

March 20, 1945.

R. F. WARREN, JR

2,372,142

LUBRICATED ROPE

Original Filed June 19, 1940

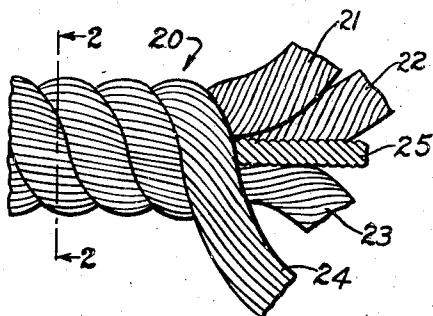


Fig. 1

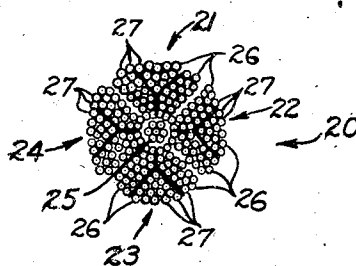


Fig. 2

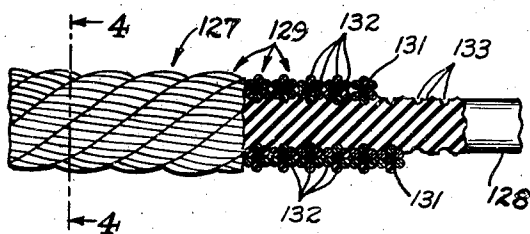


Fig. 3

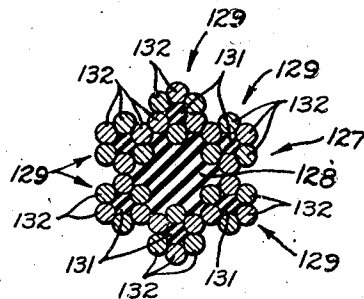


Fig. 4

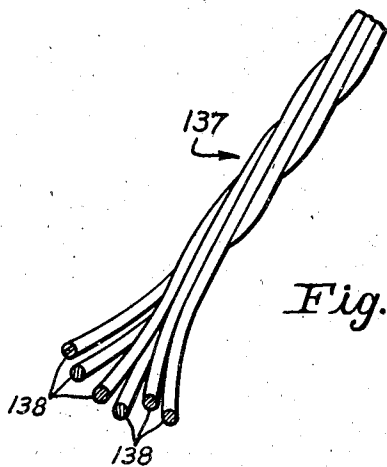


Fig. 5

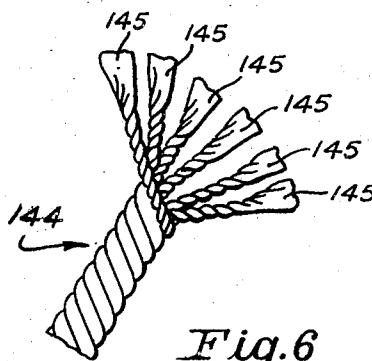


Fig. 6

INVENTOR
Richard F. Warren, Jr.
BY *John H. Hume*
ATTORNEY

UNITED STATES PATENT OFFICE

2,372,142

LUBRICATED 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. 457,198

10 Claims. (Cl. 57—149)

This invention relates to new and useful improvements in ropes and has particular relation to the lubrication of 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 disclosed. 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 four strand rope having a core;

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

Fig. 3 is a side elevational view with part in section showing a modification;

Fig. 4 is an enlarged transverse sectional view as along the line 4—4 of the rope of Fig. 3;

Fig. 5 is a perspective view showing a modified construction of rope core; and

Fig. 6 is a similar view showing another modification.

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

Referring in detail to the drawing and at first more particularly to Figs. 1 and 2, the rope 20 there shown comprises a core 25 about which are laid four strands 21, 22, 23 and 24. Core 25 and each of the mentioned strands are each made up of filaments and the core is shown as comprising a single bundle of filaments while each of said strands comprises three bundles or yarns 26 although this number may be varied as desired. The filaments are individually identified as 27 and it will be understood that the required number of filaments are twisted together to form the core 25 and that each yarn 26 includes the desired number of filaments.

Rope 20 is made up of vinylidene chloride although as will later appear other plastics may be used and it will be understood that the core 25 may be of metal if a stiffer or stronger rope is required. When the rope 20 is entirely of plastic material its stiffness may be controlled by predetermining the diameters of the filaments used in making the rope. Further the stiffness of the rope may be predetermined by the amount of orientation which has been affected in the filaments.

Referring now to Figs. 3 and 4 the rope there generally designated 127 includes a main core

128 over which are laid strands 129 each comprising a core 131 and a series of wires 132 twisted about such core 131. The main core 128 is a large diameter filament or bar-like element of vinylidene chloride and prior to incorporation in the rope is round or circular in transverse section. This core is extruded. Cores 131 also are of vinylidene chloride or other plastic material as will later fully appear.

The strands 129 are laid about the main core 128 under tension whereby portions of the wires 132 coming into contact with the core deform the latter providing grooves 133 therein as shown in Fig. 3. The core 128 is resilient whereby as the strands tension on the rope being under load the strands may press further into the core but as the load is eased the core tends to return to its original shape. When the core is perfectly round in transverse section it is engaged the same on all its sides by the wires of the strands whereby such strands are evenly supported throughout the length of the rope.

Fig. 5 shows a core separate from other rope structure. This core, generally designated 137, comprises a plurality of small diameter vinylidene chloride filaments 138 twisted together. The core thus formed may be used in the rope 20 or the rope 127 and the cores 25, 128 and 131 may be of the structure of core 137. Core 137 is quite flexible and provides considerable surface area for the application of lubricant.

Core 137 has many desirable characteristics and particularly where it is made of a large number of relatively small diameter filaments it is substantially circular in transverse section and provides a uniform support for strands laid about it. However the core is but loosely twisted and care should be taken in unreeling it so that it does not untwist whereby it may be kept with the foreheart originally laid into it.

Fig. 6 shows a core construction wherein the vinylidene chloride, of which the core generally designated 144 is formed, has first been cut or formed into strips. Thereafter the strips are twisted to provide filaments 145 and any desired number of these are twisted together to provide the core. A core made by twisting up of a single strip may be used. However, for larger or main cores (as the core 128 as distinguished from cores 131) a plurality of the strips are twisted together to provide the core with the desired solid characteristics and with the desired resiliency and elasticity.

While vinylidene chloride is the preferred material for the making of the non-metallic or

plastic filaments used in my rope the same may be of other plastics. Other plastics which may be employed in the making of the filaments comprising the non-metallic strands and cores are certain inorganic natural plastic materials as glass fibres, quartz fibres, or bentonite (in the form known as Alsifilm) although asbestos has been found useful. I also employ organic plastic materials including synthetic resins, natural and synthetic lastics, cellulose (as ethyl cellulose) and its derivatives, protein plastic substances (as nylon), and petroleum plastic derivatives. Generally polymerization resins and particularly those of the vinyl group (which includes vinylidene chloride) are preferred for my 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 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 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. Where such filaments are used in a rope also having metal elements the feature of stretch is present since the metal elements may straighten and squeeze into the plastic filaments providing for elongation of the rope. 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.

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 alkyl 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 toluen-sulphonamide. 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 vinylcarbonic 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 Vinyllite), 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 in 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 men-

tion 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 Pli-form) 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 and can be used in the form of filaments or may be cut to strips from sheets and then the strips twisted into filaments, such as those shown at 145 of Fig. 6. 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. Polypentamethylene sebacamide 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 or sheets to be cut to strips, 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 carboxylic acid and of which one is now sold under the trade-mark Exton is very useful for my present purpose.

Another protein plastic which may be used is obtained by extracting the protein from the ref-

use 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 plasticizer 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 or 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 threads or sheets of materials 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 and condensing them with formaldehyde or other aldehydes 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 mat 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 anthophyllite, 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, abrasion resistance, 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 or 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, cores 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. Such reductions take place

while the material is in a ductile condition. The preforming and orienting operations may be simultaneously accomplished.

In making the filaments of twisted strips 145 rather than by extrusion the sheets from which the strips are to be taken are reduced to the desired thickness by repeated small reductions rather than by a single large reduction. These reductions take place while the material is heated or wetted (depending on the material being used). The finished sheets are cut to strips and the latter twisted into filaments for use in cores or the like.

Preferably the strips are cut from the sheet in such manner as to have the direction of the length of the flow of the material of the sheet represent the longitudinal axis of the strips. Thereafter as the strips are twisted they are heated or wetted (depending on the material concerned) and are stretched whereby to further orient the molecules to have the latter oriented in the direction of the length of the twisted strip and on a bias with respect to that which was the longitudinal axis of the strip prior to the twisting thereof.

The disclosed plastic cores and strands particularly lend themselves to the proper lubrication of the rope. According to the invention the filaments of the cores and strands (whether thread-like or bar-like), as they are extruded and while they are still hot, are run through a bath of lubricant, as colloidal graphite, mica, colloidal aluminum, or other colloid (finely divided talc may be used) and some of the lubricating material adheres to the extruded filaments. In fact, the surfaces of the filaments are at such time soft and a portion of the lubricant becomes embedded in the same and remains there when the filaments cool and harden. Of course additional amounts of the lubricant adhere to the outer surfaces of the filaments.

Rather than follow the above process, if so desired, the lubricant may be applied to the extruded elements only just prior to their incorporation in a rope. That is, the filaments having been allowed to cool and having, for example, been stored, they are heated in their surface portions to soften such portions and are then passed through the bath of lubricant for the purpose specified.

The above described processes for applying lubricant to extruded core or strand filaments is also applicable when the cores or strands are fabricated from strips 145 cut from sheets. Such sheets while hot are passed through a bath of the lubricant to have the latter adhere thereto. After the sheets have set with the lubricant in and on them they are cut into strips and the latter are twisted into filaments 145 for use in the fabrication of cores and strands 144 as in Fig. 6.

Filaments treated as described when fabricated into a rope will serve over a longer period to supply lubricant to such rope. The working of the filaments against one another and metal elements of the rope working against the treated plastic filaments (Figs. 3 and 4) has some tendency to work the excess lubricant into said non-metallic filaments. Thus the excess lubricant is not quickly rubbed off the filaments and will be available during the life of the rope. The lubricant will not at first run or drip from the rope and be available in large quantities but will be slowly yielded up from the plastic filaments and be used over a long period of time.

The third method of applying or incorporating the lubricant, particularly in synthetic plastics,

is to mix the lubricant with the plastic material to form a homogeneous mass. The mass is then extruded into filaments of thread-like or bar-like structure or it may be formed into sheets to be cut into strips. In this method it is preferred that the lubricant include the material sold commercially under the name Vistanex and comprising a polymerized vinyl derivative, namely, polyisobutylene and polyisobutadiene. Such material has lubricating properties but in addition thereto has lastic characteristics.

This third method is also applicable when the plastic involved is glass or quartz or the like having a high melting point. However, it is preferred where the plastic has a high melting point, to dissolve the Vistanex together with graphite or talc or mica or molybdenite in a suitable solvent and then pass the filaments of the plastic having the high melting point through the lubricant. Thus, the filaments will be coated and a portion of the lubricant embedded in their surface portions.

Obviously the lubricant may be used in connection with metal strands or elements or with other plastics named herein. Vistanex has a tendency to adhere and so is particularly useful on the metal filaments or rope elements and may also be used as a lubricant for natural fibres. The Vistanex or some other cold flow material is also suitable for the lubrication of other plastics since it will gradually feed to the surfaces of the non-metallic elements as needed and will not completely run off or be squeezed off when such elements are under pressure or strain.

When the lubricant is not applied to the core or cores and strands or elements as above described, it may be applied only to the surface of such elements and this process may best be applied when such elements comprise twisted strips of the plastic. In this connection it is noted that a large amount of surface area is available, particularly in the cores 137 and 144 of Figs. 5 and 6 to receive the lubricant.

The wire elements (Figs. 3 and 4) have lubricant applied directly to them and as they work against the plastic strands and cores such metallic strands will be continuously lubricated by the squeezing out of the lubricant from the non-metallic strands or elements. At first there will be a tendency to work excess lubricant into the plastic elements of the rope and thereafter the lubricant will be available as needed.

Each of the above described processes of lubricating the rope will serve also to deluster the plastic filaments whereby they are more easily handled during the fabrication of rope cores or strands. However the surfaces of some of the materials herein named are glossy or glazed and render the elements difficult to handle in multiple for the twisting or other fabrication of them into ropes or strands or cores.

To provide for non-glossy surfaces whereby the filaments of plastics will frictionally engage one another and therefore may be better held for twisting or laying, titanium dioxide may be added to the mass prior to the extruding, drawing or rolling process whereby to deluster the resulting filaments. This matter of delustering the filaments does not apply when the strands or cores are in the form of single bar-like elements since in such instances there is no problem of holding a multiple of the filaments and twisting them about one another.

The vinylidene chloride, and to some extent the other vinyl compounds mentioned above, is to a

large extent self lubricating. Thus with this particular material while lubricant may be added as a coating or worked into the surface of the filaments or into the mass of the material prior to formation of the filaments, the lubricant is not so important as is its addition to or use with other of the plastic materials mentioned. Since the vinylidene chloride is self lubricating, there is no tendency for the strands or filaments of the rope to bind on one another or on associated strands or filaments of other materials with which it may be used in a rope.

The present lubricated rope or cable has several advantages in addition to the fact that the lubricant is available in the rope as needed over a long period of time. For example, an elevator cable lubricated in accordance with the invention will be kept cleaner due to incorporation of the lubricant into the material of the cable rather than adding it to the surface of the cable. In addition the rope or cable of the invention is cleaner to handle and remains cleaner when stored. Further, as the adhesive effect of the plastics on the lubricant exceeds that of sheaves, pulleys and the like the latter used with the rope or cable of the invention will remain comparatively clean.

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

1. A rope including a flexible longitudinally extending element comprising a plastic material, and particles of a lubricant embedded in the surface portion of said element whereby each such particle is at least partly surrounded by the material of said element and is cemented in place thereby.

2. A rope comprising metallic elements and flexible non-metallic elements, said non-metallic elements of a plastic material, and particles of a lubricant embedded in the surface portions of said non-metallic elements whereby such particles are at least partly surrounded by the material of said elements and are cemented in place thereby.

3. A rope comprising a flexible resilient core, a series of ropes laid about said core in engaging relation therewith, each of said ropes comprising metallic and non-metallic elements, said non-metallic elements of a plastic material, and particles of a lubricant embedded in the surface portions of said non-metallic elements whereby such particles are at least partly surrounded by the material of said elements and are cemented in place thereby.

4. A wire rope including a core of a plastic material, and particles of a lubricant embedded in the surface portions of said core and at least partly surrounded by the plastic material thereof and cemented in place thereby.

5. A wire rope comprising a core including a single bar-like element of a plastic material, and particles of a lubricant embedded in the surface portions of said element and at least partly surrounded by the plastic material thereof and cemented in place in such material.

6. A rope including a core consisting of a plurality of filaments of a plastic material, and colloidal graphite in the surface portions of said filaments and cemented in place by the material thereof.

7. A rope composed of filaments of a plastic material, and particles of a lubricant embedded in the surface portions of certain of said filaments and cemented in place therein by the material thereof.

8. A rope core comprising a single strand of layed rope, said strand comprising filaments of a plastic material, and particles of a lubricant embedded in and at least partly surrounded by and cemented in place by the material of said filaments.

9. A rope core comprising a plurality of elements twisted together, each of said elements comprising a twisted strip of a plastic material,

and particles of a lubricant embedded in and at least partly surrounded by and cemented in place by the material of said strips.

10. A rope including a flexible longitudinally extending element, said element of a plastic material, and particles of a lubricant embedded in and distributed substantially uniformly throughout the diameter and length of said element.

RICHARD F. WARREN, JR.