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2,450,409

ROLL COVER FOR TEXTILE FIBER DRAFTING

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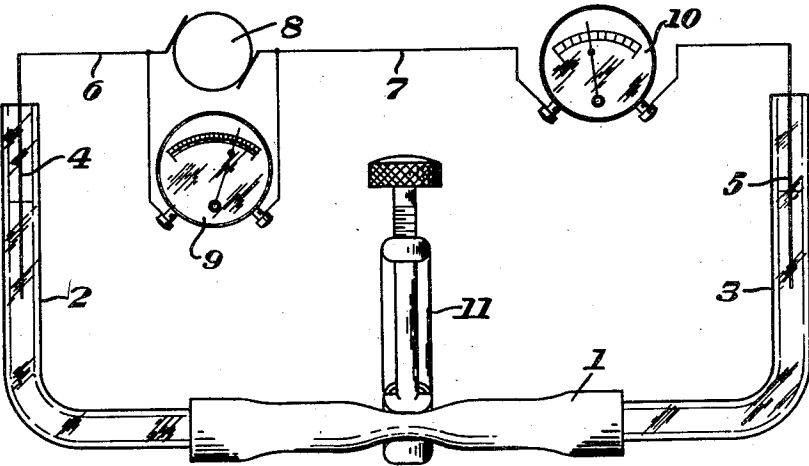


Fig. 1.

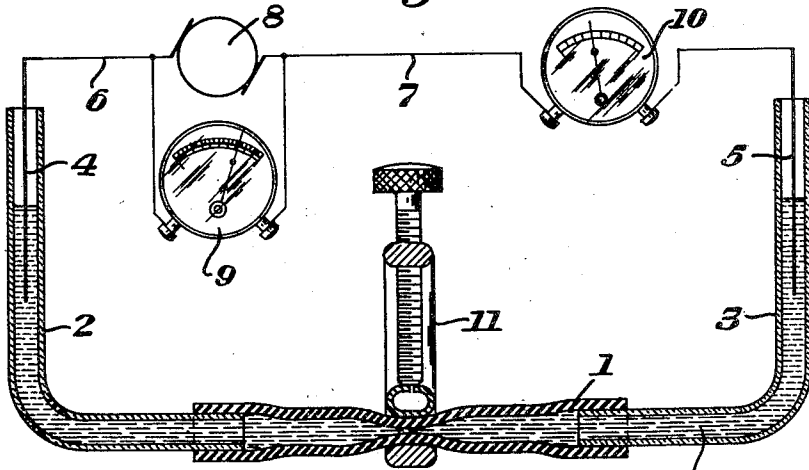


Fig. 2.

OIL RESISTANT VULCANIZED
SYNTHETIC RUBBER MODI-
FIED WITH AN ELECTROLYTE

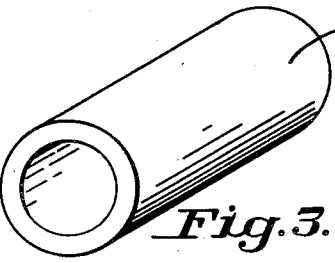


Fig. 3.

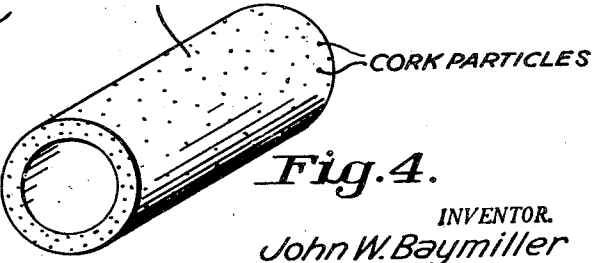


Fig. 4.

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UNITED STATES PATENT OFFICE

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ROLL COVER FOR TEXTILE FIBER
DRAFTING

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19 Claims. (Cl. 19-143)

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Reference is had to the accompanying drawings, in which:

Fig. 1 is an elevation and Fig. 2 is a cross-section, respectively, of a test apparatus used in selecting the ionizable materials which are effective when added to synthetic rubbers in accordance with my invention; and

Figs. 3 and 4 are perspective views of roll coverings in the form of cots embodying my invention.

This application is a continuation-in-part of my copending applications Serial Nos. 498,680, filed August 14, 1943; 526,380, filed March 14, 1944, and 542,879, filed June 30, 1944, all of which are now abandoned. The invention relates to roll covers or cots for textile fiber drafting machinery used in the drafting of cotton, rayon, worsted and the like fibers. I have discovered that roll covers and cots made of synthetic rubber may be rendered lap-resistant by the incorporation in the synthetic rubber of certain electrolytes which are ionizable in water although not necessarily ionizable in the synthetic rubber itself.

In connection with the drafting of cotton, rayon, worsted and like fibers, it has been found that an unusual tendency exists for the fibers to "lap up" around the drafting roll, and the problem is particularly difficult in drafting rayon fibers. This problem exists in varying degrees with all types of roll covers with which I am familiar and tends to reduce substantially the field of usefulness of roll covers.

Many attempts have been made to utilize various materials in the formation of roll covers for textile drafting machinery, such as spinning and drawing frames. Leather is a material frequently used. Its chief disadvantages reside in its cost, susceptibility to wear, prevalence of damage caused by the clearing of lap-ups from its circumference and the frequency with which replacements are necessary. Cork composition roll covers or cots have been used to a considerable degree in the textile industry in place of leather. Their advantage over leather rests in their initial low cost and the length of service each cot is capable of rendering. These two types of cots comprise the vast majority of all the cots actually used in the textile industry.

Attempts have been made to utilize oil-resistant synthetic rubbers to form the working surfaces of textile fiber drafting roll covers. Such roll covers have been made of "neoprene" (a polymerized chloroprene) and "Perbunan" (a butadiene acrylonitrile copolymer), two well known oil-resistant synthetic rubbers. These materials, while oil-resistant, do not possess the req-

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uisite resistance to lapping up. "Neoprene" is not used in the industry at the present time because of its extreme tendency to lap up. Cots of "Perbunan" have been used to some extent for use with cotton and in certain worsted operations, since only a moderate amount of lapping up is encountered. Such cots are not satisfactory for rayon fibers and certain cotton fibers, for they lap up excessively when used for drafting such fibers.

I have discovered that if certain water-ionizable materials or electrolytes are incorporated in certain synthetic rubbers, roll covers of which would normally be non-resistant to lapping up, roll covers made of such modified synthetic rubbers are resistant to lapping up under normal conditions of use, that is, under the conditions of humidity and temperature customarily employed in textile mills.

I have also devised a simple test by means of which there may be selected materials which can be incorporated in synthetic rubber to make lap-resistant roll covers.

I believe that the lapping behavior of textile cots is connected or related to electrokinetic phenomena and that the adhesion of textile fibers to the surface of the cot which causes lapping up depends upon the electrokinetic or zeta potential at the cot surface. According to electrokinetic theory and experiments described in the literature, when two substances, such as distilled water and glass, are brought into contact, there is an adsorption of charges or ions from the water onto the glass surface, setting up what is known as a Helmholtz electric double layer; "Electrokinetic Phenomena," Abramson, 1934; "Outlines of Biochemistry," Gortner, second edition, 1938, pages 147-150; "Physical Chemistry," MacDougall, revised edition, 1943, pages 686-694. This double layer in the case just mentioned is believed to consist of a layer of negative charges in water firmly fixed or attached to the glass surface, and an adjacent layer of positive charges lying in the water beyond the layer of negative charges and movable with the water. The electrokinetic or zeta potential is the potential between the layer of charges fixed to the solid surface with respect to the movable charged layer in the water. In the case of a glass-water interface the zeta potential is negative. It is usually expressed in millivolts. Since such electrokinetic or zeta potential exists between the two layers of charges, and since the negative layer and positive layer are adjacent to each other, there is an attraction between the water and the glass

and the two are held comparatively firmly together at the surface of the glass. Proof that there is adhesion of the water to the glass by the mechanism of electrokinetic potential is furnished by measurements of what is called "streaming potential." If the water is forced through a capillary tube, the two layers of positive and negative charges will be sheared apart tangentially, and work is performed in the shearing of these two layers. If two electrodes are dipped into the water at the ends of the capillary and these electrodes connected with a wire, it will be found that when the water is mechanically forced through the capillary tube the work necessary to shear the double layer apart is manifested by a current flowing through the wire and the potential between the electrodes is dependent upon the rate at which the water is forced through the tube. Conversely, if an electric current is passed through such capillary tube, the liquid will move toward that electrode which has the charge opposite to that of the movable layer of the Helmholtz double layer. In the case of a glass capillary filled with distilled water, the water will move toward the negative electrode since the movable layer in the water consists of positive ions. This is the case with capillaries of most materials.

It has been found that the incorporation of certain water-ionizable materials or electrolytes in the distilled water will lessen or even reduce to zero the electrokinetic or zeta potential, thereby reducing or completely stopping the electrokinetic flow or electro-osmosis through the capillary. In the literature there are recited various determinations of the zeta potential for varying concentrations of different electrolytes in a simple distilled water-glass system. Some of them, such as sodium chloride, potassium chloride and sodium sulphate decrease the electrokinetic potential a comparatively small amount, and even with increasing concentrations the electrokinetic potential between the glass and the water remains appreciably negative. Other electrolytes have a very pronounced effect and even with limited concentrations lower the electrokinetic potential between the glass and the water to substantially zero. Still others, such as thorium salts, reduce the electrokinetic potential to zero very rapidly, then cause it to reverse to positive, and then, with further increasing concentrations, cause the electrokinetic potential to approach zero. "Outlines of Biochemistry," Gortner, pages 147-150; "Physical Chemistry," MacDougall, pages 694-696.

I believe the failure of the synthetic rubber cots heretofore produced and used in textile mills may be explained as follows: A certain amount of water is adsorbed upon the surface of a cot, particularly under the operating conditions of modern textile mills where a high relative humidity, usually about 60%, is maintained to prevent accumulation of static charges and to render the fibers more amenable to drafting. I believe that such water forms a Helmholtz double layer upon the surface of the cot and, in the case of synthetic rubber compounds heretofore used, the rubber surface has a zeta potential with respect to the moisture film. The fibers also have a certain amount of water adsorbed on their surfaces so that I believe that there is present on the fibers also a Helmholtz double layer with the surface of the fiber having a zeta potential negative with respect to the adsorbed water film. There is thus a zeta potential set up in the cot-water interface and another zeta potential set up at the

fiber-water interface resulting in firm adhesion of water to both the synthetic rubber and fiber. When the two are pressed firmly together, as in the drawing operation, the water film becomes common to both the cot and the fiber and the forces of cohesion in the water itself tend to bond or cement together the cot and fiber, thus causing lapping of the fiber around the cot. This may be a unique conception, but I believe it acceptably explains the lapping up action which occurs with the synthetic rubber cots of commerce as heretofore made. While I have set forth the electrokinetic theory in some detail because I believe it offers the best explanation of the phenomena which I have observed, it is to be understood that the invention is not limited to the theory.

I have found by making and testing cot covers that the incorporation of certain electrolytes including animal proteins (preferably glue), ion exchange resins, and the inorganic electrolytes, calcium nitrate, aluminum sulphate, potassium aluminum sulphate, sodium aluminum sulphate, ferric sulphate, potassium ferric sulphate, sodium ferric sulphate, sodium carbonate and phosphoric acid, when incorporated into synthetic rubbers, such as butadiene acrylonitrile copolymers (sold commercially as "Perbunan," "Chemigum," and "Hycar"), polymerized chloroprene (sold commercially as "neoprene"), and isoprene acrylonitrile copolymers, reduces or overcomes the tendency of the cot to lap or pick up fibers. The test which is hereinafter described shows that the incorporation of these electrolytes into the synthetic rubbers as set forth above reduces the zeta potential at the rubber-water face to substantially zero. I therefore believe that the non-lapping characteristics imparted to the cots by the incorporation of such electrolytes is due to the fact that the electrolyte in the synthetic rubber-electrolyte mixture supplies the necessary electric charges to reduce the zeta potential at the cot-water interface to zero or substantially zero, thereby destroying the adhesion between the cot and the water film and thus preventing lapping. While I have made and tested cots made of the specific materials set forth above, I believe that other electrolytes may be used which prevent lapping due, as I believe, to the reduction of the zeta potential between the working face of the cot and water, provided, of course, that such electrolytes are dispersible in the synthetic rubber and are not injurious thereto.

I have also found that moisture should be present at the surface of the cot, at least to the extent normally present under operating conditions in textile mills. Experiments have been carried out wherein synthetic rubber cots containing these electrolytes have been prepared under extremely dry conditions, that is, they have been dried on the rubber mill at a high temperature, vulcanized in a hot air oven at 300° F., and kept stored in a desiccator after they have been prepared. Even though they contained the electrolytes, the cots lapped up badly. When the same synthetic rubber-electrolyte composition cots were exposed to the usual humid atmosphere of a textile mill, or dipped in water and the surface wiped free of water, the cot functioned very well with regard to lapping. I believe that the presence of a certain amount of moisture is required to bring the electrolytes into water solution where their charges are effective in reducing the zeta potential.

I have also found that the effectiveness of the electrolytes in synthetic rubber cots when mois-

ture is present is related to the water vapor permeability of the vulcanized synthetic rubber. For instance, "Chemigum N-1" has the highest water vapor permeability of the synthetic rubbers with which I have experimented. "Perbunan" has the next highest permeability and is followed by "Hycar OR-15", "Neoprene GN" and a special isoprene acrylonitrile copolymer (made experimentally) in the order named. I have found that the higher the permeability of the synthetic rubber containing the electrolyte, the better the resistance to lapping. I offer as a possible theoretical explanation of these observations, that the electrolytes incorporated into the synthetic rubber are more readily available at the surface in the case of the synthetic rubbers having the greater water vapor permeability.

The electrolyte should be thoroughly and uniformly dispersible in the synthetic rubber. It may be dispersed by heating or melting the electrolyte and incorporating it in the synthetic rubber in the usual rubber mill, or by making a concentrated solution and adding it to the synthetic rubber in the usual rubber mill. When the electrolyte has been thoroughly milled into the synthetic rubber, it is apparently uniformly dispersed therein so that the mixture has the appearance of a homogeneous solution. When a thin sheet of the milled mixture is viewed in front of a light it has the same transparent appearance as the untreated synthetic rubber. There are no discrete particles of the electrolyte observable to the naked eye or even under 150 magnifications.

All electrolytes are not satisfactory for the purpose of preventing lapping up when incorporated in synthetic rubber cots. A simple apparatus has been devised and has been used by me by means of which the satisfactory electrolytes may be distinguished from those which are not satisfactory for this purpose. Referring now to Figs. 1 and 2 of the drawings, the apparatus comprises a short length of tubing 1 of a synthetic rubber in which the electrolyte is incorporated, in the ends of which are inserted two upright L-shaped glass tubes 2 and 3. In the apparatus as I have used it the rubber tube 1 is about 2 inches long and has an internal diameter of about $\frac{3}{8}$ inch. Each of the L-shaped pieces of glass tubing has a total length of about 3 inches and an internal diameter of about $\frac{1}{8}$ inch. Extending into the open ends of the L-shaped glass tubes 2 and 3 are platinum electrodes 4 and 5 connected through wires 6 and 7 to a source of direct current such as a generator 8. A volt meter 9 is connected across the wires 6 and 7. A milliammeter 10 is inserted in one of the lead wires 6 or 7. A screw pinch clamp 11 is applied to the rubber tube 1 whereby it may be adjustably constricted.

A synthetic rubber composition, as described for instance in the specific examples hereinafter set forth, containing the electrolyte to be tested is compounded, milled and extruded to form a small tube and vulcanized in the same manner in which the roll covers are vulcanized. The tubes are vulcanized on clean glass rods to prevent any metallic contamination which might affect the test. The vulcanized tube containing the electrolyte to be tested is inserted in the apparatus as indicated by reference numeral 1 between the two glass tubes 2 and 3. The test apparatus is filled with distilled water indicated at 12 to within about one-half inch or so of the tops of the vertical arms of the glass tubes 2 and 3, and the platinum electrodes 4 and 5 are insert-

ed so as to dip into the distilled water for a distance of approximately one-half inch. The middle of the synthetic rubber tube 1 is constricted by the pinch clamp 11 so as to form a capillary passage and thus produce the condition necessary for electro-osmosis. A suitable direct current electromotive force is impressed upon the electrodes 4 and 5. In practice, I have employed an electromotive force of 720 volts. The constriction of the tube 1 by the pinch clamp 11 is adjusted to give a current of about .04 milliamperes at 720 volts. This current is measured by means of the milliammeter 10. When the electromotive force of the order of seven hundred volts is impressed across the electrodes 4 and 5, it is found that practically all synthetic rubber compositions, including those compounded with electrolytes, will show a fairly strong initial flow toward the negative electrode through the adjusted capillary opening in the tube 1. The flow of current can be observed by the rise of water level in one tube and the fall of the water level in the other tube. The water flow is in accordance with the laws of electro-osmosis as explained, for example, at pages 145 to 147 in "Outlines of Biochemistry," by Gortner. The fact that such flow takes place toward the negative electrode indicates that the zeta potential of the synthetic rubber with respect to distilled water is negative. If the electric current is kept constant, the rate of flow through the capillary is directly proportional to the zeta potential at the interface between the synthetic rubber surface and the distilled water.

With some of the better lap-resistant synthetic rubber compounds, such as "Chemigum" and glue, this negative flow will very rapidly drop off, sometimes in a matter of minutes, to substantially zero. Other lap-resistant synthetic rubber-electrolyte compounds, depending, I believe, upon their water vapor permeability and the effectiveness of the electrolyte incorporated in the synthetic rubber, will show a drop to approximately zero in the negative flow in periods up to forty-eight hours. In some cases the flow will reverse and go to a slightly positive flow. Occasionally the flow of water will reverse several times from positive to negative and back again, but always remaining close to the zero point. From the data which I have collected from my tests, there is quite a clear-cut correlation between the flow recorded in these electro-osmosis tests and the lapping behavior of the cots made from the same synthetic rubber compositions. The electro-osmotic flow through rubber tubing made from synthetic rubber compositions which show a satisfactory lap resistance will reach the zero point, or substantially the zero point, at the end of forty-eight hours or before, and will show a flow not exceeding one cubic millimeter per minute in either the positive or negative direction when the conditions previously stated obtain, namely, that the pinch clamp is adjusted to provide a current of .04 milliamperes at 720 volts between the electrodes.

In carrying out the tests, the rubber tube 1 and glass riser tubes 2 and 3 are filled with distilled water 12. The apparatus is then permitted to stand for a period of forty-eight hours and thereupon a determination of the electrokinetic potential is made in the following manner. The electrodes are supplied with 720 volts direct current and the pinch clamp is adjusted until the milliammeter reads .04 milliamperes. Measurement is then made of any rise in the water column. If little or no flow is noted over a period

of 30 minutes, the current on the electrodes is reversed and the results checked. If no flow is occasioned or if the flow is not more than about 1 cubic millimeter per minute, the composition is acceptable for lap-resisting textile fiber drafting cots. If the flow substantially exceeds this amount, the textile fiber drafting cots do not have satisfactory non-lapping characteristics. No water flow through the capillary opening in the tube indicates that the zeta potential between the synthetic rubber composition and the distilled water is zero. However, it is not necessary that the zeta potential be reduced to exactly zero. If the zeta potential is reduced to substantially zero, which I define as so close to zero that the flow of water under the conditions above set forth is not more than about 1 cubic millimeter per minute, the adhesion between the textile fibers and a cot having a working surface made of such synthetic rubber composition is reduced sufficiently so that the cots are lap-resistant. This, I believe, is due to the fact that the zeta potential across the Helmholtz double layer at the surface of the cot is so reduced as effectively to eliminate lapping up.

The water flow can be accurately measured by observing the rise and fall of the water surface in one of the glass tubes. In making the observations above described, the rise of the water level is small enough so that the back pressure of the water from the higher water column and the consequent static pressure against the flow through the capillary opening may be disregarded, particularly as in making the readings the current flow is reversed in checking the results.

The observations made by the test apparatus check with the lapping resistance of the textile cots and corroborates what I believe to be the reason why certain electrolytes when incorporated in the synthetic rubber cots will work, namely, that such electrolytes are effective in reducing the zeta potential between the surface of the synthetic rubber cot and the water which is absorbed from the atmosphere upon the cot surface.

The electrolytes which I have found to be effective have certain common characteristics. They are, of course, materials which are not injurious to the synthetic rubber in which they are incorporated and do not deleteriously affect the synthetic rubber mix. They are all readily ionizable in water. They are uniformly dispersible in the synthetic rubber. They are effective when incorporated in the synthetic rubber in reducing the zeta potential between the synthetic rubber and water to substantially zero. These qualities can be readily ascertained from common knowledge of their chemical and physical characteristics and by simple tests such as above indicated, so that it is possible to foretell whether or not a particular electrolyte will be effective to prevent lapping up by a synthetic rubber cot in which the electrolyte is incorporated.

By the term "synthetic rubber" I mean those synthetic substances which are commonly referred to as "synthetic rubbers" and which have physical properties resembling those of natural rubber, as set forth, for example, in the definition of synthetic rubber appearing on pages 3 to 4 of the circular C427 of the United States Department of Commerce entitled "Synthetic Rubbers: A Review of Their Compositions, Properties, and Uses," by Lawrence A. Wood, issued June 25, 1940; and on page 9 of "Natural and Synthetic Rubbers," by Harry L. Fisher, being the Edgar Marburg lectures of 1941 presented before the Forty-

fourth annual meeting of the American Society for Testing Materials.

My tests have been carried out primarily with synthetic rubbers of the following types: butadiene acrylonitrile copolymers, of which "Perbunan," "Chemigum" and "Hycar" are commercial examples, and which contain varying percentages of acrylonitrile; chloroprene polymer, of which "neoprene" is a commercial example; and isoprene acrylonitrile copolymers, which have been made experimentally. These have all proved satisfactory synthetic rubber bases for non-lapping cots when mixed with the proper electrolytes. These synthetic rubbers have certain common characteristics which adapt them for use in covers for textile drafting rolls. They are vulcanizable. When vulcanized they are oil-resistant, resilient and non-thermoplastic. When vulcanized they are all water permeable to a certain extent, as indicated by the following tests, the results of which are expressed in the terms used in the American Society for Testing Materials, Methods for Water Vapor Permeability, in which the results were obtained with a humidity differential existing between desiccated air and air of 80% relative humidity of 70° F.:

"Chemigum N-1"— 2.2×10^{-3} grms. per sq. cm. per day

"Perbunan"— 1.5×10^{-3} grms. per sq. cm. per day

"Hycar OR-15"— 1.0×10^{-3} grms. per sq. cm. per day

"Neoprene GN"— 0.8×10^{-3} grms. per sq. cm. per day

While my tests show that synthetic rubbers of the butadiene acrylonitrile copolymer type, the polymerized chloroprene type, and the isoprene acrylonitrile copolymer type are satisfactory, I believe that any synthetic rubber having the characteristics above indicated may be employed. As contrasted with synthetic rubbers having the characteristics above indicated as essential for satisfactory operation, there are synthetic rubbers of the "butyl" and "Vinylite" types, which are not satisfactory because they cannot be vulcanized, or are not sufficiently oil-resistant, or are subject to excessive cold flow because of their thermoplastic nature.

I cite the following examples of compositions made of synthetic rubber and containing ionizable substances which prevent lapping up when used in textile drawing rolls.

Example 1

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer)	100
Sulphur	10
Triacetin	10
Titanium dioxide	15
Zinc oxide	10
Graphite No. 64	2.6
Benzothiazyl disulphide	1.5
Diphenylguanidine	0.2
Glue	50

In the manufacture of a cot from this composition, the ingredients are incorporated on a rubber mill. The milled mass is fed to a tuber and a body of approximately the desired diameter is formed and placed upon a mandrel. The assembly is wrapped with cotton tape and vulcanized by the application of heat at about 300° F. for about one hour. The tube is then removed from the mandrel, cut to the desired lengths, and they are

ready for application as covers for drafting rolls. The covers are buffed by grinding to produce a desired surface finish after they have been assembled on the rolls.

In the above example, sulphur is a vulcanizing agent, triacetin is a plasticizer, titanium dioxide and graphite are pigments, zinc oxide is a vulcanization promoter, and the benzothiazyl disulphide and diphenylguanidine are accelerators. The usual substitutions may be made for these ingredients as is well-known to the synthetic rubber compounder. The glue employed was Swift's "Economy" glue. However, other glues may be used, such for example as Cudahy Packing Company's "Rex" glue, Peter Cooper "AA" glue, etc. Equivalent amounts of other animal proteins, such as gelatin or casein or mixtures thereof, may be employed in place of glue.

Example 2

	Parts by weight
"Neoprene" (polymerized chloroprene) -----	100
Magnesium oxide -----	4
Glue -----	50
Titanium dioxide -----	15
Graphite #64 -----	2.6
Zinc oxide -----	5.4
Cork, 20-30 mesh -----	50

This composition is prepared and the cot may be formed in the same manner as disclosed above with regard to Example 1. Zinc oxide and magnesium oxide used in the above compound are polymerization agents and are effective for vulcanizing the "neoprene."

I have found that the lap resistance of some synthetic rubber electrolyte-containing cots, particularly those of the chloroprene type, is improved by incorporating cork granules. The cork granules become a part of the exposed surface of the cot after buffing and appear to impart to the cot some of the characteristics of the cork, particularly its lap resistance. By incorporating animal protein into the compound, its lap resistance is increased tremendously. Unless lap resistance is improved, the finished product is unacceptable, for my work has established that, for satisfactory results, the body material must, in all instances, be substantially resistant to lapping. Attempts have heretofore been made to obtain the desired result by merely incorporating cork particles. Such attempts failed because the synthetic rubber composition which formed the matrix in which the cork granules were imbedded was not, in itself, resistant to lapping. It should be borne in mind that when a cot is buffed for use, both the severed cork particles and the body material form the working surface. If either is not resistant to lapping a satisfactory product will not result. If only a minor portion of this surface be non-resistant to lapping, unsatisfactory results will be obtained for even a small area not so resistant when engaged by the fibers being drafted will cause lapping, and once lapping starts, the roll must be removed and the fibers stripped off, reducing production.

While "neoprene" compositions incorporating animal proteins produce satisfactory results, improved results are obtained on certain types and sizes of fiber when cork is incorporated, and for most uses, I prefer to incorporate both the animal protein and the cork. In the example above, cork of 20-30 mesh is incorporated. This mesh size is determined in accordance with United States Standard sieves. For best results, the particles should not be larger than 10 mesh or

smaller than 50 mesh; particularly good results are obtained with cork particles falling within the range of 20-30 mesh.

Example 3

	Parts by weight
Isoprene acrylonitrile copolymer -----	100
Dibutyl phthalate -----	10
Sulphur -----	10
Pigment -----	15
Zinc oxide -----	10
"Santocure" (n-cyclohexylbenzothiazyl-sulphenamide) -----	1.5
Casein -----	50

The composition may be prepared and the cot may be formed in the same manner as disclosed in connection with Example 1. In the above compound, dibutyl phthalate is a plasticizer, sulphur is a vulcanizing agent, zinc oxide is a vulcanization promoter, and "Santocure" is an accelerator. Substitutions may be made in these ingredients as desired.

I have found, as disclosed above, that the incorporation of certain salts in synthetic rubber compounds for this purpose also render the cot formed from the compound more resistant toward lapping up under normal conditions of use. A suitable compound illustrating the use of a salt is as follows:

Example 4

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer) -----	100
Calcium nitrate -----	20
Titanium dioxide -----	15
Zinc oxide -----	5
Triacetin -----	10
Gastex (carbon black) -----	0.3
Sulphur -----	10
Altax (benzothiazyl disulphide) -----	2

The synthetic rubber is milled in any suitable rubber mill until it is satisfactory for use. Then the salt is melted or dissolved in water and milled into the synthetic rubber at a suitable temperature. In the above example, the calcium nitrate is melted and milled into the synthetic rubber at a temperature of 45° C. to 50° C. The remaining ingredients may be added to the milled mass as is customary and well-known in the industry. The compound so prepared is then sheeted or tubed by means of any suitable tubing device. If the compound be sheeted, it is rolled about a mandrel to form a tube. If the compound be tubed, the tube is slipped on the mandrel. In either case, the cot stock disposed about the mandrel is wrapped with wet fabric tape and cured with open steam. The temperature and duration of cure are not material since depending upon the type of compound, the period of cure may be greater or less at low or higher temperatures. For the above compound, I have found a curing time of 55 minutes at 300° F. is satisfactory.

After the curing operation, the tape is stripped from the tubes and the tubes are removed from the mandrel, buffed or ground to remove the tape marks and to obtain a satisfactory surface, and are cut to size. The cot so formed may be supplied to spinning mills or, if desired, may be mounted on drafting rolls at the place of manufacture.

In the above compound, the "Perbunan" is, of course, the synthetic rubber forming the mass of the cot. The calcium nitrate is an added electro-

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lyte. I have found that certain other salts, such as aluminum sulphate, potassium aluminum sulphate, sodium aluminum sulphate, ferric sulphate, potassium ferric sulphate, sodium ferric sulphate, and sodium carbonate, may be substituted with satisfactory results. Other salts may be used provided they have the necessary qualities pointed out above, namely, that they are not injurious to the synthetic rubber mix, are readily ionizable in water, are uniformly dispersible in the synthetic rubber, and are effective when incorporated in the synthetic rubber in reducing the zeta potential between the synthetic rubber and water to substantially zero. Zinc oxide is used as an activator for the accelerator, Altax. Other conventional accelerators may be used in place of Altax. Triacetin is used as a softener or plasticizer and other plasticizers may be used in its place, for example, tricresyl phosphate, dibutyl phthalate, or dibenzyl ether. Titanium dioxide and Gastex are used primarily as pigments to impart a desired color to the cot compound. Sulphur, of course, is the vulcanizing agent. If desired, suitable fillers or other pigments may be incorporated in the compound.

In accordance with the theory as disclosed above, it would naturally follow that a cot so made if dry would probably not be satisfactory in fiber drawing and this appears to be the case. Before use, the cot should be exposed to water for a sufficient time for the cot to adsorb some amount of water if it be desired that it possess requisite resistance to lapping up immediately when it is placed on the frame for use. If desired, the cot may be dipped in water before use, but this is generally not necessary since under the usual conditions of humidity encountered in the textile industry, it is only necessary that the cot remain in such humid atmosphere for a short period of time to adsorb the necessary amount of water to permit its satisfactory use.

	Example 5, Parts by Weight	Example 6, Parts by Weight
"Perbunan" (butadiene acrylonitrile copolymer).....	100	100
Aluminum sulphate.....	20	20
Sodium carbonate.....	15	15
Titanium dioxide.....	5	5
Zinc oxide.....	5	5
Triacetin.....	10	10
Gastex.....	0.3	0.3
Sulphur.....	10	10
Altax.....	2	2

The cot compounds of Examples 5 and 6 may be prepared in accordance with the procedure disclosed in Example 4. Cots are formed from such compounds similarly to the procedure disclosed in Example 4. In all cases, the cots so formed are highly satisfactory in use after they are exposed to water for a sufficient period of time to adsorb a small amount of the water at the surface of the cot.

Example 7

	Parts by weight
Isoprene acrylonitrile copolymer.....	100
Calcium nitrate.....	20
Titanium dioxide.....	15
Zinc oxide.....	5
Triacetin.....	10
Gastex.....	0.3
Sulphur.....	10
Altax.....	2

This compound is formed following the pro-

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cedure described above with regard to butadiene acrylonitrile copolymers and the cot so produced possesses improved resistance toward lapping up.

Example 8

	Parts by weight
"Neoprene GN" (polymerized chloroprene).....	100
Light magnesia.....	4
Stearic acid.....	3
Titanium dioxide.....	15
Graphite.....	2.6
Neozone A.....	2
Zinc oxide.....	5
Calcium nitrate.....	20

The above materials may be compounded in the same manner as taught for "Perbunan" types of compounds and the cot obtained shows considerably greater resistance to lapping up than is usually secured with cots which include "neoprene." The light magnesia is used as a curing agent; in its place, I may use litharge or lead dioxide. Stearic acid is used as a lubricant and if desired, paraffin may be used in its place. Titanium dioxide and graphite are used primarily to impart a desired color to the stock. Neozone A is an anti-oxidant and any suitable anti-oxidant may be used in its place. Zinc oxide is used primarily as a curing agent. Other suitable salts may be substituted for the calcium nitrate, as indicated in connection with Example 4, supra.

In the following examples numbered 9, 10 and 11 phosphoric acid is used as the electrolyte. Phosphoric acid has the necessary characteristics for an electrolyte as indicated above. It does not deleteriously affect or degrade the synthetic rubber, as would strong acids such as sulphuric or nitric.

Example 9

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer).....	100
Sulphur.....	10
Phosphoric acid.....	10
Titanium dioxide.....	15
Zinc oxide.....	5
Gastex.....	0.3
Triacetin.....	10
Altax.....	1.5

The above material may be compounded in the same manner as previously disclosed for the manufacture of cots. The cots so formed are highly satisfactory in use after they are exposed to water for a sufficient period of time to adsorb a small amount of water at the surface of the cot.

As pointed out previously, other synthetic rubbers may be used in place of "Perbunan." A satisfactory cot including "neoprene" may comprise the following:

Example 10

	Parts by weight
"Neoprene GN" (polymerized chloroprene).....	100
Light magnesia.....	4
Stearic acid.....	3
Titanium dioxide.....	15
Graphite.....	2.6
Neozone A.....	2
Zinc oxide.....	5
Phosphoric acid.....	10

The above compound may be formed into cots as previously described.

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A similar cot may be formed including isoprene acrylonitrile copolymer. A suitable example of such compound which may be formed as previously described is as follows:

Example 11

	Parts by weight
Isoprene acrylonitrile copolymer	100
Phosphoric acid	10
Sulphur	10
Titanium dioxide	15
Zinc oxide	5
Gastex	0.3
Triacetin	10
Altax	1.5

I have found that compounds including combinations of electrolytes, such as animal proteins and the salts or acids described above, provide cots which in some instances are even more satisfactory in resistance toward lapping up than the compounds described above. A suitable formula for cot manufacture which includes an animal protein and a salt is as follows:

Example 12

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer)	100
Calcium nitrate	20
Glue	50
Titanium dioxide	15
Zinc oxide	5
Triacetin	10
Gastex	0.3
Sulphur	10
Altax	2

The above compound may be formed into a cot as disclosed in connection with Example 1. It will be understood other suitable electrolytes may be used in place of calcium nitrate.

Example 13

	Parts by weight
Isoprene acrylonitrile copolymer	100
Calcium nitrate	20
Glue	50
Titanium dioxide	15
Zinc oxide	5
Triacetin	10
Gastex	0.3
Sulphur	10
Altax	2

This compound is formed following the procedure described above and the cot so produced possesses greatly improved resistance toward lapping up.

Example 14

	Parts by weight
"Neoprene GN" (polymerized chloroprene)	100
Glue	50
Light magnesia	4
Stearic acid	3
Titanium dioxide	15
Graphite	2.6
Neozone A	2
Zinc oxide	5
Calcium nitrate	20

The above materials may be compounded in the manner disclosed above and the cot obtained shows considerably greater resistance to lapping

up than is usually secured with cots which include "neoprene."

Example 15

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer)	100
Sulphur	10
Phosphoric acid	20
Glue	50
Titanium dioxide	15
Zinc oxide	5
Gastex	0.3
Triacetin	10
Altax	1.5

This compound may be formed in the manner described above.

Example 16

	Parts by weight
"Neoprene GN" (polymerized chloroprene)	100
Light magnesia	4
Glue	50
Stearic acid	3
Titanium dioxide	15
Graphite	2.6
Neozone A	2
Zinc oxide	5
Phosphoric acid	20

The above materials may be compounded in the same manner as previously described. Cots obtained show greater resistance to lapping up than is usually secured with cots which include "neoprene." While the animal protein is preferably glue, other animal proteins may be used.

Example 17

	Parts by weight
Isoprene acrylonitrile copolymer	100
Sulphur	10
Phosphoric acid	20
Titanium dioxide	15
Zinc oxide	5
Gastex	0.3
Triacetin	10
Altax	1.5
Glue	50

The above ingredients may be compounded as described above.

In the above compounds, it is particularly important that the amount of animal protein, salt or acid be included in an amount sufficient to enhance the resistance of the cot to lapping up but in an amount insufficient to affect deleteriously the essentially rubber-like characteristics of the cot compound.

When an animal protein such as glue is employed as the electrolyte, it is in general undesirable to include less than 15 parts by weight of the animal protein to 100 parts by weight of the synthetic rubber, since substantially no improvement in lap resistance is encountered with a lesser amount. It is preferred to use at least 25 parts by weight of animal protein to 100 parts by weight of synthetic rubber. For optimum results the animal protein should be at least about 40 parts by weight to 100 parts by weight of synthetic rubber, as this amount appears to be in general more effective than 25 parts. The animal protein may be incorporated nearly to the point where the animal protein ceases to be

the internal phase. However, it is in general undesirable to incorporate animal protein above about 75 parts by weight to 100 parts by weight of synthetic rubber, since greater amounts of animal protein result in excessive hardness and other undesirable physical properties. For optimum results the animal protein is not more than about 60 parts by weight to 100 parts by weight of synthetic rubber, since a greater amount of animal protein tends to increase the hardness of the product beyond that which is normally desirable.

While in the neighborhood of 50 parts of glue to 100 parts of synthetic rubber have been found to give excellent results with most synthetic rubbers, the particular percentages may be varied somewhat, depending upon the particular synthetic rubber employed. Butadiene acrylonitrile copolymers are somewhat more resistant to lapping up than polymerized chloroprenes and isoprene acrylonitrile copolymers and, therefore, the amount of animal protein required for the butadiene acrylonitrile copolymers may be reduced somewhat beyond that which gives the best results for polymerized chloroprene and isoprene acrylonitrile copolymers.

When the inorganic electrolytes are employed as above indicated, the amounts are in general considerably less than those of the animal protein type of electrolytes. It is in general undesirable to employ below about 5 parts by weight of the inorganic electrolyte to 100 parts by weight of the rubber since no substantial improvement in resistance to lapping is discernible below these concentrations. It is preferred to use at least about 10 parts by weight of the inorganic electrolyte to 100 parts by weight of the synthetic rubber. The inorganic electrolyte, however, should not be added in amount sufficient to deleteriously affect the essentially rubber-like characteristics of the synthetic rubber composition. Generally speaking, increasing the inorganic electrolyte above about 40 parts by weight of electrolyte to 100 parts by weight of synthetic rubber produces undesirable effects. It is preferred to employ not more than about 30 parts by weight of the inorganic electrolyte to 100 parts by weight of synthetic rubber. For optimum results we have employed, as indicated in the examples, in the neighborhood of 20 parts by weight of inorganic electrolyte to 100 parts by weight of synthetic rubber.

Two or more of such inorganic electrolytes may be added together, in which case the aggregate of the added electrolytes should come within the same ranges of parts per 100 parts of synthetic rubber as above stated for a single added electrolyte.

One or more of such inorganic electrolytes may be added with animal protein if desired, in which case the amounts of the animal protein and the inorganic electrolyte added are preferably the same as when added alone. The cot, however, has somewhat increased lap resistance over that afforded by either one of these electrolytes alone. While it is preferred in the case of adding both animal protein and inorganic electrolytes to use the full amount of each which would be used if added singly, the aggregate amount may be somewhat reduced and still obtain the same lap resistance as would be afforded by using either one alone in full amount.

In addition to the electrolytes specifically described above, I have found that ion exchange resins may be employed as electrolytes. An ex-

ample of a synthetic rubber composition employing an ion exchange resin is as follows:

Example 18

	Parts by weight
"Perbunan" (butadiene acrylonitrile copolymer)-----	100
Amberlite XE-7-----	40
Sulphur-----	10
Titanium dioxide-----	15
Zinc oxide-----	5
Altax (benzothiazyl disulphide)-----	2

Amberlite XE-7 is an "A" stage cation active resin of the phenol sulphonie acid formaldehyde type of the class described in the Adams and Holmes United States Patent No. 2,191,853, and manufactured by Resinous Products and Chemical Company. This resin was obtained in the form of a water solution which was incorporated into the rubber on a standard rubber mill in the same manner as the animal proteins mentioned above.

Other ion exchange resins may be employed as I believe that ion exchange resins as a class are operative. Ion exchange resins are described in the chapter by R. J. Myers entitled "Synthetic resin ion exchangers," appearing in the book entitled "Advances in Colloid Science," edited by E. O. Kraemer, published by Interscience Publishers, Inc., New York, 1942, and in the Adams and Holmes Patents Nos. 2,104,501 and 2,151,883, and the Myers and Eastes Patent No. 2,362,086.

As in the case of the other electrolytes, the ion exchange resin should be employed in an amount sufficient to effectively reduce the zeta potential to substantially zero to prevent lapping up, but should not be employed in an amount sufficient to deleteriously affect the essentially rubber-like characteristics of the synthetic rubber. The ion exchange resins are preferably incorporated into the synthetic rubber in the same parts by weight as in the case of animal proteins. The ion exchange resins may be used alone or may be incorporated with animal proteins or inorganic electrolytes or both.

Cork granules may be included in any of these various synthetic rubber mixes. As noted above in connection with Example 2, the presence of the cork granules improves the lap resistance of some synthetic rubber cots, particularly those of the chloroprene type. The cork granules also reduce the tendency to eyebrow in all of the compositions.

An "eyebrow" may be defined as a collection of waste fibers pulled from the roving by the cot which is not carried rearwardly of the clearer board by the rotating cot and which accumulates at the front of the clearer board in a bunch-like formation. As the eyebrow increases in size, it is occasionally pulled from the clearer board by the roving being spun and causes a hard spot in the yarn which is called a "nub."

The cork granules may be included in various quantities. I have found that the amount of cork granules included in the various mixes may fall within the range of 25 to 125 parts by weight to each 100 parts by weight of the synthetic rubber. The cork granules may vary as to particle size. For most satisfactory results the cork granules should not be larger than about 10 mesh or smaller than about 50 mesh and I have found that particularly good results are obtained with cork granules falling within the range of 20 to 30

meshes to the inch United States Standard sieves. The cork granules are preferably added along with the other ingredients which are incorporated in the synthetic rubber on the rubber mill and are thus uniformly distributed in the synthetic rubber mix so that there is a uniform distribution of such particles at the working surface.

Granules or particles of other materials which minimize eyebrowing may be similarly employed in place of cork. Such materials include wood flour, fine mesh sand (preferably about 100 mesh), organic filler particles of a nature similar to cork such as soft wood, balsa, etc., as well as other materials which minimize eyebrowing.

In the drawings, Fig. 3 is a perspective view of a roll cover embodying my invention identified by a suitable legend; and Fig. 4 is a similar view of such a roll cover including cork granules.

While I have disclosed certain preferred embodiments of my invention, it will be understood that my invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized rubber-like butadiene acrylonitrile copolymer, having uniformly dispersed therein as the dispersed phase between about 40 and 60 parts of glue to 100 parts of the butadiene acrylonitrile copolymer, whereby the roll cover is rendered lap-resistant.

2. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized rubber-like butadiene acrylonitrile copolymer, having uniformly dispersed therein as the dispersed phase between about 10 and 30 parts of calcium nitrate to 100 parts of the butadiene acrylonitrile copolymer, whereby the roll cover is rendered lap-resistant.

3. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized, rubber-like butadiene acrylonitrile copolymer, having uniformly dispersed therein as the dispersed phase between about 40 and 60 parts of glue and between about 10 and 30 parts of calcium nitrate to 100 parts of the butadiene acrylonitrile copolymer, whereby the roll cover is rendered lap-resistant.

4. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dispersed phase between about 25 and 75 parts of animal protein which is dispersible in the synthetic rubber to 100 parts of the synthetic rubber, whereby the roll cover is rendered lap-resistant.

5. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dispersed phase at least 15 parts of animal protein which is dispersible in the synthetic rubber to 100 parts of the synthetic rubber, whereby the roll cover is rendered lap-resistant.

6. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dis-

persed phase between about 5 and 40 parts of calcium nitrate to 100 parts of the synthetic rubber, whereby the roll cover is rendered lap-resistant.

7. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dispersed phase between about 25 and 75 parts of an ion exchange resin to 100 parts of the synthetic rubber, whereby the roll cover is rendered lap-resistant.

8. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient nonthermoplastic somewhat water vapor permeable synthetic rubber which is normally nonresistant to lapping up, having uniformly dispersed therein as the dispersed phase between about 5 and 40 parts to 100 parts of the synthetic rubber of an inorganic electrolyte which is readily ionizable in water and which is capable of reducing the zeta potential of the working surface in contact with distilled water to substantially zero, whereby the roll cover is rendered lap-resistant.

9. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient nonthermoplastic somewhat water vapor permeable synthetic rubber which is normally nonresistant to lapping up, having uniformly dispersed therein as the dispersed phase between about 10 and 30 parts to 100 parts of the synthetic rubber of an inorganic electrolyte which is readily ionizable in water and which is capable of reducing the zeta potential of the working surface in contact with distilled water to substantially zero, whereby the roll cover is rendered lap-resistant.

10. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient nonthermoplastic somewhat water vapor permeable synthetic rubber which is normally nonresistant to lapping up, having uniformly dispersed therein as the dispersed phase between about 25 and 75 parts of glue to 100 parts of the synthetic rubber, whereby the roll cover is rendered lap-resistant.

11. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dispersed phase an effective amount of an electrolyte which is readily ionizable in water and reduces the zeta potential of the working surface in contact with distilled water to substantially zero, whereby the roll cover is rendered lap-resistant.

12. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized synthetic rubber selected from the class consisting of butadiene acrylonitrile copolymers, polymerized chloroprene and isoprene acrylonitrile copolymers, having uniformly dispersed therein as the dispersed phase an effective amount of an electrolyte which is readily ionizable in water and reduces the zeta potential of the working surface in contact with distilled water to substantially zero, whereby the roll cover is rendered lap-resistant.

13. A lap-resistant roll cover for textile fiber drafting having a working surface made of a

vulcanized oil-resistant resilient non-thermoplastic somewhat water vapor permeable synthetic rubber which is normally non-resistant to lapping up, having uniformly dispersed therein as the dispersed phase an effective amount of an electrolyte which is readily ionizable in water and reduces the zeta potential of the working surface in contact with distilled water to the point where the electro-osmotic flow obtained through a capillary tube of the synthetic rubber composition is not more than about 1 cubic millimeter per minute under an impressed voltage of 720 volts and a current of .04 milliamperes 48 hours after the contact of the distilled water with the synthetic rubber surface of the capillary, whereby the roll cover is rendered lap-resistant.

14. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic synthetic rubber having a water vapor permeability of at least about 0.8×10^{-3} grams per square centimeter per day measured with a humidity differential between that of desiccated air and air at 80% relative humidity at 70° F., which said working surface is normally non-resistant to lapping up, having uniformly distributed therein as the dispersed phase an effective amount of an electrolyte which is readily ionizable in water and reduces the zeta potential of the working surface in contact with distilled water to the point where the electro-osmotic flow obtained through a capillary tube of the synthetic rubber composition is not more than about 1 cubic millimeter per minute under an impressed voltage of 720 volts and a current of .04 milliamperes 48 hours after the contact of the distilled water with the synthetic rubber surface at the capillary, whereby the roll cover is rendered lap-resistant.

15. A lap-resistant roll cover for textile fiber drafting having a working surface made of a vulcanized oil-resistant resilient non-thermoplastic synthetic rubber having a water vapor permeability of the order of 1 or 2×10^{-3} grams per square centimeter per day measured with a humidity differential between that of desiccated air and air at 80% relative humidity at 70° F., which

said working surface is normally non-resistant to lapping up, having uniformly distributed therein as the dispersed phase an effective amount of an electrolyte which is readily ionizable in water and reduces the zeta potential of the working surface in contact with distilled water to the point where the electro-osmotic flow obtained through a capillary tube of the synthetic rubber composition is not more than about 1 cubic millimeter per minute under an impressed voltage of 720 volts and a current of .04 milliamperes 48 hours after the contact of the distilled water with the synthetic rubber surface at the capillary, whereby the roll-cover is rendered lap-resistant.

16. A lap-resistant roll cover for textile fiber drafting in accordance with claim 5, having cork granules uniformly distributed in the synthetic rubber mix at the working surface.

17. A lap-resistant roll cover for textile fiber drafting rolls in accordance with claim 6, having cork granules uniformly distributed in the synthetic rubber mix at the working surface.

18. A lap-resistant roll cover for textile fiber drafting in accordance with claim 11, having cork granules uniformly distributed in the synthetic rubber mix at the working surface.

19. A lap-resistant roll cover for textile fiber drafting in accordance with claim 11, having particles of a material which minimizes eyebrowning uniformly distributed in the synthetic rubber mix at the working surface.

JOHN W. BAYMILLER.

REFERENCES CITED

The following references are of record in the file of this patent:

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Number	Country	Date
3,686	Great Britain	1898

Certificate of Correction

Patent No. 2,450,409.

October 5, 1948.

JOHN W. BAYMILLER

It is hereby certified that errors appear in the printed specification of the above numbered patent requiring correction as follows:

Column 4, line 7, before the word "fiber" insert *the*; column 7, line 43, for "absorbed" read *adsorbed*; column 8, line 26, after "humidity" for "of" read *at*; lines 51 and 52, for "izonizable" read *ionizable*;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of March, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.