing material having the property of permanently stretching to a predetermined degree, curing the rubber, slitting the composite sheet thus formed into ribbons, stretching the ribbons until the backing material has reached a predetermined point of elongation, and then releasing the rubber constituent of the ribbons by eliminating the fugitive backing.

3. A process of making elastic threads comprising the steps of attaching two sheets of a water-soluble backing material to the surfaces of an uncured rubber sheet, said backing material having the property of permanently stretching, curing the rubber, slitting the composite sheet thus formed into ribbons, stretching the ribbons until the backing material has reached a predetermined degree of elongation, and then releasing the rubber by dissolving the backing material.

4. A process of making elastic threads comprising the steps of attaching two sheets of polyvinyl alcohol or other permanently orientable and soluble plastic material to the surfaces of an uncured rubber sheet, curing the rubber, slitting the composite sheet thus formed into ribbons, stretching the ribbons until the plastic material has reached a predetermined degree of orientation, and then removing the plastic material.

5. A process in accordance with claim 4 in which the rubber is cured after the composite sheet is slit into ribbons.

6. A process of making elastic threads comprising the steps of attaching two sheets of polyvinyl alcohol or other permanently orientable and soluble plastic material to the surfaces of an uncured rubber sheet, curing the rubber, slitting the composite sheet thus formed into ribbons, stretching the ribbons until the plastic material has reached a predetermined degree of orientation, and then washing out the plastic material to release the rubber constituent of the threads.

7. The process of making an elastic thread comprising the steps of attaching a sheet of backing material to an uncured sheet of rubber, said backing material having the property of stretchability to a fixed degree of permanent elongation, slitting the composite sheet thus formed into ribbons, stretching the ribbons to a degree short of the permanent elongation of the backing material, heating the rubber so as to first relax the rubber and then complete the cure, again stretching the ribbons, and then releasing the rubber by removing the backing material.

8. The process of making an elastic thread comprising the steps of attaching a sheet of polyvinyl alcohol to an uncured sheet of rubber, slitting the sheet thus formed into ribbons, stretching the ribbons to orient partially the polyvinyl alcohol, heating the rubber so as to first relax the rubber and then complete the cure, again stretching the ribbons, and then releasing the rubber by dissolving the polyvinyl alcohol.

9. The process of making an elastic thread comprising the steps of attached two sheets of polyvinyl alcohol to opposite sides of a sheet of uncured rubber, slitting the sheet thus formed into ribbons, stretching the ribbons to orient partially the polyvinyl alcohol, heating the rubber so as to first relax the rubber and then complete the cure, again stretching the ribbons, and then

releasing the rubber by dissolving the polyvinyl alcohol.

10. The process of making an elastic rubber thread comprising the steps of enclosing the uncured rubber element of the thread in a sheath of a material which has the property of stretchability to a predetermined degree of permanent elongation, curing the rubber, stretching the thread until the said material has reached a predetermined degree of elongation, and releasing the rubber by removing the sheath.

11. The process of making an elastic rubber thread comprising the steps of locating the uncured rubber element of the thread in a sheath of a permanently orientable plastic material, curing the rubber and stretching it with the sheath, and then releasing the rubber by removing the sheath.

12. The process of making an elastic rubber thread comprising the steps of locating the uncured rubber element of the thread in a sheath of polyvinyl alcohol, curing the rubber and stretching it with the sheath until the polyvinyl alcohol has reached complete orientation, and then releasing the rubber by removing the sheath.

13. A process in accordance with claim 11 in which the sheath is removed by dissolving the plastic material.

14. The process of making an elastic rubber thread comprising the steps of forming a sheath on the uncured rubber element of the thread, said sheath being composed of a material which has the property of stretchability to a fixed degree of permanent elongation, stretching the rubber and the sheath concurrently and curing the rubber, and then removing the sheath to release the rubber.

15. The process of making an elastic rubber thread comprising the steps of forming a sheath on the uncured rubber element of the thread, said sheath being composed of a material which has the property of stretchability to a fixed degree of permanent elongation, stretching the rubber and the sheath concurrently until the material of the sheath has reached its fixed degree of stretch, curing the rubber, and then removing the sheath to release the rubber.

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