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SMOOTH-SURFACED PAPER BODY AND METHOD OF FORMING SAME

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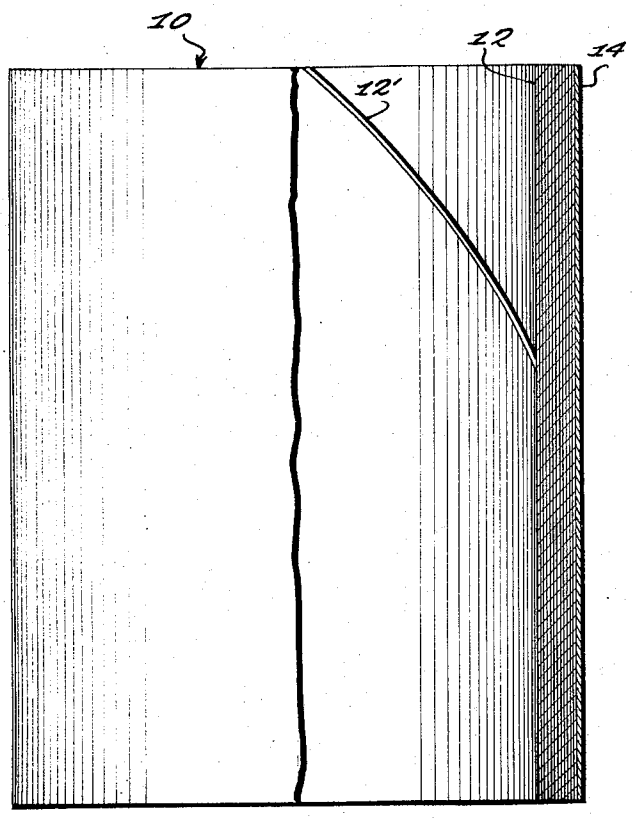


Fig. 1

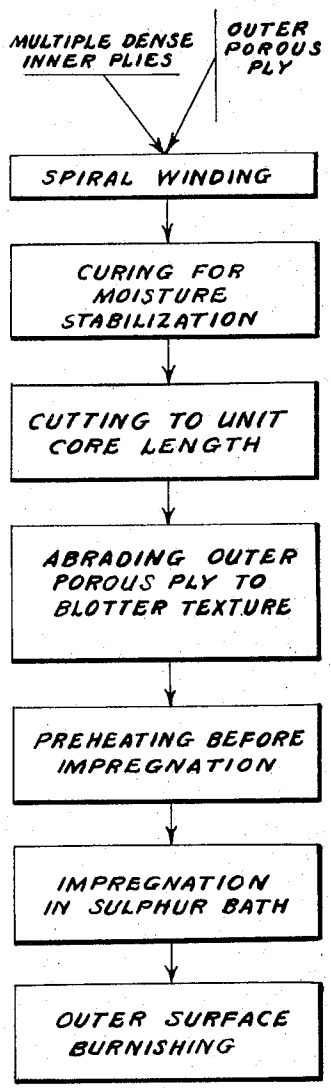


Fig. 2

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SMOOTH-SURFACED PAPER BODY AND METHOD OF FORMING SAME

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This invention relates in general to the smooth-surfacing of paper bodies and in particular to the formation of paper core structures having exceptionally hard and smooth outer surfaces adapting them uniquely for use as textile yarn carriers, as well as for advantageous core service in a number of other instances such as in the handling of foils and films.

The prior art has been concerned for some time with the problem of providing a fully satisfactory yarn carrier for supporting packages of the relatively elastic synthetic yarns, such as nylon and Dacron, which impose heavy compressive stresses on a supporting core by reason of the cumulative compressive force generated from the reaction of such yarns to the winding tension that is necessarily applied as they are wound into a package.

Yarns of this sort are commonly packaged by producers on tubular supporting cores. A representative supporting core might have a length of about 5½", an inside diameter of perhaps 3 11/16", and a wall thickness sufficient to provide adequate strength against the compressive stresses. In addition to adequate strength, the supporting core must also present a suitable outer surface for receiving the yarn upon winding and releasing it upon withdrawal. These structural properties could be provided without undue difficulty if it were not for the governing importance of cost, which has heretofore forced a greater compromise with the required structural properties than is desirable.

According to the present invention this limiting cost factor is circumvented by making it possible to form a fully adequate supporting core from a simple paper body. A spiral wound paper body, for example, may be constructed readily, and at good cost advantage, to provide the needed strength against the compressive stresses that must be dealt with; and the outer surface of this body may then be excellently conditioned in accordance with the present invention by impregnating the outer spiral wound ply with sulfur and burnishing it smooth.

It has previously been known that sulfur impregnation produces a strengthening and hardening effect on paper (see, for example, U.S. Patent No. 1,396,060). Insofar as we are aware, however, the prior art has not appreciated the possibility of developing a sulfur-impregnated paper surface by burnishing, which produces a surfacing effect that is exceptional and surprising. Just why this surfacing effect is obtained upon burnishing has not been determined with any certainty. It may be that the impregnated sulfur, having crystalized in and on the treated outer ply, behaves somewhat like a crystalline wax or resin in response to burnishing. In any event, the result is exceptional both as to the degree of surface smoothness and gloss obtained, and as to the scuff and moisture resistance at the burnished surface.

These and other features of the present invention are described at further length below in relation to the accompanying drawings, in which:

FIG. 1 is a side elevation in quarter section illustrating the structural form of an embodiment of the core structure of the present invention, and

FIG. 2 is a schematic flow diagram indicating the manner in which the core structure of FIG. 1 is formed.

The representative embodiment of the invention illustrated by the drawings incorporates a spiral wound construction of the basic paper body because spiral winding offers substantial production and cost advantages, as well as providing good strength readily, and the following detailed description of the invention is accordingly based, as a matter of convenient and significant exemplification, on this advantageous embodiment.

Before proceeding, however, it should be noted that the basic paper body might alternatively be convolutely wound if desired; that the illustrated tubular form of the basic paper body might be other than cylindrical, such as conical, for example; and that, further, the basic paper body might have any laminated shape adapted for its intended use, or it might be formed otherwise than by laminating, as by molding, for example.

Also, while the illustrated embodiment has its entire outer surface developed in accordance with the present invention, a restricted surface portion might be developed in essentially the same manner and to equal advantage for particular purposes, as in providing a smooth tip portion on conical textile yarn cores (see, for example, U.S. Patents No. 1,896,135 and No. 2,014,040). Additionally, while the illustrated embodiment indicates the exceptional surface smoothness that may be developed according to the present invention, it should be noted that the advantages of the invention may also be realized short of the fullest smoothness possible in instances where it is desirable that the surface have a somewhat textured character, as will be noted further presently.

Returning to a particular consideration of the illustrated embodiment, a core structure is designated generally by the reference numeral **10** as formed according to the present invention to provide the strength and outer surface condition needed for satisfactory service as a supporting carrier for producer's packages of the synthetic yarns that are elastic enough to impose heavy compressive stresses from their wound package form. In an actual embodiment of the form illustrated, the outer surface gloss and smoothness of the core structure is readily apparent, as is the telltale mark of the outer surface seam that reflects its spiral wound construction.

FIG. 1 illustrates the arrangement of this spiral wound construction of the core structure **10** as comprising a predominant plurality of inner spiral wound plies **12** associated with at least one outer covering ply **14**. The inner plies **12** are employed to build the body of the core structure **10** with adequate strength, and for this purpose they are preferably formed from a short-fibered hardwood sheet, such as might be produced from semi-chemical stock, that has been highly calendered to render it dense and provide good crush strength in the spiral wound structure. Typically these inner plies **12** have a thickness of about .023" to .024", and about twelve to fourteen such plies are needed to build a core structure **10** like the one illustrated in the drawings. The spiral winding of these inner plies **12** is carried out in the usual manner with the spiral wraps of each ply being defined by a slightly spaced butt seam (as at **12'** in FIG. 1), and with the seams of adjacent plies being staggered as they are superimposed.

The outer covering ply **14** is associated in the same spiral winding operation (as indicated in FIG. 2), although it is preferably of a different and special nature for facilitating the ultimate outer surface conditioning. Suitably this outer ply **14** consists of chipboard such as is formed from waste stock, and is characterized by an open and pourous formation. It will normally be used in a thickness of about .016" to .020", and is provided with deckle edges (by abrading) so that it may be wound with a smooth overlapping spiral seam. A thicker outer ply **14**, or more than one such ply, may be employed to facilitate deeper sulfur impregnation whenever desired in particular instances.

Following spiral winding (as again illustrated in FIG. 2), the resulting tubular structure is cured to prepare it for further processing. For this purpose the tubular structure is initially cut to gross lengths of perhaps twelve feet or so which are subjected to oven curing to set the laminating adhesive and drive off the moisture to a level of about 5%. Upon removal of these lengths from the curing treatment, the tubular structure tends to regain moisture to some extent, perhaps to a level of 7½%, but then becomes stabilized against substantial moisture content variation, which has the important effect of subsequently maintaining good dimensional stability.

After curing, the gross spiral lengths are cut to the unit size of the core structure **10** that is to be formed, and the exposed surface of the outer porous ply **14** is then preferably abraded to a blotter-like texture in preparation for sulfur impregnation. The sulfur impregnation might be accomplished without such abrading, and even without employing a special outer porous ply **14**, as by pressure impregnation of the sort disclosed in the previously noted U.S. Patent No. 1,396,060, but the impregnation is substantially facilitated if the outer ply **14** has a porous nature and is abraded to invite impregnation.

Immediately prior to impregnation the individual cores **10** are preheated to preclude undue sulfur crystallization at the surface of the outer ply **14**. We have found that preheating to a temperature in the order of 125° F. accomplishes this result effectively. The following impregnation is then carried out by immersion in a molten sulfur bath. The bath is prepared by heating powdered commercial sulfur in an open tank to a temperature that is maintained within the range from about 240° F. to 280° F. The ends of the cores **10** are plugged so that the impregnation takes place only at the surface of outer ply **14**, and an immersion time of approximately four to six minutes produces satisfactory impregnation of a porous outer ply **14** that has been abraded as previously noted in the course of forming a core **10** of the type illustrated.

Upon removal of the impregnated cores **10** from the molten bath the sulfur pickup hardens at once, and they are ready for the final burnishing step that particularly characterizes the present invention. At this stage the outer core surface has a dull and discolored appearance and, if the outer ply **14** has been abraded prior to impregnation, the surface nap produced by abrading is still quite evident although modified appreciably in texture by the filling effect of the sulfur impregnation.

The final burnishing step amounts in essence to a frictional working of the dull, sulfur-filled, outer surface of the impregnated cores **10**. It is suitably accomplished with one or more fine abrasive belts selected for polishing action as the frictional working takes place. During this frictional working there is only a slight removal of material from the core surface—not more than about .005" to .007" in preparing cores **10** of the illustrated type, and the material that is removed appears in the main to be surface situated sulfur. The transformation of the core surface upon frictional working, however, is truly remarkable and surprising, for from the dulled surface condition produced by sulfur impregnation a smooth and glossy surface appears.

Moreover, this smooth and glossy surface has an unusual hardness against stuffing and the like, as well as an excellent resistance to moisture, which apparently results from the sulfur-filled condition of the paper structure at and adjacent the burnished surface. That is, the fibrous body of the impregnated paper apparently has its interstices filled with sulfur that has become crystalline and that dominates the changed character of the impregnated paper to fix or set its fibrous structure against disturbance by moisture as well as otherwise to stabilize the structure and strengthen it materially.

The exceptional physical characteristics that are thus provided by a sulfur-impregnated and burnished core structure **10** in accordance with the present invention afford particular advantage in dealing with the previously mentioned synthetic yarns that exert unusual compressive stresses in package form by reason of their elastic nature. The result of these compressive stresses is a tendency to deform the winding surface of the supporting core concavely with respect to its length, for a traversing winding pattern is used in building producer's packages of such yarns, and the compressive purchase of the end loops formed as the traverse reverses is less than that of the regularly disposed wraps between the package ends, so that the generated compressive forces become greater towards the lengthwise center of the package from each end.

Structural strength to withstand these compressive forces can be provided to a reasonable degree, and the present invention allows the usual specifications for this purpose to be met readily. However, because the extent to which the compressive forces are generated is affected materially by the adjustment of winding tension, it can happen that an inadvertently heavy winding tension will result in a concave deformation of the winding surface despite the structural strength specified to prevent such deformation. But even when this happens, the exceptional smoothness and stability of the winding surface that the present invention makes possible still allows withdrawal of the yarn windings therefrom substantially as if the concave deformation had not occurred.

Such a result is particularly significant with a spiral wound core structure **10**, because the outer ply seam of such a structure terminates angularly at each core end so as to dispose a sharply pointed configuration of the ply thereat which normally has a troublesome tendency to come loose as a protruding ear formation on which yarn being withdrawn is apt to snag and break; and the structural disturbance resulting from a concave winding surface deformation promotes such ear formation. This cannot happen, however, with a sulfur-impregnated and burnished winding surface formed according to the present invention, because a substantial coalescence of the outer ply seam edges occurs to eliminate any potential for ear formation even though there may still remain some sign of the spiral seam at the winding surface.

As was noted initially, the present invention also lends itself effectively to providing the burnished surface, either entirely or partially, with a textured character, rather than developing it to the fullest smoothness possible. Such a character is sometimes desirable in textile yarn carriers in order to anchor the beginning yarn wraps adequately against slippage on the winding surface as the building of a yarn package is started (see, for example, U.S. patents, No. 1,634,492 and No. 2,219,836). A surface character of this sort, particularly when the outer surface ply has been abraded prior to sulfur impregnation, can be provided readily according to the present invention simply by limiting the extent or degree of burnishing so that the degree of surface working is sufficiently lessened to yield the desired result. The effect obtained may also be regulated, either alternatively or additionally, by employing somewhat coarser abrasive belts for the surface working. In either or both of these ways the satiny surface finish that is otherwise possible can be modified to have a definite textured feel, while essentially retaining the advantageous surface condition characterizing the present invention with a difference only in degree of smoothness attained; so that when the term "smooth" is used in the appended claims it is to be understood as contemplating the foregoing possibility of texturing the burnished surface as desired, as well as polishing it glassy smooth.

Finally, it should be noted that the exceptional characteristics suiting a core structure **10** formed according to the present invention for use to particular advantage as a textile yarn carrier in handling the relatively elastic synthetic yarns likewise render the invention applicable generally for providing particularly useful core structures in a number of other instances. The previously noted

use for foils or films is a significant example, for foil and film materials exhibit a pronounced tendency in roll form to take on at each roll convolution a damaging, or at least degrading, impression of any core surface imperfection. The present invention makes it possible to provide a suitable core structure readily that is free of surface imperfections and excellently adapted for supporting foil or film rolls, either of mill size or of smaller widths as slit to customer specifications.

The present invention has been described in detail above for purposes of illustration only and is not intended to be limited by this description or otherwise except as defined in the appended claims.

We claim:

1. A paper body of substantial thickness characterized by a surface normal to said thickness that is impregnated with sulfur and burnished smooth.

2. A paper body of substantial thickness impregnated with sulfur at and adjacent a surface thereof normal to said thickness and having said impregnated surface burnished smooth.

3. A laminated paper body characterized by an exceptionally hard and smooth surface portion, said paper body having the exposed layer at said surface portion impregnated with sulfur and burnished smooth.

4. A tubular paper body characterized by an exceptionally hard and smooth outer surface, said paper body being formed of laminated multiple plies and having at least the outer ply thereof impregnated with sulfur and the exposed surface of said impregnated ply burnished smooth.

5. A tubular paper body characterized by an exceptionally hard and smooth outer surface, said paper body being formed of spiral wound multiple plies, having at least the outer ply thereof impregnated with sulfur, and having the exposed surface of the impregnated outer ply burnished smooth.

6. A tubular paper body as defined in claim **5** and further characterized in that at least said outer ply has a relatively porous formation for inviting said sulfur impregnation.

7. A tubular paper body as defined in claim **6** and further characterized in that the inner spiral wound plies are predominantly of dense and highly calendered stock for providing said paper body with crush strength.

8. A core structure for supporting textile yarn packages, said core structure comprising laminated paper plies super-imposed by winding and adhesively secured, and having at least a portion of the outer ply impregnated with sulfur and burnished smooth at the exposed surface of the impregnated ply portion.

9. A tubular core structure for supporting textile yarn packages of the type that impose heavy compressive stresses on the supporting core, said core structure comprising multiple paper plies laminated by winding, the inner plies being predominantly of dense and highly calendered stock for withstanding said compressive stresses, at least one outer ply being of a relatively porous formation and being impregnated with sulfur, and the impregnated outer ply having the exposed surface thereof burnished smooth.

10. The method of investing a paper body with an exceptionally hard and smooth surface portion, which method comprises impregnating the paper body at and adjacent said surface portion with sulfur and then burnishing the impregnated surface portion smooth.

11. The method of forming a tubular paper body with an exceptionally hard and smooth outer surface, which method comprises laminating multiple paper plies in tubular form, impregnating at least the outer ply of the laminated body with sulfur, and then burnishing the exposed surface of the sulfur-impregnated outer ply.

12. The method defined in claim **11** and further characterized in that at least the outer ply of said laminated body is provided with a relatively porous formation for inviting said sulfur impregnation.

13. The method defined in claim **12** and further characterized in that the exposed surface of said outer ply is abraded to a blotter-like texture prior to sulfur impregnation.

14. The method defined in claim **11** and further characterized in that said laminated body is cured upon formation to stabilize the moisture content thereof, and is then preheated to facilitate subsequent sulfur impregnation.

15. The method defined in claim **11** and further characterized in that said sulfur impregnation is carried out by immersion in a molten sulfur bath.

16. The method defined in claim **15** and further characterized in that said molten sulfur bath is maintained at a temperature within the range from about 240° F. to 280° F., and said laminated body is preheated to a temperature in the order of 125° F. prior to immersion in said bath.

17. The method defined in claim **11** and further characterized in that said laminated body is formed with inner plies that are predominantly of dense and highly calendered paper stock.

18. The method defined in claim **11** and further characterized in that said laminated body is formed by spiral winding.

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