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R. J. ENGLAND ET AL
TEXTILE FILAMENT GUIDE

3,080,134

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FIG. 1

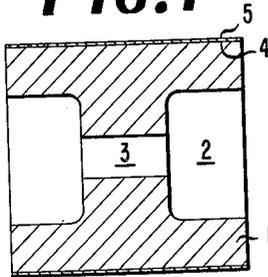


FIG. 2

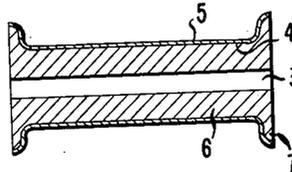


FIG. 3

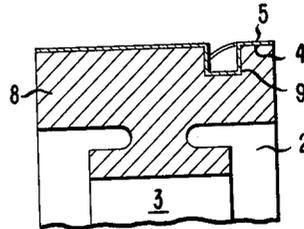


FIG. 4

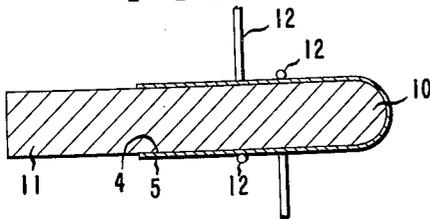


FIG. 5

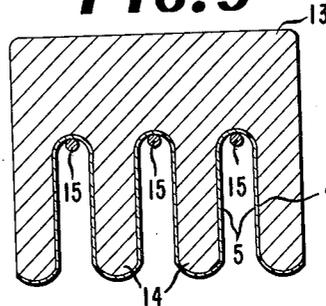


FIG. 6

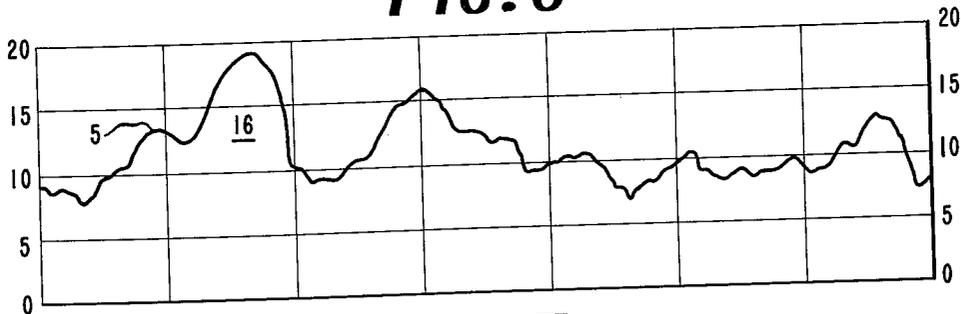
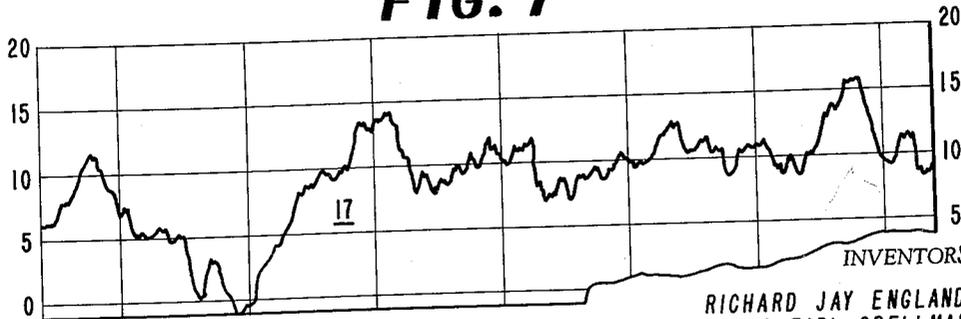


FIG. 7



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TEXTILE FILAMENT GUIDE

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13 Claims. (Cl. 242—157)

This invention relates to improved apparatus for handling running filaments, threads, yarns, strands, ribbons, films, and other thin, elongated structures. More particularly, it relates to apparatus having a novel surface characterized by low friction and high resistance to wear when used in contact with thin, elongated structures on the run.

In the processing of a thin, elongated structure the surfaces of various apparatus elements are in contact with the structure as it is advanced. Such surfaces customarily include the surfaces of rolls, pins, guides, and the like. In commercial practice, it is highly desired that these surfaces be characterized both by long wear life and by very low friction between the running yarn or film and the various surfaces.

Cast ceramic materials having surfaces ground or lapped to a smooth finish are frequently used as guides or elements for handling moving yarns or the like. However, for reasons of mechanical strength or adequate transfer of heat, it is frequently necessary to provide apparatus consisting primarily of metal. Attempts have been made to provide suitable ceramic layers or coatings around such metallic articles by spraying molten ceramic materials onto the metallic surfaces. However, the as-sprayed ceramic coatings are jagged and unsuitable; and when they are ground or lapped in the conventional manner, wear is very rapid and the coefficient of friction rapidly increases from an initial value of approximately 0.25 to values on the order of 0.6.

Heretofore, when apparatus consisting essentially of metal and having low friction surfaces has been required, the metallic surface has frequently been sand blasted and then chrome plated to provide a "matte finished" chrome surface, which is characterized by a low coefficient of friction, on the order of 0.15-0.3. However in many industrial uses, the matte finished chrome surfaces have an effective life of only a few weeks; for example, in many forms of textile equipment, the running filamentary material passes over a very narrow area continuously and a track is cut into the matte finished chrome surface rather rapidly.

It is an object of this invention to provide an improved surface having high resistance to wear and low frictional characteristics when used in contact with thin, elongated structures on the run. A further object is to provide improved apparatus for handling moving thin, elongated structures, said apparatus being characterized by high resistance to wear and low frictional characteristics.

It has now been found that enhanced wear life and low friction are achieved in apparatus for handling moving thin, elongated structures in which the surfaces contacting the said moving elongated structures are metallic surfaces having bonded thereto a continuous coating of hard ceramic material with a smoothly rounded nodular surface. In general, the surface is characterized by a surface roughness of 70-250 r.m.s. (root mean square) microinches and substantial freedom from sharp peaks. Surprisingly, the coefficient of friction for such a surface is only about 0.15-0.25, equivalent to that of a matte finished chrome surface. However, the novel surface of the invention is also characterized by a wear life in the range of four to ten times that of matte finished chrome surfaces, or even higher.

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The invention will be more fully understood by reference to the accompanying drawings, in which:

FIGURE 1 is a transverse vertical sectional view of a roll having the novel, smoothly rounded nodular ceramic surface of the invention;

FIGURE 2 is a similar view of a flanged separator roll having the novel surface of the invention;

FIGURE 3 is a similar view of the upper half of a traverse roll having the novel surface of the invention;

FIGURE 4 is a similar view of a draw pin having the novel surface of the invention;

FIGURE 5 is a top view of a yarn guide in which the yarn-contacting surfaces are the novel surfaces of the invention;

FIGURE 6 is a cross section of the novel surface of the invention, greatly magnified, showing the smoothly rounded nodules; and

FIGURE 7 illustrates a cross section of a flame-sprayed ceramic surface, greatly magnified, from which the novel surface of the invention may be derived.

Turning now to the figures, FIGURE 1 illustrates a right circular cylindrical metallic roll 1 suitable for use as a feed roll or for general purpose applications in textile operations. The roll has hollowed portions 2 at either end and central bore 3 by which the roll may be supported and rotated by a shaft. To the periphery 4 of the metallic portion of the roll is bonded a continuous coating 5 of hard ceramic material having a smoothly rounded nodular surface. The thickness of the ceramic coating is greatly exaggerated in FIGURES 1-5.

FIGURE 2 illustrates a right circular cylindrical metallic roll 6 having central bore 3 and flanges 7. Such a roll is suitable for use as a separator roll in textile operations. To the periphery 4 of the metallic portion of the roll is bonded a continuous coating 5 of hard ceramic material having a smoothly rounded nodular surface. The ceramic coating follows the contour of the flanges at the ends of the roll.

FIGURE 3 represents the upper half of a traverse roll 8 having hollowed portions 2 at either end and central bore 3 by which the roll may be supported and rotated by a shaft. The surface of the roll contains helical groove 9 for traversing yarn. As in the rolls of FIGURES 1 and 2, a continuous coating 5 of hard ceramic material having a smoothly rounded nodular surface is bonded to the periphery 4 of the metallic portion of the roll. The nodular ceramic coating is bonded to the sides and bottom of the groove 9 as well as to surface of the roll.

FIGURE 4 shows a substantially cylindrical metallic draw pin 10. A continuous coating 5 of hard ceramic material having a smoothly rounded nodular surface is bonded to the periphery 4 of the metallic portion of the pin. One end 11 of the pin is left bare, the pin thereby being adapted for insertion into a socket in a block (not shown) heated by suitable means so that the draw pin may be heated to the desired temperature. The metallic portion of the pin is suitably made of copper to promote uniformly rapid flow of heat.

In operation, yarn 12 is passed from a feed roll, wrapped one or more times about the draw pin, and is then passed to a draw roll operating at a higher peripheral speed than the feed roll.

FIGURE 5 illustrates a top view of a metallic yarn guide 13 having four "fingers" 14 between which ride yarns 15, seen in cross section. To the periphery 4 of the metallic portion of the guide is bonded a continuous coating 5 of hard ceramic material having a smoothly rounded nodular surface. The ceramic coating follows the contour of the fingers throughout the portion of the guide normally contacted by the yarn.

FIGURE 6 illustrates a portion of an actual cross section of the surface of the novel ceramic coating 5, as

traced by a graph-recording, stylus type surface measuring instrument ("Talysurf" Model No. 3, Taylor Hobson Co., England). The smoothly rounded nodules 16 in the cross section are readily observed. In the figure, the vertical magnification is 1000 and the horizontal magnification is 100.

FIGURE 7 illustrates a portion of an actual cross section of the surface of a flame-sprayed ceramic coating 17 from which the novel surface of the invention may be derived, as described below. The cross section of FIGURE 7 is traced by the same instrument at the same magnification as the cross section of FIGURE 6. The as-sprayed ceramic surface characteristically comprises a highly irregular surface containing sharp peaks.

In preparing apparatus provided with the novel surface of the invention, metallic apparatus of the desired design is first fabricated in the usual manner. Stainless steel, aluminum, or any other metal generally suitable for the fabrication of metallic apparatus may be used. The surface or surfaces to be provided with the ceramic coating should be quite clean and free from particles of rust, organic substances, and other materials and preferably the surface should be roughened, such as by sand blasting it.

The ceramic coating which is bonded to the metallic apparatus may be composed of any metal oxide melting above about 600° C., preferably 1000° C., which solidifies from the state of a fused coating into a hard-surfaced coating insoluble in water. Among such metal oxides are alumina (aluminum oxide, Al_2O_3), silica (silicon dioxide, SiO_2), chromium sesquioxide (Cr_2O_3), beryllium oxide (BeO), zirconium oxide (ZrO_2), stannic oxide (SnO_2), and titania (titanium oxide, TiO_2). Mixtures of the oxides may be used if desired, and materials other than metal oxides may be added to the ceramic composition, including pigments or fillers.

In a highly preferred embodiment of the invention, the ceramic coating is comprised of alumina. Alumina is readily flame-sprayed by any of the various known techniques and bonds well with metals, especially stainless steel, to achieve coatings of good to excellent density. The flame-sprayed alumina coatings exhibit high resistance to abrasion and corrosion and have exceptionally long wear life.

The flame-spraying or coating procedure may be carried out by any of various known methods employing ceramic material in the form of a rod or in powdered form in which the ceramic material is heated to the molten state and projected or sprayed upon the metallic surface in the form of fine globules which are thereby bonded to the metallic surface. The heating of the ceramic material may be accomplished by means of a flame produced by chemical burning, such as an oxyacetylene flame, either in the form of a continuous flame or as a continual series of detonations. Heating may also be accomplished by means of a flame produced by electrical means, such as a plasma jet or arc. Examples of such procedures are described by Poorman et al. in U.S. Patent 2,714,563; by Stackhouse et al. in "Product Engineering," vol. 29, pages 104-6, December 8, 1958; by Ault in the "Journal of the American Ceramic Society," vol. 40, pages 69-74, March 1, 1957; and by Oechsle in "Metal Finishing," vol. 55, pages 67-71 and page 76, December, 1957.

The as-sprayed ceramic surface is not suitable as such for use on apparatus for handling textile materials and films, since the as-sprayed surface is too rough and contains numerous sharp surface irregularities which not only result in a high coefficient of friction but also cause damage to yarns and films which are processed thereon. Customarily, the as-sprayed surfaces are ground down substantially smooth by grinding, lapping, or brushing procedures in preparing the surfaces for actual use in their various applications. The resulting smooth surfaces have an initial coefficient of friction of approximately

0.25, but are characterized by rapid wear and a rapid increase in the coefficient of friction, up to about 0.6.

In preparing the novel surface of the invention, the rough surface of the as-sprayed ceramic coating is converted to a surface characterized by smoothly rounded nodules by smoothing down the surface only partially by means of brush-finishing or tumbling techniques. For instance, an abrasive material such as particles of silicon carbide may be applied in an aqueous slurry to the as-sprayed surface by a power-driven brush sufficiently long to smooth off sharp peaks in the surface and to reduce the surface roughness to a value in the range 70-250 r.m.s. microinches, being careful to interrupt the brushing within this range rather than continue it in the conventional manner until the surface roughness is reduced to 16-40 r.m.s. microinches. By stopping the brush-finishing operation within the surface roughness range of 70-250 r.m.s. microinches, the ceramic coated surface is found to contain numerous smoothly rounded nodules. In use, apparatus provided with such a surface is characterized by a low coefficient of friction, in the range 0.15 to 0.25, and an exceptionally long wear life when compared with other low-friction surfaces such as matte-finished chrome surfaces.

The as-sprayed ceramic coating may also be converted to a smoothly rounded nodular surface by means of a tumbling technique. For instance, the apparatus having the as-sprayed ceramic coating may be placed in a tumbling tank having a rubber internal lining and tumbled in an aqueous slurry of 240 grit size silicon carbide for a time sufficient to reach but not go below 70-250 r.m.s. microinches surface roughness and to smooth off sharp peaks in the surface. The tumbling time required to achieve the novel surface of the invention varies depending on conditions, but frequently is in the range of two to four hours.

The thickness of the smoothly rounded nodular ceramic coating should generally be in the range 0.001-0.050 inch. Smoothly rounded nodules having an average height of at least 70 microinches cannot be produced on ceramic coatings substantially thinner than 0.001 inch while maintaining continuity of the coating. While the upper limit is less definite, coatings having a thickness of 0.010 inch are generally satisfactory for most purposes and useful coatings as thick as 0.050 inch are readily prepared. It is observed that the size of the nodules increases with the thickness of the coating and also with the diameter of the metallic apparatus coated, i.e., with increasing radius of curvature of the metallic surface being coated. It is also observed that increasing nodule size is conducive to increased wear life, within the surface roughness limits of 70 to 250 r.m.s.

The expression "thin elongated structures" is used herein to denote shaped articles, particularly shaped articles of polymers, in which at least one dimension of the structure is relatively quite large and at least one dimension of the structure is relatively quite small. The expression therefore comprehends ribbons and films as well as filaments and yarns.

The term "coefficient of friction" as used herein refers to the coefficient of friction value given by a yarn friction indicator (such as the "Shirley Frictometer," product of Shirley Developments, Ltd., Manchester, England) when applied to 150 denier, 34 filament polyethylene terephthalate yarn containing 0.3% titanium dioxide passed at 250 yards per minute over the surface being tested.

Surface roughness values in r.m.s. microinches referred to herein are values given by a stylus type surface measuring instrument giving a direct reading in r.m.s. microinches (such as the "Type Q Amplimeter, Model 11," product of the Physics Research Company, Ann Arbor, Michigan) when the instrument is applied to the surface to be tested.

Example

A series of cylindrical steel rolls, 5.5 inches in diameter

and 8 inches long, are roughened by sand blasting and continuous coatings of alumina, 0.004 inch in thickness and having a surface roughness of 210 r.m.s. microinches, are flame-sprayed upon the surface of the rolls using a detonation gun. The coated surfaces are lightly brush finished to a surface roughness of 175 r.m.s. microinches using a power driven brush and an aqueous slurry of 240 grit size silicon carbide. The finished surface is a smoothly rounded nodular surface having a coefficient of friction of 0.2.

The rolls prepared as described above are used as first stage draw rolls in a two-stage drawing process to produce 250 filament, 1100 denier polyethylene terephthalate yarn. The speed at the first draw roll is 2070 yards per minute in each case and eight wraps of the yarn are taken around the roll. The ultimate wear life of these rolls averages 115 days before the flame-spraying of a new ceramic surface is required.

In a control experiment, another set of the steel rolls are roughened by sand blasting, chrome plated, and polished to provide a matte finished chrome surface having a coefficient of friction of 0.2 and a surface roughness of 100 r.m.s. microinches. When the rolls are employed as first stage draw rolls in the drawing process described above, the ultimate wear life of the rolls averages only 15 days before the provision of a new chrome plated surface is required.

In addition to the longer wear life of the novel, smoothly rounded nodular ceramic surface, it is also observed that the novel surface accumulates substantially no deposit of textile finishing agent from the running yarn and that virtually no filament wraps occur in service. In contrast, the matte finished chrome rolls are observed to accumulate deposits of yarn finish and intermittent difficulty with filament wraps is encountered.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof, and therefore it is not intended to be limited except as indicated in the appended claims.

We claim:

1. Apparatus for handling and guiding moving continuous lengths of films, filaments and similar articles which comprises a metallic core and bonded firmly thereto a hard ceramic coating characterized by the presence of rounded surface nodules with a roughness of 70 to 250 root mean square microinches measured with a conventional stylus type surface measuring instrument giving

direct reading in root mean square microinches and being free from sharp peaks.

2. The apparatus of claim 1 in which the coefficient of friction between the said surface and a polyethylene terephthalate yarn moving at 250 yds./min. in contact therewith is between about 0.15 and about 0.25.

3. The apparatus of claim 1 in which the said coating is from 0.001 to 0.05 inch in thickness.

4. The apparatus of claim 3 in which the thickness of the said coating is about 0.01 inch.

5. The apparatus of claim 1 in which the melting point of the said coating is about 600° C.

6. The apparatus of claim 5 in which the melting point is above about 1000° C.

7. The apparatus of claim 1 in which the said metallic core is copper.

8. The apparatus of claim 1 in which the said metallic core is steel.

9. The apparatus of claim 1 in the form of a rotatable roll.

10. The apparatus of claim 1 in the form of a snubbing pin.

11. The apparatus of claim 1 in the form of a grooved guide.

12. The apparatus of claim 1 in which the said metallic core is aluminum.

13. A snubbing pin for use in textile machinery handling polyglycol terephthalate yarns and filaments which comprises a copper core having a hard adherent ceramic surface coating thereon, characterized by rounded surface nodules with a roughness of between 70 and 250 root mean square microinches measured with a conventional stylus type surface measuring instrument giving direct reading in root mean square microinches, being free from sharp peaks, having a thickness of the order of about 0.006 inch and a coefficient of friction with respect to polyglycol terephthalate yarn moving at 250 y.p.m. in contact therewith of between about 0.15 and about 0.25.

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