

July 5, 1960

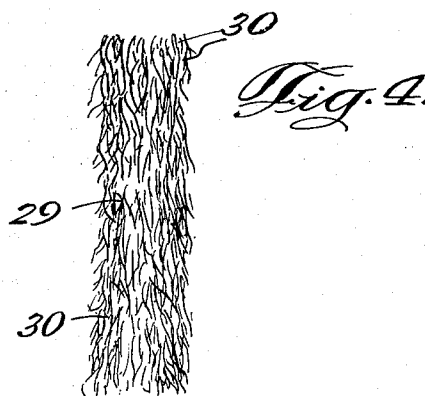
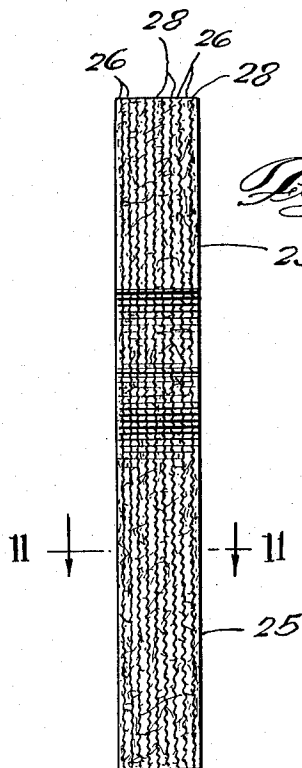
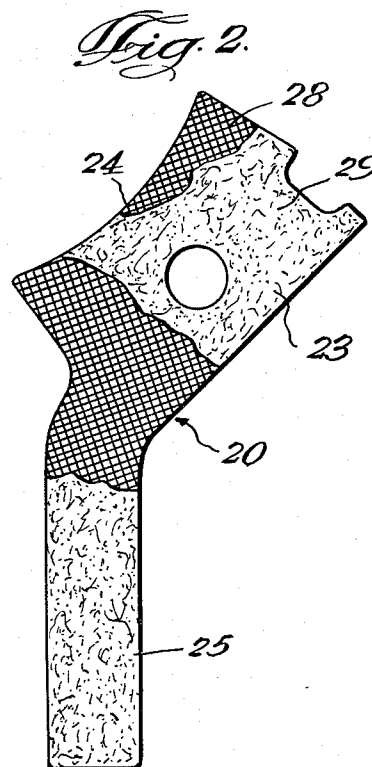
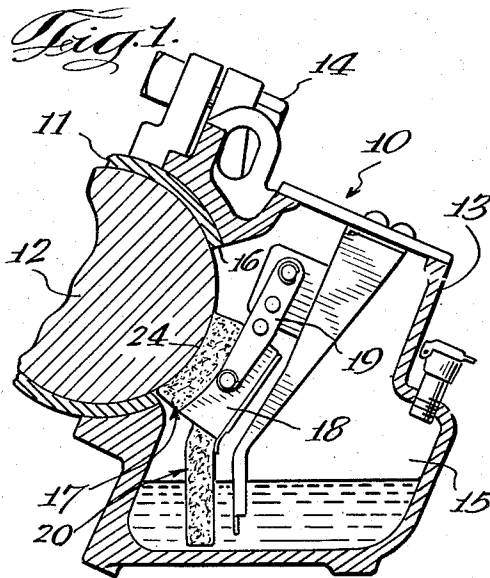
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2,943,378

HIGH LIFT FABRIC FOR LAMINATED LUBRICATOR WICK

Filed Sept. 8, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 5.

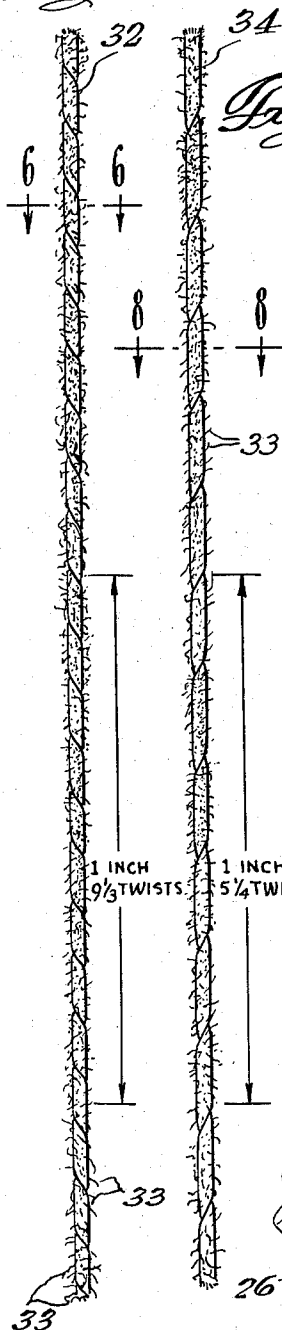


Fig. 7.

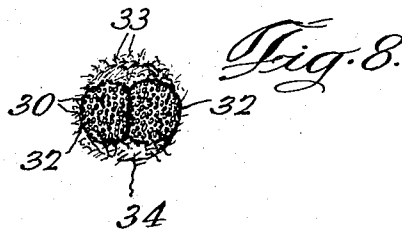
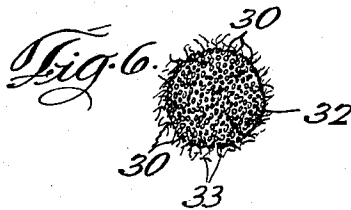


Fig. 9.

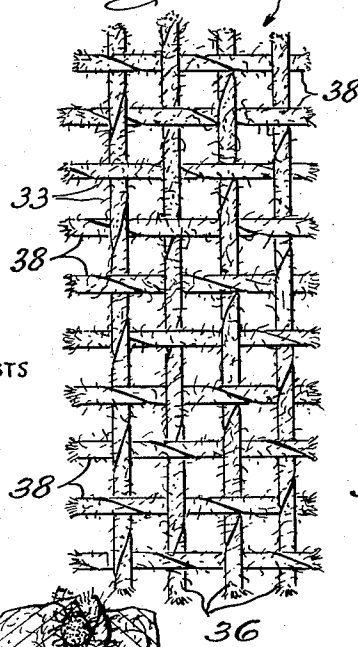


Fig. 10.

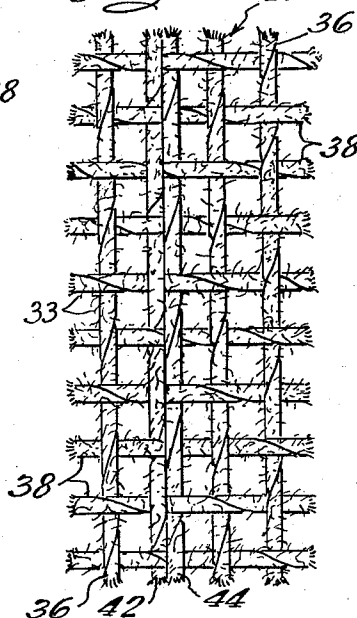


Fig. 11.



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HIGH LIFT FABRIC FOR LAMINATED LUBRICATOR WICK

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14 Claims. (Cl. 28—78)

This invention relates to a high lift fabric for laminated lubricator wicks or the like, and more particularly, to such a fabric having improved lubricant lifting qualities.

Patent No. 2,708,611, granted to Robert J. Harkenrider on May 17, 1955, the disclosure of which is hereby incorporated by reference, describes a laminated lubricator body for diesel locomotive traction motor suspension bearings comprising alternating layers of relatively thick layers of coarse material such as felted wool and relatively thin layers of fine threads or yarns, such as cotton, having a high capacity for lifting lubricant.

As disclosed in said patent, felt of desired density and coarseness for lubricating purposes will lift oil a maximum of about three to four inches. Felt material that is dense enough to lift oil five to six inches does not lift the oil fast enough and tends to clog with dirt too readily along the lubricator surface that is to be applied against the journal to be lubricated. Fine fibers on the other hand lift better than felt, but do not make as good applicators due to the tendency to clog and glaze.

Said patent discloses that in felting fibers of suitable density and coarseness to make a lubricant applicator, inserts of fine fibers, vegetable or animal, may be embedded in the fabric. Animal fibers mat together due to minute scales on their surfaces, while vegetable fibers, for instance, do not have felting characteristics because of the absence of those scales. However, in felting animal fibers to form the desired lubricating body, fine vegetable fibers, woven or unwoven, may be incorporated in the body, the felted animal fibers encompassing the vegetable fibers so applied and embodying them in the lubricating body.

The principal object of this invention is to provide a high lift fabric that, when incorporated in lubricator bodies such as the type described in the above mentioned patent, will materially increase the lubrication provided by such lubricator bodies.

Another object of the invention is to provide a high lift fabric in which the capillary action provided is controlled and standardized by using a specified twist in spinning the yarn out of which the fabric is made.

Still another object of the invention is to provide a high lift fabric made from yarn composed mainly of synthetic protein fibers.

A further object of the invention is to provide a laminated lubricator body in which the various layers thereof are more cohesively bonded together than was heretofore possible, thus providing improved transfer of lubricant from the high lift portions thereof to the lubricant applying portions thereof.

Other objects, uses and advantages will be obvious, or become apparent from a consideration of the following description and the drawings.

In the drawings:

Figure 1 is a transverse vertical sectional view through a typical motor suspension bearing and the axle to which

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it is applied, showing our improved lubricator body applied to the journal;

Figure 2 is a side elevational view of one of the laminated felt bodies employed as illustrated in Figure 1, with parts broken away for clarity of illustration;

Figure 3 is an end view of the lubricator body shown in Figure 2;

Figure 4 is a diagrammatic illustration of a sliver of fibers that is spun into the yarn from which our improved fabric is woven;

Figure 5 is a diagrammatic plan view illustrating a portion of a single yarn employed in our fabric;

Figure 6 is a diagrammatic cross sectional view along line 6—6 of Figure 5;

Figure 7 is a view similar to that of Figure 5 illustrating a plied yarn employed in our fabric;

Figure 8 is a cross sectional view along line 8—8 of Figure 7;

Figure 9 is plan view of a portion of a fabric employed in the laminated lubricator bodies illustrated in Figures 1—3;

Figure 10 is similar to Figure 9 but illustrates a modified fabric; and

Figure 11 is a diagrammatic fragmental large scale cross sectional view along line 11—11 of Figure 3.

But the diagrammatic drawings and the corresponding description are used for the purpose of disclosure only.

In Figure 1, the reference numeral 10 indicates a familiar form of motor suspension bearing provided with a liner or shell 11 forming the actual bearing for the shaft or axle 12. Associated with these elements is a motor suspension bearing cap or axle cap 13 secured to the motor suspension bearing by bolts 14 and provided with an oil reservoir 15.

The object of the lubricator of this invention is to lift the oil or lubricant from the reservoir 15 and apply it to the axle 12 through the window opening 16 in the shell or liner 11. That function is performed by a felt body or bodies, generally indicated at 17, assembled in a holder or holders 18 pivoted to levers 19 and urged toward the axle by a suitable spring, all substantially as disclosed in Patent No. 2,640,742, granted June 2, 1953, the disclosure of which is incorporated by reference in interests of brevity.

It is commercially difficult to make a lubricator body of the type shown in Figure 1 having sufficient area to cover the surface of the journal exposed in the window opening with the fibers substantially endwise to fit evenly against the journal, and feed evenly to the surface. For that reason, the applicator is made up of a group of felt bodies, one of which is shown in Figures 2 and 3. The individual bodies 20 may have individual holders or may have the same holder as disclosed in the above mentioned patent.

As shown in Figure 2 the lubricator body has a thickened portion 23 provided with a curved surface 24 adapted to bear against the surface of the journal and apply the lubricant. The curved surface 24 is preferably an arc of a circle having a radius equal to that of the journal, as shown in Figure 1. Depending from the thickened portion 23 is a wick 25 intended to hang in the oil reservoir and lift the oil and apply it to the thickened portion 23.

As indicated in Figures 2 and 3, the body 20 is laminated and consists of alternating layers of carded wool or felt 26 and woven fine material 28. The woven fabric 28 is preferably so oriented with respect to the felt lamination that the arcuate cut for the surface 24 finds all warp and woof strands of the fabric 28 making a substantial angle with the arcuate surface 24.

The fabric 28 constitutes an important feature of our invention. Generally speaking, a fabric made in accord-

ance with the principles about to be discussed provides a capillary material that not only lifts oil higher but which also aids in binding the lubricator body together into a more cohesive mass than was heretofore possible.

We have found that at least two factors have an important bearing on the high lift characteristics of yarn, namely the diameter, or denier, of the fibers employed in spinning the yarn, and the amount of twist in the resulting yarn.

Yarns made from small denier fibers (that is, fine fibers) lift more oil because they have greater fiber surfaces. That is, the increased fiber surfaces provided by employing finer fibers in standard size yarn provide more capillaries of a size best adapted for lifting liquids. Parenthetically, it may be added that the lubricant is lifted in the capillaries formed by the small spaces between the outer surfaces of the fibers, and not through any possible cores within the fibers. Moreover, we have determined that there is an optimum size of the capillaries for good oil wicking. If they are too small, the oil will rise to a satisfactory height but very little oil will be lifted, and foreign matter will easily block the capillaries. If the capillaries are too large, the oil will not be lifted to the desired height.

With respect to yarn twist, after considerable experimentation, we have found that yarn of optimum high lift characteristics may be provided by proportioning the twist in the yarn to the yarn number on the woolen system in accordance with the following formulae:

For single yarn (yarn that is not plied) the turns per inch in the yarn should be equal to 2.25 times the square root of the cut of single yarn, while for plied yarn, the turns per inch should be equal to 1.80 times the square root of the cut of plied yarn.

In these formulae, the constants, which may be termed the twist factor, were determined by experimentation. The cut refers to the "cut" or size of the yarn or yarn number in the woolen system. It is the number of 300 yard lengths in a pound of yarn. Thus a 17 cut-yarn contains 17 times 300 yards per pound of the yarn. The higher the number, the finer the yarn.

While the above formulae when employed in yarn making will result in yarn having consistently higher lift, the lift may be still further increased by selecting fibers having substantially the same or equivalent characteristics hereinafter described.

One successful fabric produced in accordance with the teachings of our invention is diagrammatically illustrated in Figures 4 through 11, a portion of the fabric itself being generally indicated at 31 in Figure 9. The fiber composition in this embodiment consists of a uniform blend of 85% Vicara, code 500, bright, unbleached, 3 denier, with the fibers approximately three inches long, and 15% wool, 64's quality AA type. A suitable antistatic finish, such as that sold under the trademark Avcosol 104, made by the American Viscose Corporation of Marcus Hook, Pennsylvania, plus a small amount of Zelec NE, made by E. I. du Pont de Nemours & Co., Inc., of Wilmington, Delaware, should be applied to the fibers to aid in spinning. The yarn is preferably spun on the woolen system, as distinguished from the worsted and cotton systems.

Vicara is a synthetic protein base fiber, made from corn protein, or zein, by the Virginia-Carolina Chemical Corporation. Protein fibers are known under the generic term of azlon. These fibers are smooth and have a circular diameter. Vicara is preferred because it possesses a combination of desired properties. Foremost among these is its outstanding oil lifting performance. With optimum fiber and yarn properties herein specified, Vicara yarn will wick oil over eight inches in twenty-four hours at 70°. Vicara is outstanding in its stability to heat and acids. It will not soften below 475° F. It is at least equal to wool in heat resistance, and is similar

to wool in many other respects since it is a synthetic protein fiber.

There are five principal considerations involved in the selection of the type of Vicara fibers best suited for oil wicking. These are fiber code, luster, denier, finish, and staple length.

The code number indicates the extent of cure, which in turn governs the degree of shrinkage of the fiber on boiling or steaming. The low code fibers 500 and 600, have minimum shrinkage in water, while the higher codes, 800 and zycon, have maximum shrinkage. Code 500 was selected because it shrank the least and still has good oil lifting properties. Since the present felt body construction depends quite a bit on the felting through of the carded wool through the open spaces of the Vicara fabric, the high shrinkage of code 800 Vicara or zycon would tend to reduce the size of the open spaces and make felting more difficult. This could be compensated for by reducing the number of ends and picks, or warp and woof threads, in the fabric.

With respect to luster, bright unbleached Vicara fibers were selected, as delustering and bleaching modify the fibers and increase the costs without improving the oil lifting properties. As initially spun, Vicara fibers are bright.

With respect to denier or diameter size, it has already been mentioned that small denier fibers are preferable. It has been found, for instance, that three denier fiber size Vicara yarn will lift about 50% more oil than the 5 or more denier fiber size Vicara yarn of equal weight. The 2 denier size is also satisfactory for oil wicking, but these fine fibers are more easily broken than are the 3 denier fibers.

The fiber length selected for the Vicara fabric is the longest that could be economically spun in order to have the best formed capillaries. Fibers processed on the woolen system are generally not more than three inches in staple length. Fibers spun on the worsted system can be up to six or even 9 inches in staple length.

The finish referred to is an antistatic finish that must be applied to the fibers in order to spin the yarn. This finish must be removed from the fibers at some stage during the processing of the fabric. This is further discussed hereinafter.

The wool fiber with which the Vicara fiber is blended is a raw wool fiber of relatively small denier. The number 64 refers to the fiber diameter, and a fine wool fiber was chosen because the Vicara fiber is fine. The wool fibers were added to ease the task of spinning the yarn. It has also been found that the wool improves the bond between the layers of the fabric and the layers of felt.

The specified fiber was spun into 2-ply 17 cut yarn with the yarn twist of $9\frac{1}{3}$ turns per inch, "S" direction or to the left as shown in Figure 5 in the single, and $5\frac{1}{4}$ turns per inch "Z" direction, or to the right as shown in Figure 7 in the plied yarn. This twist is in accordance with the above mentioned formulae. As mentioned above, the "cut" refers to the size of yarn or yarn number in the woolen system. Thus a 17 cut yarn contains 17 times 300 yards per pound of the yarn. When two 17 cut single yarns are plied together, the resulting plied yarn is of 8.5 cut. If coarser or finer yarn than $\frac{3}{17}$'s cut are used, the yarn twist, in turns per inch, of both the single and the ply must be changed proportionately in accordance with the two formulae above mentioned.

The yarns of the illustrated fabric 31 were spun on the woolen system as mentioned above. The woolen system of spinning is less expensive than the worsted system as it eliminates the formation of the tops and the combing operation. While yarn spun on the woolen system lifts oil higher but carries less oil than yarn spun on the worsted system, felt bodies 20 made with Vicara fabrics woven from yarns spun on the woolen system

lifted as much oil as felt bodies containing Vicara fabric, the yarns of which were spun on the worsted system. Yarns spun on the woolen system are not as smooth as those spun on the worsted system. The "fuzziness" of the woolen spun yarn promotes fulling to form a more cohesive felt body, and probably contributes to better transfer of oil from the Vicara fabric to the wool felt layers. While the woolen system is thus the preferred system of spinning, yarn spun on the worsted or cotton systems will have improved high lift characteristics if the above mentioned formulae are employed. All of the principles herein discussed will apply to yarn regardless of how it is spun, within the limits dictated by fiber requirements for the particular system. However, for maximum lubricant lift results, the woolen system is recommended.

Plied yarns are preferably used in weaving the fabric as single yarn would have to be sized for satisfactory weaving. When two or more plied yarns are employed, we have found that it is unnecessary to use any sizing materials at all. Where single yarns are employed, Drisize 156, made by Colloids, Inc., Newark, New Jersey, has been found to be the least objectionable size to oil wicking.

We have also found that 2-ply yarns are also more uniform in size. This is an important consideration, as small defects in a yarn could block the passage of oil. These two advantages, namely, the elimination of sizing and desizing and more uniform yarn outweigh the small additional cost of plying. Additionally the plied yarn consistently lifts oil higher than single yarn of the same diameter.

We have found that yarn twist is perhaps the most important yarn factor contributing to good oil wicking properties. We have also found that the size of the capillaries is regulated by the size of the yarn, the amount of yarn twist and the direction of twist in the single and plied yarn. Experimentation has shown that yarn having twist in accordance with the above mentioned formulae lifted oil a maximum in height and amount. As progressively less twist than this optimum was applied, the height and amount of oil lifted decreased. When appreciably more twist than the optimum was applied, the amount of oil lifted dropped off sharply. Twist in the yarn is also important because it influences the weavability of the yarn and the wear properties.

It was found experimentally that the single yarns should have approximately four more turns per inch and in the opposite direction to the twist in the plied yarn. The result is a net twist that governs the size of the capillaries.

After the yarn has been spun, it is then woven into a fabric. Of the many weaves and knits studied, the two that have the most merit were the leno and the plain weave. The leno woven fabric has good dimensional stability, minimum unraveling, and good oil transfer at the point of interlacing between warp and filling yarns. The plain weave is less expensive, and lifted oil slightly higher. A modified form found to be satisfactory was a fabric having a plain weave reinforced every two inches with a pair of leno yarns in the warp. In the embodiments of the invention illustrated in Figure 9, which is a preferred form, the spun yarn is woven into a plain weave fabric 31, as shown in Figure 9.

One of the most important steps in the preparation of a good wicking fabric is the removal of the antistatic finish that is applied to the fibers to aid in processing. We have found that the chlorinated hydrocarbon type solvents do a good job of removing this finish. A satisfactory unit for performing this step of the process is the Derby Cleaner, a dry cleaning unit found in some textile finishing plants. This unit satisfactorily removes the finish and permits processing of the cloth in open width form to minimize disruption of the open weave pattern. For instance, the solvent used in the Derby

unit at Virginia Woolen Mills is trichloroethylene. Trichloroethylene is extensively used as a dry cleaning agent. It has been found that maximum flow of solvents should be used in this unit as the fabric is in the bath only a very short time. At least two passes through the solvent should be made.

Another necessary step in the production of the Vicara fabric is the preshrinking of the fabric before felting; otherwise the fabric will pull together and prevent fulling through the open spaces in the fabric. Therefore, after the dry cleaning process, the fabric is passed through a three bowl rinse. The bowls contain water with the first bowl containing a small percentage, about 0.05%, of a non-ionic wetting agent, such as Triton X-100, made by Rohm & Haas Company, Philadelphia, Pennsylvania, and at least one bowl should be about 140° F. After passing through the three bowl rinse, the fabric should be dried with as little tension as possible on the warp and with no stretch or tension in the woof.

In making the fabric out of which the laminations for the lubricator body 20 are formed, we prefer to make the fabric in sheets or strips 56 inches wide, 84 yards in length, and the fabric should not contain more than the 11 ends and 9 picks per inch.

The preshrunk fabric is now ready for the felting machine. The combining of the fabric and the layers of felt may be done in any conventional manner.

Figures 4-11 diagrammatically illustrate some of the features of our new fabric. Figure 4 diagrammatically illustrates a sliver 29 of Vicara and wool fibers intermixed for spinning on the woolen system. Preferably the individual fibers 30 are about 3 inches in length as mentioned above. Slivers such as that shown in Figure 4 are spun into the single thread or yarn such as that indicated in Figure 5. It will be noted that the individual fibers 30 are not necessarily parallel to each other, which is typical in slivers spun on the woolen system.

Yarn 32 of Figure 5 consists of sliver 29 twisted in accordance with the above mentioned formula for single yarn. As indicated in the figure the single yarn 32 is provided with a twist of $9\frac{1}{2}$ turns per inch in the "S" direction or to the left. Figure 6 diagrammatically illustrates the individual fibers 30 bunched together in the yarn 32 thus providing elongate capillaries between them, that is, between the individual fibers. Figures 5 and 6 also show that while a great proportion of the mass of fibers forms the body of the yarn, a plurality of loose fiber ends 33 project from the yarn in all directions. This "fuzziness" is one feature that promotes increased transfer of lubricant between fabric 31 and the adjacent layers of felt, and also aids in fulling to form a more cohesive felt body.

Figure 7 diagrammatically illustrates a 2-ply yarn 34 having a twist of $5\frac{1}{4}$ turns per inch in the "Z" direction. This is in accordance with the above mentioned formulae for plied yarn. Figure 8 diagrammatically illustrates the 2-ply, that is, the two single yarns 32 forming the plied yarn 34, and the individual fibers 30 therein. The "fuzzy" fiber ends 33 are also indicated in these figures.

Figure 9 diagrammatically illustrates plain weave fabric 31 employed in making the lubricator body 20. Fabric 31 comprises warp and woof threads or yarns 36 and 38 each comprising a plied yarn 34. Figure 10 illustrates a modified fabric 40 comprising a plain weave reinforced at suitable intervals, say every two inches, by a pair of leno yarns 42 and 44 in the warp. Yarns 42 and 44 each comprise a plied yarn 34. In Figures 9 and 10 the "fuzzy" ends 33 have been largely omitted to avoid undue complexity of the figures, but these ends will be present in the manner shown in Figures 5-8.

Figure 11 is an attempt to illustrate how the fuzzy ends 33 cooperate with the fibers of the felt to promote oil exchange and fulling or felting.

While Vicara has been specified as the preferred fiber in the illustrated embodiments, other fibers having high

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lift characteristics may be employed, for instance, cotton and rayon. Cotton fibers are reasonably satisfactory, but rayon melts at relatively low temperatures. Vicara is preferred as it is more compatible with wool felt, since it is a synthetic protein.

The foregoing description and the drawings are given merely to explain and illustrate our invention, and the invention is not to be limited thereto, except insofar as the appended claims are so limited since those skilled in the art who have our disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

We claim:

1. In a lubricator having high lift characteristics, a wicking material having a single yarn comprising spun fibers having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system.

2. In a lubricator having high lift characteristics, a wicking material having plied yarn comprising a plurality of single yarns each having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system, said single yarns being spun to provide a reverse twist substantially in accordance with the formula

$$1.80\sqrt{P}$$

P being the yarn number of the plied yarn on the woolen cut system.

3. The lubricator set forth in claim 2 wherein said yarn is spun from azlon fibers.

4. The lubricator set forth in claim 2 wherein said yarn is spun from a uniform blend of about 85% Vicara fibers and about 15% wool fibers.

5. In a lubricator, a high lift fabric comprising single yarn woven into a plain weave, said yarn having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system.

6. In a lubricator, a high lift fabric comprising plied yarn woven into a plain weave, said plied yarn comprising single yarn having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system, said plied yarn having a reverse twist in turns per inch substantially in accordance with the formula

$$1.80\sqrt{P}$$

P being the yarn number of the plied yarn on the woolen cut system.

7. The lubricator set forth in claim 6 wherein said fabric contains no more than eleven ends and nine picks per inch.

8. The lubricator set forth in claim 7 wherein said single yarn is 17 cut with a twist of substantially nine and one third turns per inch, and wherein the plied yarn has a reverse twist of about five and one-quarter turns per inch.

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9. The lubricator set forth in claim 8 wherein the fiber composition of said yarn comprises a uniform blend of about 85% code 500, bright, unbleached 3 denier, 3 inch staple Vicara fibers and about 15% 64's wool fiber.

10. A lubricator body comprising alternate layers of felt and fabric, said fabric comprising yarns formed from fibers spun into single yarns having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system.

11. The lubricator body set forth in claim 10 wherein the single yarns are plied into a yarn having a twist in turns per inch substantially in accordance with the formula

$$1.80\sqrt{P}$$

P being the yarn number of the plied yarn on the woolen cut system.

12. A laminated lubricator body comprising a woven fabric received between two layers of felt, said fabric being of the open mesh type and formed from yarns formed from fibers spun on the woolen system into single yarns having a twist in turns per inch substantially in accordance with the formula

$$2.25\sqrt{N}$$

N being the yarn number in the woolen cut system, said yarns thereby including a multiplicity of loose fiber ends projecting laterally therefrom, said layers of felt being felted together through the mesh openings of said fabric and said loose fiber ends intermeshing with the fibers of said layers of felt.

13. The lubricator body set forth in claim 12 wherein the single yarns are plied into a yarn having twist in turns per inch substantially in accordance with the formula

$$1.80\sqrt{P}$$

P being the yarn number of the plied yarn on the woolen cut system.

14. The body set forth in claim 12 wherein the fiber composition of said yarn comprises a uniform blend of about 85% Vicara fibers and about 15% wool fibers.

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