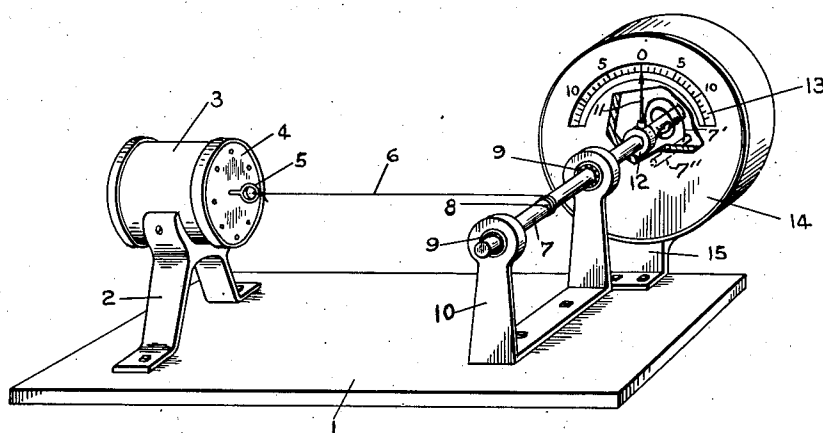


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PRECISION MEASURING INSTRUMENT HAVING A
THREAD FOR A MOTION TRANSMISSION LINK
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PRECISION MEASURING INSTRUMENT HAVING A THREAD FOR A MOTION TRANSMISSION LINK

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1

This invention relates to mechanical devices, such as, for example instruments employed for measuring and/or recording purposes, and relates more particularly to improved mechanical devices containing as an essential element thereof threads of substantial dimensional stability.

An object of this invention is the provision of mechanical devices of increased accuracy as, for example, measuring and/or recording instruments, containing threads of a textile material as an essential element thereof.

Another object of this invention is the application in mechanical devices of dimensionally stable textile threads of high tenacity regenerated cellulose prepared by stretching and then saponifying filaments or yarns having a basis of cellulose acetate or other organic ester of cellulose.

Other objects of this invention will appear from the following detailed description and the accompanying drawing.

In the construction of many types of instruments or other mechanical indicating devices of a high degree of precision, flexible threads of a textile material form essential elements thereof. For a high order of accuracy and precision the threads must possess a high degree of dimensional stability. Any change in length, i. e. contraction or elongation, during variations of temperature and humidity must be eliminated. In instruments heretofore employed, threads of various textile materials such as, for example, cotton, silk, or synthetic linear polyamide condensation products have been employed. Such threads, however, do not possess the degree of dimensional stability during variations of temperature and humidity necessary to obtain the required accuracy. Since the over-all precision of those instruments containing such threads can be no greater than the degree of dimensional stability of the individual threads employed, it is of utmost importance that threads of maximum dimensional stability be employed.

I have now discovered that precision instruments and indicating devices of extreme accuracy, in which threads form an essential element, may now be constructed if the threads employed in said devices comprise high tenacity regenerated cellulose yarns having a basis of stretched and saponified cellulose acetate or other organic acid ester of cellulose material. Threads formed of these regenerated cellulose yarns are of pronounced dimensional stability. Preferably, the regenerated threads which I employ are those in which the elongation characteristics are such that the change in length is no greater than 0.3%

2

over a variation in humidity of from 10 to 100% and no greater than 0.5% over a temperature variation from -50 to $+80^{\circ}$ C.

The cellulose acetate or other organic ester of cellulose yarns or threads which are stretched and then saponified to yield the regenerated cellulose yarns or threads employed in the devices of my invention may be prepared by extruding a solution of cellulose acetate or other organic ester of cellulose, dissolved in a suitable volatile solvent, through a plurality of orifices into an evaporative medium as in the dry method of spinning, or into a coagulating or precipitating liquid medium as in the wet method of spinning. The filaments formed in this manner are associated together to form the desired multi-filament yarn or thread. In addition to cellulose acetate, other organic esters of cellulose which may be employed for the preparation of the dimensionally stable regenerated cellulose yarns are, for example, cellulose propionate, cellulose butyrate and mixed esters such as cellulose acetate-propionate and cellulose acetate-butyrate.

After the yarn or thread is formed, it is then stretched. This is usually done when the yarn is in a somewhat softened condition. The yarn may be softened by treating it with a solvent, latent solvent, or swelling agent for the cellulose acetate or other organic ester of cellulose. This softening treatment may be carried out by bath or padding methods, or by exposing the cellulose acetate materials to vapors of said organic solvents, latent solvents or swelling agents during, or just prior to, the stretching operation. The yarns may also be softened by radiant heat or by the use of steam or hot water. After softening, the yarns may be stretched in a continuous manner by being passed from a roll which rotates at a low speed to one rotating at a higher speed, the roller rotating at a higher speed serving to give the yarn the desired stretch. The degree of stretch may be varied by increasing or decreasing the differential in the speeds of the rollers. The yarn may be stretched in a plurality of stages. For example, part of the stretch may be imparted to the yarn by softening and stretching in one stage and the remainder of the stretch may be imparted by a second softening and stretching operation. More than two stages of stretch may, of course, be employed. After stretching, the yarns may be taken up on bobbins or may be collected in a centrifugal spinning box or Topham box.

By stretching the yarns, as described, the latter may be increased in length to the extent of

200, 300, 500 or even 1000 to 2000% of their original length. Preferably, the yarns employed in accordance with my invention are stretched at least 1000% or more. The stretching causes the cellulose acetate or other cellulose ester yarn or thread to acquire a relatively high tenacity and great resistance to further stretching. This increased tenacity is retained and frequently enhanced upon saponification. After the yarns or threads have been saponified and the regenerated cellulose yarns or threads obtained, the latter may then be employed in forming the threads which are incorporated in the measuring or indicating devices produced in accordance with this invention.

The cellulose acetate or other organic ester of cellulose yarns or threads which are stretched and saponified in the preparation of the regenerated cellulose yarns or threads may be of any degree of esterification. For example, in the case of cellulose acetate materials, they may have an acetyl value of from 40 to 62%, calculated as acetic acid.

The yarns may be saponified by batch processes or in a continuous manner. When a continuous process is employed the stretched yarns may be led directly into a saponifying bath, the path through the saponifying bath being sufficiently extended so that the yarn is completely saponified before leaving the bath. After saponification the yarn is washed free of the saponifying agent, dried and wound into packages of convenient size.

The saponification may be carried out by means of any suitable basic agent. The saponifying agent may be inorganic in nature such as, for example sodium hydroxide, potassium hydroxide, sodium silicate, ammonium hydroxide, sodium carbonate or other inorganic basic agent. Organic saponifying agents may also be employed such as, for example, methyl amine, ethylene diamine, triethanolamine or other organic bases. The saponifying agent may be employed in varying concentrations in aqueous, alcoholic or aqueous-alcoholic solutions. The saponifying bath may be at a temperature of 20 to 100° C. For example, when aqueous solutions of sodium hydroxide are employed, they may be of a concentration of 0.1 to 5% by weight and saponification may be effected in from 30 to 180 minutes with the solution at 30 to 90° C. When employing aqueous solutions of sodium hydroxide as the saponifying medium, it is preferable to include a salt such as sodium sulfate or sodium acetate in said solution.

The threads employed in accordance with my invention may contain from 10 to 500 or more filaments and have a total denier of from 30 to 1000 or more depending upon the particular device in which they are to be incorporated and the type of service they are to be subjected to. Not only single yarns but also plied yarns may be employed. When plied yarns are employed to form the threads, the latter may comprise 2, 3 or even more plies. The denier per filament in the yarn or thread may vary quite considerably. I prefer, however, to use filaments of a denier of from 0.2 to 2.0 in forming the improved regenerated cellulose yarns or threads. The plied yarns may have a twist therein of from 1 to 30 or more turns per inch of S-twist or Z-twist, and the plied yarn may have a twist of from 5 to 20 or more turns per inch of either S-twist or Z-twist.

In order further to illustrate my invention the following examples are given:

Example I

A 90 filament cellulose acetate thread of 600

denier is softened, stretched to 10 times its original length and saponified at 60° C. with a 0.5% solution of sodium hydroxide containing 8% of sodium acetate. 3 ends of the 60 denier regenerated cellulose yarn obtained are plied together to form a thread of a total denier of 180. The single yarns contain 23 turns per inch of S-twist. The plied yarn is formed by plying the twisted individual ends and giving the plied yarn 17 turns per inch of Z-twist. This thread has a maximum elongation of 0.3% with a variation in relative humidity from 10 to 100% and of 0.5% with a temperature change of from -50° to +80° C. The thread may then be incorporated as an essential element of a precision indicating device as illustrated, for example, by the accompanying drawing wherein a pressure sensitive indicating device is shown.

Referring now to the drawing in which an aneroid barometer designed to indicate a degree of change from any particular pressure condition is shown, the instrument comprises a base board 1 carrying a bracket 2 on which is mounted a sealed, evacuated chamber 3. One face of sealed chamber 3 comprises a diaphragm 4 having fixed thereto an eye 5. Fastened to eye 5 and responsive to any horizontal movement thereof is the plied regenerated cellulose thread 6 of high dimensional stability. From eye 5 thread 6 is passed around a rotatable shaft 7, several turns being taken, and then suitably fixed in a hole 8 passing through the shaft. Shaft 7 is mounted in roller bearings 9 which are carried in a bracket 10 fastened to baseboard 1. Shaft 7 carries at one end thereof an indicating pointer 11 set in a collar 12 rotatably mounted on shaft 7 and adapted to be fixed thereon in any radial position as by suitable locking means (not shown). Pointer 11 cooperates with a scale 13 graduated in suitable units and fixed to a circular mount 14 fastened to base 1 as by a bracket 15. Pointer 11 may be set at the zero point of the scale, as shown.

Any variation in barometric pressure causes diaphragm 4 to move in a horizontal direction due to the increase or decrease in the volume of evacuated chamber 3. This horizontal movement is transmitted through eyelet 5 to thread 6 which in turn causes a radial motion of shaft 7. This radial motion is amplified by the indicating pointer 11, the variation in pressure being observed by reading the movement of pointer 11 on scale 13. Shaft 7 may be provided with a suitable calibrated hair spring 7', anchored at one end in a post 7'' mounted on the inner face of circular mount 14 with the other end being set in shaft 7, to prevent any rotation of shaft 7 without a corresponding movement of diaphragm 4, eyelet 5 and thread 6. The extreme dimensional stability of thread 6 permits the accurate transmission of the movement of eye 5 to indicator 11 over wide extremes of both temperature and humidity and, consequently, devices containing said regenerated cellulose threads require no calibration or adjustment because of variations in external temperature or humidity conditions.

Example II

The thread described in Example I may be replaced with a regenerated cellulose thread comprising 3 ends of a 120 filament, 90 denier yarn of 19 turns per inch S-twist plied to form a single thread of 13.4 turns per inch Z-twist. Extremely satisfactory results may be obtained.

It is to be understood that the foregoing detailed description is given merely by way of illus-

5

tration and that many variations may be made therein without departing from the spirit of my invention.

Having described my invention, what I desire to secure by Letters Patent is:

1. In a precision measuring instrument having a condition responsive device, an indicator and a motion transmission tensioned cable forming a connection therebetween, said tensioned cable comprising a high tenacity, dimensionally stable regenerated cellulose thread, said thread comprising stretched and saponified continuous filaments having a basis of an organic ester of cellulose, and having an elongation no greater than 0.3% over a variation in relative humidity of 10 to 100%.

2. In a precision measuring instrument having a condition responsive device, an indicator and a motion transmission tensioned cable forming a connection therebetween, said tensioned cable comprising a high tenacity, dimensionally stable regenerated cellulose thread, said thread comprising stretched and saponified continuous filaments having a basis of cellulose acetate, and having an elongation no greater than 0.3% over a variation in relative humidity of 10 to 100% and an elongation of no greater than 0.5% over a temperature variation of -50 to $+80^{\circ}$ C.

3. In an aneroid barometer comprising an evacuated chamber provided with a flexible diaphragm adapted to move on variation in external pressure and indicating means responsive to the motion of said diaphragm, a thread intermediate of said diaphragm and said indicating means adapted to transmit the diaphragm movement to said indicating means, said thread comprising a high

6

tenacity, dimensionally stable regenerated cellulose thread of stretched and saponified continuous filaments having a basis of an organic ester of cellulose, and having an elongation no greater than 0.3% over a variation in relative humidity of 10 to 100%.

4. In an aneroid barometer comprising an evacuated chamber provided with a flexible diaphragm adapted to move on variation in external pressure and indicating means responsive to the motion of said diaphragm, a thread intermediate of said diaphragm and said indicating means adapted to transmit the diaphragm movement to said indicating means, said thread comprising a high tenacity, dimensionally stable regenerated cellulose thread of stretched and saponified continuous filaments having a basis of an organic ester of cellulose, and having an elongation no greater than 0.3% over a variation in relative humidity of 10 to 100% and an elongation of no greater than 0.5% over a temperature variation of from -50 to $+80^{\circ}$ C.

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