May 14, 1946. R. F. WARREN, JR 2,400,181

ROPE

Original Filed June 19, 1940

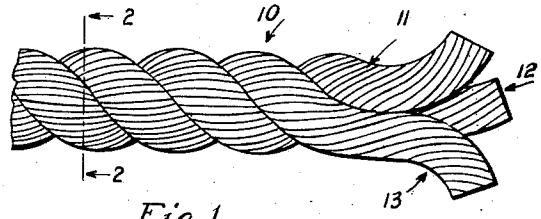


Fig. 1.

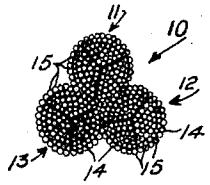


Fig. 2.

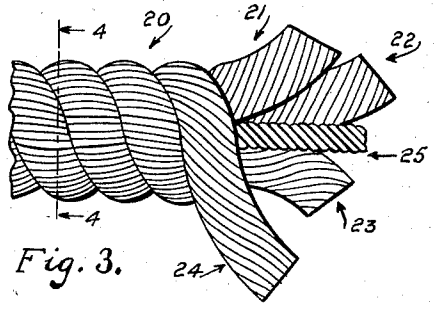


Fig. 3.

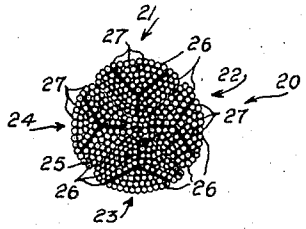


Fig. 4.

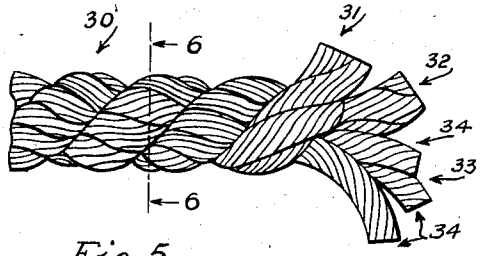


Fig. 5.

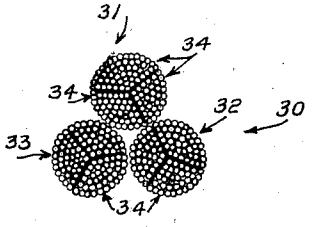


Fig. 6.

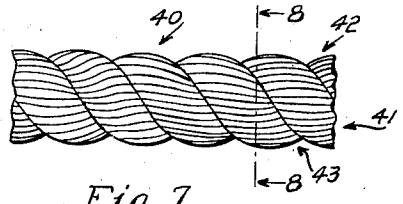


Fig. 7.

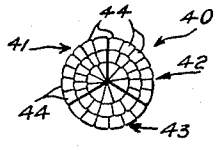


Fig. 8.

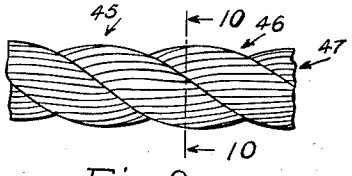


Fig. 9.

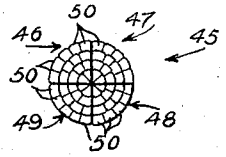


Fig. 10.

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UNITED STATES PATENT OFFICE

2,400,181

ROPE

Richard F. Warren, Jr., Stratford, Conn.

Original application June 19, 1940, Serial No. 341,352. Divided and this application September 3, 1942, Serial No. 457,200

2 Claims. (Cl. 57—140)

This invention relates to new and useful improvements in ropes.

The objects and advantages of the invention will become apparent from a consideration of the following detailed description taken in connection with the accompanying drawing wherein satisfactory embodiments of the invention are shown. However, it is to be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

In the drawing:

Fig. 1 is a side elevational view of a short section of a three strand rope made in accordance with the invention;

Fig. 2 is an enlarged transverse sectional view taken as along the line 2—2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1 but showing a four strand rope of the type having a heart or core;

Fig. 4 is a transverse sectional view taken as along the line 4—4 of Fig. 3;

Fig. 5 is an elevational view of a short section of a cable-laid rope;

Fig. 6 is a transverse sectional view taken as along the line 6—6 of Fig. 5;

Fig. 7 is an elevational view of a short section of a three strand lariat rope;

Fig. 8 is a transverse sectional view taken as along the line 8—8 of Fig. 7;

Fig. 9 is a view similar to Fig. 7 but showing a four strand lariat rope; and

Fig. 10 is a transverse sectional view taken as along the line 10—10 of Fig. 9.

The present application is a division of my application Serial No. 341,352, filed June 19, 1940.

For the purpose of the following specification and claims, I use the word "rope" to describe any size of rope whether it be such as is commonly called a rope or whether it be such as may be called a cable, cablet, hawser or the like. Further in this specification and in the claims, I use the word "strand" to describe those physically separate elements or members generally comprising a number of filaments or yarns which, when combined in multiple, constitute a "rope" although it will be understood that certain multi-element "strands" herein disclosed are "ropes" and when combined with one another simply constitute larger diameter ropes.

Referring in detail to the drawing and at first more particularly to Figs. 1 and 2 at 10 is generally indicated a short section of a three strand rope. Rope 10 includes strands 11, 12 and 13 each comprising three similar yarns 14 although as the description proceeds it will become evident that the number of yarns involved is not a part of the invention. A number of filaments 15 are twisted together to form a yarn (a bundle of filaments) and the yarns are twisted together to form strands which latter when twisted together, form the rope. Filaments 15 may be solid thread-like elements of choosen diameters or each such filament may comprise a large number of very fine filaments twisted together. The diameter of the yarns may vary and may be determined by the sizes of the filaments used and/or the number used and the sizes of the strands are determined by the diameter and number of the yarns used and, of course, the sizes and number of strands used in making the rope determines the diameter of the latter.

In the present instance the rope is made of vinylidene chloride (known commercially as Venalloy) or other vinyl derivative or other plastic material and preferably of a synthetic plastic material. Later in this specification the materials concerned are set forth. Since the rope is of a plastic the diameters of the filaments used may be predetermined whereby to give a rope of the desired characteristics. For example, where very fine filaments are used, a rope of greater flexibility may be obtained than is the case when relatively large diameter filaments are used. For my present purpose it is not necessary that all the filaments in a rope be of the same diameter. All the filaments in any particular yarn may be of the same or different diameters and in fact, for certain purposes an entire yarn may be a solid integral mass, i. e. a single filament as in Figs. 7 and 8.

The stiffness of the rope may also be determined to some extent by the amount of orientation which has taken place in the rope elements. When the filaments come from the extruding or spinning operation, they are rather soft and are very flexible. As they are stretched and oriented they increase in stiffness and by carrying the orientation process to predetermined points the stiffness of the resulting filaments and the ropes made from the latter may be determined. Obviously, this applies only when the plastic used in making the filaments is such as may be oriented and the amount of orientation which may be effected depends on the particular plastic used.

Referring now to Figs. 3 and 4 there is shown a rope generally designated 20 made up of four

strands 21, 22, 23 and 24 twisted together about a heart or core 25. As disclosed, each of the mentioned strands is made up of three yarns 26, each comprising filaments 27. The filaments are twisted together to form the yarns and the latter are then twisted together to form the strands which are then twisted about the core 25.

While this core was substantially round in transverse section prior to the laying operation, it is noted (see Fig. 4) that in the laying operation the heart has been crushed into a more or less diamond shape, the sides being concave. It will be appreciated in connection with the ropes 10 and 20 that prior to the laying of the yarns into the strands, the yarns were substantially round in transverse section but have been crushed out of shape in the laying operation. It is also true that the strands are deformed in the laying operation.

Core 25 as here disclosed comprises a number of filaments twisted together to form in effect a strand. The rope 20 is made up entirely of vinylidene chloride although other plastic materials later mentioned, may be used and it will be understood that the core 25 may be made of steel if a stiffer rope is desired. Even when the rope is entirely of plastic its stiffness may be controlled by pre-determining the diameters and/or by orientation of the filaments as above suggested.

Figs. 5 and 6 disclose a cable laid rope of vinylidene chloride formed by twisting together three of the ropes which I disclosed in Figs. 1 and 2. However, it will be appreciated that three of the ropes 20 of Figs. 3 and 4 might also be twisted together to form a cable laid rope. As to the details, it is noted that the cable laid rope disclosed and which is generally designated 30, includes three ropes 31, 32 and 33 each in turn, made up of three main strands 34 and such strands are shown as each comprising three yarns 35. Each yarn as above suggested, may comprise a single large diameter filament although as shown it is made up of a number of filaments (of the same or different diameters) this depending on how flexible or how rigid a rope it is desired to produce.

Figs. 7 and 8 show a three strand lariat type rope generally designated 40 and the strands of which are designated 41, 42 and 43. Each strand comprises a number of yarns 44 and as here disclosed, each yarn comprises but a single element or filament of vinylidene chloride. This type of rope is necessarily relatively stiff and the single filament yarns are therefore rather desirable. However, the invention is not limited to such construction since obviously, each yarn may comprise a number of small filaments twisted together.

Figs. 9 and 10 also show a lariat rope but one comprising four strands and such rope is generally designated 45 and is made up of strands 46, 47, 48 and 49. Each of said strands is shown as comprising a number of yarns 50 although each yarn comprises but one filament or element of vinylidene chloride. It will be understood that if a more flexible rope is desired, each yarn may be formed of a plurality of filaments as suggested in connection with rope 40.

In making the rope of the invention each of the filaments (metallic and non-metallic) is preformed or formed on a helix whereby the filaments in a strand interfit with one another without stress. Thus should any filament become broken the ends of such filament will not have a tendency to spread outwardly of the zone of the body of the strand and will resist unstranding and thus remain in place giving something to the strength of the assembly. This same preforming operation is carried out in connection with the strands made of the preformed filaments whereby the strands being formed into helices will lie in an unstressed neutral condition in the ropes.

The preformed construction has little internal stress and therefore, ropes made as described will lie in a flat or straight condition with no real tendency to snarl or twist. When the ropes are to be cut it is not necessary to seize the ends as they will not unlay. Also such ropes have a longer life when run on sheaves; they are easier to splice; resist rotating in grooves; spool or coil perfectly and resist whipping.

While in connection with the disclosed embodiments of the invention the various filaments have been described as of vinylidene chloride it is to be understood that such material is the plastic preferred in the making of my ropes but that other plastic may be used. Generally speaking the filaments comprise organic plastic materials or certain inorganic plastic materials as glass fibres, quartz fibres, or bentonite (in the form known as Alsifilm) although asbestos has been found useful for my present purpose.

In fact some of the organic plastics may be used with clay or other cheap fillers as well as with fillers of cotton, silk, wool, waste ends from rope making, or other fibrous materials both natural and synthetic. Thus cotton, silk, wool, rayon and other regenerated celluloses, or other fibrous material may be used in the form of flock, stable fibres, threads, swatches of woven fabrics or impregnated sheets cut to strips for twisting into elements or strands. In addition cellulose derivatives while in alpha and beta stage may be used as fillers and to toughen the material.

Vinylidene chloride possesses about all of the characteristics required. It is oil, acid, and alkali resistant, non-inflammable, has the desired modulus of elasticity, tensile and flexural strength, is resilient, will not oxidize, is not too adversely affected by sun or other light rays and has exceptionally few solvents. Further it is for the most part (as are the other vinyl derivatives) resistant to corrosive halides such as chlorine and bromine and also to mustard gas. Vinylidene chloride is permanently water proof and is not affected by bacteria and will not support fungus growth and so is not likely to decay through biochemical attack. The vinylidene chloride (sold commercially as Venalloy) is in most respects mentioned herein similar to another vinyl compound sold commercially as Vinyon. However the latter is not as desirable due to the necessary use of plasticizers which dissipate in time making the material very brittle.

Vinylidene chloride has a critical point of set in that such material when stretched to the point of most yield has a return of about 10 percent. The stretching must be accomplished within a short time following extrusion as otherwise the material must be soaked in heat to cause it to return to random orientation prior to stretching to prevent the formation of cracks in its surface. Plastic filaments having a fixed amount of stretch and return provide a rope which gradually takes up its load. The parts will return to normal on being relieved of the load. The initial portion of the stretch is most easily obtained and as the rope elongates each succeeding degree of

elongation requires a greater or increased load so that the load in any given instance is gradually taken up.

The filaments and cores of the rope of the invention may be of any of the various plastics as above suggested and such plastics include synthetic resins, natural and synthetic lastics, cellulose (as ethyl cellulose) and its derivatives, protein plastic substances (as nylon), and petroleum plastic derivatives. There are several chemical types of synthetic resins such as (1) phenol-aldehydic resins, (2) amino-aldehydic resins, (3) hydroxy-carboxylic resins, (4) sulphonamide resins, (5) resins from sugar, (6) vinyl resins including resins from vinyl derivatives, (7) indene resins and (8) lignin plastic substances. The polymerization resins and particularly the vinyl resins are preferred for my purpose.

Under the type (1) may be included resins such as phenol formaldehyde, cresol and cresylic acid, other tar acids and formaldehydes, phenol furfuraldehyde or other tar acids and other aldehydes. Under type (2) is included urea and formaldehyde resins, and aniline resins obtained by condensing aniline and formaldehyde and other anilines or amines and other aldehydes.

Under type (3) I include materials produced by the esterification of polybasic acids with polyhydric alcohols. Such materials are frequently called alkyd resins, this title including adipic acid resins obtained by the condensation of adipic acid and glycerin or by the condensation of glycerin with phthalic anhydride. Type (4) includes the sulphonamide resins developed from para toluenesulphonamide. The resins from sugar, type (5) above, are obtained by condensing saccharide with aldehydes and urea.

Vinylidene chloride (sold commercially as Venalloy) is included in the group of vinyl resins (type 6) including resins from vinyl derivatives and such group also comprehends vinyl ester, vinyl butyrate, vinyl chloride, acrylic resins from vinyl carbonic acid ester, vinyl carbonic acid, vinyl benzole or polystyrol, divinyl or butadiene, vinyl ester or vinyl chloride, copolymerized polyvinyl chloride and polyvinyl acetate (known commercially as Vinylite), vinyl acetate, polymers of vinyl halides combined with different percentages of plasticizers (known commercially as Koroseal) the commercial article known as Vistanex and comprising polyiso butylene polymerized with boron trifluoride and also comprising polyiso butadiene having a tacky to rubber-like structure, the commercial products known as Vinyon (a copolymer of polyvinyl chloride and polyvinyl acetate), Butacite (a reaction product of vinyl acetate resin with butyraldehyde), and Rezel (resulting from the fact that the introduction of an unsaturated resinous ester of the maleate polyester type into a compound of the type ($R—CH=CH_2$) has the property of curing the latter), the polymer of ester of acrylic acid known commercially as Plexigum, polymers of the esters of methacrylic acids such as the polymethacrylic resin sold as Lucite and Plexiglas. Isobutyl methacrylic resins, certain plastic obtained by mixing the monomer of styrene with vinylidene chloride and with ethylene glycol and maleic acid and copolymerizing the mixture, styrene and in addition thereto the resin known as polystyrene.

Resins of the indene group (type 7) include polyindene and poly-cumaron. Under type (8) I include lignin and its derivatives extracted from paper mill waste waters and other sources. The lignin may be separated into various chemical components of no value to me here but also into colored gums and by various treatments into clear transparent resins useful for my present purpose. Lignin is hydrogenated with Raney nickel catalyst, in aqueous solution yielding methanol, propylcyclohexane, hydroxy propylcyclohexanes, and a colorless resin which may again be separated into an alkali soluble and an alkali insoluble component. I use either of these components in the production of resins to be used in the making of ropes.

Under the heading of natural and synthetic lastics, I include as natural lastics—balata, rubber, gutta percha and latex to be used alone or as a coating or processed or compounded with other materials. As the synthetic lastics I mention polymerized chloroprene (of the type now sold as neoprene); polymerized butadiene (of the type sold as Buna or Perbunan); polymethylene polysulphide (of the type sold as Thiokol); chlorinated rubber (of the type sold as Tornesit); rubber hydrochloride (of the type sold as Pliofilm); and isomerized rubber (of the type sold as Pliform) and any latex of these. Also sulphonated rubber or synthetic sulphonates to promote wire adhesion.

Certain materials sometimes called synthetic lastics I prefer to include under the heading of vinyl derivatives. For example, it appears that the polymerized vinyl derivative known commercially as Vistanex (polyiso butylene and polyiso butadiene) might be included under either group. Such material is used in the present instance when mixed with other materials and has certain lubricating properties of value in the making of ropes.

Under the heading of cellulose and its derivatives I include cellulose acetate; regenerated cellulose; cellulose xanthate; benzylcellulose; ethylcellulose; cellulose hydrate; cellulose triacetate; cellulose acetobutyrate; cellulose acetopropionate; hydrolysed cellulose acetate and others of the cellulose esters and ethers. Railan a rayon thread made from cellulose extracted from sugar cane may also be used. Most of these materials can be used alone for my purpose in the making of ropes. Also certain of these materials may be used with other materials herein mentioned for the purpose of toughening the latter.

Nitrocellulose compounded with other materials of a less flammable nature or of a nature to prevent flammability, may be used. Halowax or the like may be used for compounding with nitrocellulose and it is noted that the latter is so far as cost, strength and the like are concerned, a desirable material for my purpose. Other non-inflammable plasticizers which may be compounded with nitrocellulose for my purpose are monophenyl phosphate and di (paratertiary butyl phenyl) mono 15 tertiary butyl 2 xenyl phosphate. The flammable nature of nitrocellulose may be weakened or lessened by mixing with varying proportions of cellulose acetate. Under this class may also be included Gel Cellulose which may be used for my purpose. This material may be used as a filler with other materials herein mentioned.

Under the heading of protein plastic substances, I include casein preferably in the fibrous form sold as Lactofil and Lanital made by either the wet or dry process. The material sold as Zein, and which comprises a raw material in the form of a powder, may by extrusion or the like, be converted into fibres for use here. Polypenta-

methylene sebacamide and other chemical modifications sold as nylon may also be used. Regenerated silk made by reducing waste silk and waste cocoons containing silk and then forming it into threads is also believed to fall under the present heading.

That group of compounds of which at least one is obtained by condensation polymerization from a diamine and a dibasic carbonxylic acid and of which one is now sold under the trademark Exton is very useful for my present purpose.

Another protein plastic which may be used is obtained by extracting the protein from the refuse remaining after the oil has been extracted from soy beans, oiticica nuts, and other protein bearing substances. The extracted protein is properly reacted to form plastic substances. Here it is noted that oiticica oil may be used as a pasticizer with styrene to make the latter more suitable for my purpose.

Collagen plastics are another protein substance suitable for my purpose. Such plastics are fibrous. The collagen may be recovered from the waste from tanneries or otherwise. Various resins from coffee may also be used.

The petroleum plastic derivatives include those gums or resins obtained by the oxidation or controlled polymerization of certain distillates of petroleum cracking. Thus I may use the commercially known "Santoresins" produced by this method as well as "Petropol" which is a softer type of the same material. These materials are, when used for my purpose, to be mixed with other materials listed above whereby the resultant mass may be shaped by extruding or the like to provide filaments having desired characteristics. Propane precipitated resins from distillation of crude petroleum may also be used to advantage as an assistant to produce heat penetration to materials like vinylidene chloride and retain stability.

Also cracking coal tar resins of high aromatic content condensed with formaldehyde or other aldehyde forms resins useful for my purpose. Similarly, I may use heavier petroleum products cracked and then condensed with formaldehyde or other aldehydes, hydrogenated or chlorinated either at elevated temperatures or by the addition of metallic halides. For use as rope cores comprising large diameter bars and the like, the materials are advantageous. The natural inorganic materials above mentioned may be used in the place of the organic plastics in certain instances. The glass or the quartz must be made plastic by heat and then it is spun or extruded in fibres and the latter are brought together to form strands or cores as the case may be.

Plastics comprising nitrogenous condensation products are also suitable for use in the making of various rope elements of the invention. One such plastic is now on the market under the name "Nulamine."

Preferably when glass, fused quartz or other materials which may be made into fibres of great tensile strength are used as a material in the making of ropes, it is incorporated into strands or cores or other elements and such elements may be either solid one piece structures or they may be made up of a number of separate elements. The filaments, strands or cores comprise a plastic or a combination of plastics having the inorganic fibres embedded therein and oriented to extend in the direction of the length of the strands or cores.

Thus, in such a construction the glass or quartz fibres to as large an extent as possible or as is feasible, are oriented and also each fibre coated with a plastic so that the fibres are maintained from contact with one another. The fibres may be oriented in the filaments, strands or cores by repeated reductions as through dies or by stretching of the plastic material after incorporation of the fibres therein. The presence of these oriented fibres very greatly increases the tensile strength of the filaments or cores and thus of the ropes into which they may be incorporated.

Bentonite, in especially pure form may be mixed with water to form a gel. The gel is evaporated and the particles draw toward one another and become permanently fixed, by their attraction for one another, in strings or tiny fibrils. These met together to form a tough coherent film. The bentonite may be extruded in the form of filaments or after being formed into sheets may be cut into strips and the latter twisted into filaments, such filaments to be used as above in the formation of strands or cores. Stretching of these gels produces orientation desirable for strength.

Under the general heading of asbestos, I include the fibrous varieties of the mineral amphibole, the fibrous forms of pyroxene, the mineral crocidolite of the amphibole group and also chrysotile. The principal varieties of asbestos are anthopyllite, amphibole and serpentine. Asbestos floats of any variety may be used as fillers while the longer fibres may be made into filaments for strands or cores.

Various combinations of the material disclosed may be used for the purpose of regulating resiliency, stiffness, bacteria growth, fungus growth, water-proofness, controlling the melting or softening point, control of strength factors, as elasticity, tensile and shear strength, aiding in lubrication and the like. Many of the materials disclosed herein and which are chemically incompatible with one another are mechanically miscible to form a homogeneous mass adapted to be fabricated into filaments or bars, sheets and strips to be made into ropes, or cores meeting any of the above requirements as to combinations of physical and chemical characteristics. Thus materials which may not be used alone for my purposes by reason of being too brittle and the like may be mixed with other materials and in that way utilized for the characteristics they may impart.

Formaldehyde and urea resins as well as any chlorinated material (certain synthetic lastics), and the like have germicidal properties and when used with other materials included herein will serve to prevent or arrest bacteria growth and thus decomposition of the filaments or cores due to the action of bacteria of fungus. Whether the action of said materials merely arrests bacteria growth or completely eliminates bacteria will depend on the materials and the quantities used in the mixtures.

The various filaments (whether bundles of fine filaments or single bar-like elements of considerable diameter are employed) are oriented. Where preformed structures are employed it is preferred that the molecules of the filaments be oriented in a direction parallel to the axial centers of the filaments. That is, the molecules are oriented in a direction parallel to the center of a helical line (the longitudinal center line of the filaments) rather than the parallel relation to a straight line. This is accomplished by

stretching the material through a helical die. Thus in my preformed strands or filaments I avoid obstinate internal stresses which cause a wildness of fibre. The strands or ropes made of the filaments oriented as described will have increased tensile strength and extra resistance to twisting and bending, and will lay in a rope without opposing stresses tending to open the rope.

In orienting the filaments (whether thread-like or bar-like) they are reduced to the desired diameters by repeated small reductions obtained by drawing through successively smaller dies or by repeated stretching or by passing through a flow former. Such reductions take place while the material is in a ductile condition. The preforming and orienting operations may be simultaneously accomplished.

Having thus set forth the nature of my invention, what I claim is:

1. A rope strand including a plurality of elements laid spirally together, one of said elements comprising a length of synthetic organic chemical polymer processed to a state stable under normal atmospheric conditions, said element set into the helix it occupies in said strand whereby to lie in unstressed condition in the latter, and said element of a synthetic organic chemical polymer oriented along spiral lines substantially parallel with the longitudinal center line of the helix in which said element is set.

2. A rope strand including a plurality of elements laid spirally together, each of said elements comprising a length of a single filament of synthetic organic chemical polymer processed to a state stable under normal atmospheric conditions, each of said elements set into the helix it occupies in said strand whereby to lie in neutral unstressed condition therein, and each of said elements oriented along spiral lines substantially parallel with the longitudinal center line of the helix in which it is set.

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