P. T. WISE, J. F. MALCOLM & C. T. DAVIS.

PRODUCTION OF SHEETS OR WEBS FROM FIBROUS MATERIALS.

APPLICATION FILED JULY 5, 1917.

1,281,467. Patented Oct. 15, 1918.

Fig. 1.

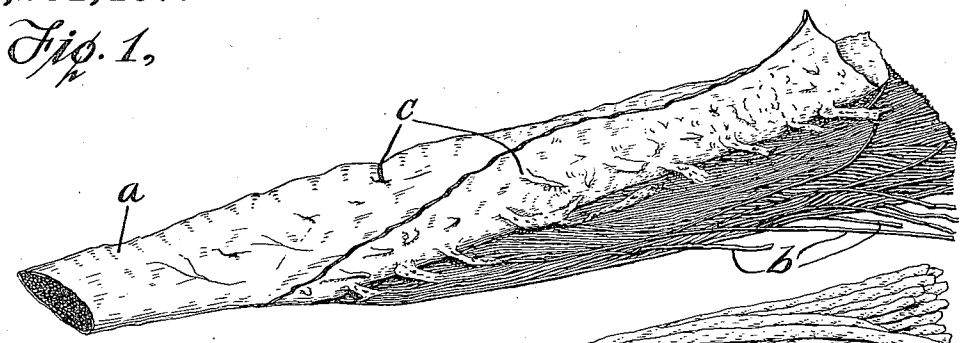


Fig. 2.

Fig. 3

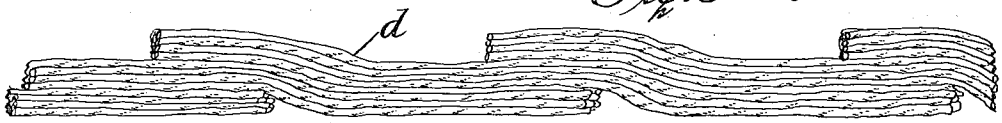


Fig. 4,

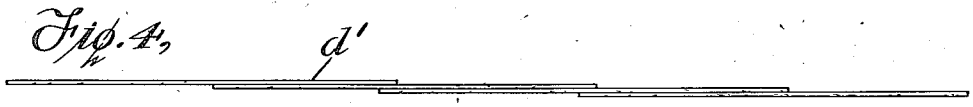


Fig. 5,

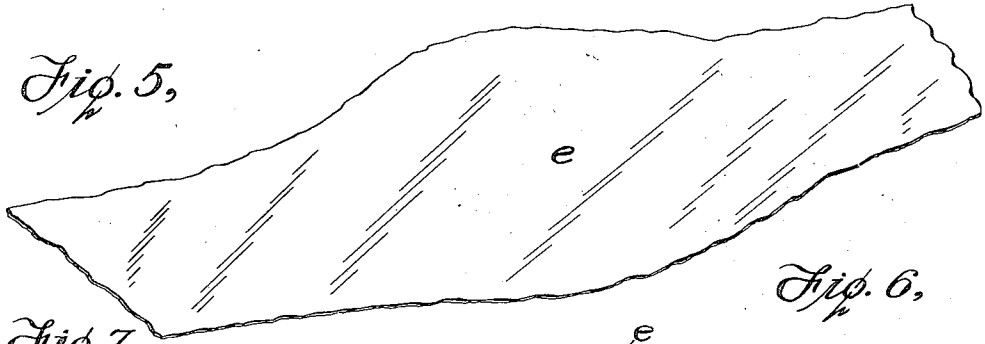


Fig. 6,

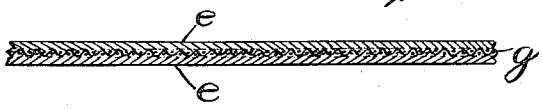
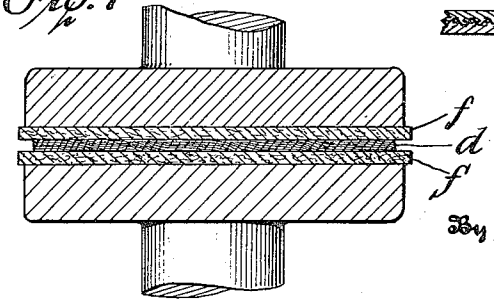


Fig. 7



Inventors
Paul T. Wise
James F. Malcolm and
Charles T. Davis.

By their Attorneys
Meyers, Cushman & Rea

UNITED STATES PATENT OFFICE.

PAUL T. WISE, OF FLUSHING, JAMES F. MALCOLM, OF ELMHURST, AND CHARLES T. DAVIS, OF BROOKLYN, NEW YORK, ASSIGNORS TO DAVIS & GECK, INC., OF BROOKLYN, NEW YORK, A CORPORATION OF NEW YORK.

PRODUCTION OF SHEETS OR WEBS FROM FIBROUS MATERIALS.

1,281,467. Specification of Letters Patent. Patented Oct. 15, 1918.

Application filed July 5, 1917. Serial No. 178,683.

To all whom it may concern:

Be it known that PAUL T. WISE, JAMES F. MALCOLM, and CHARLES T. DAVIS, all citizens of the United States, residing at Flushing, L. I., Elmhurst, L. I., and Brooklyn, State of New York, have invented new and useful Improvements in the Production of Sheets or Webs from Fibrous Materials, of which the following is a specification.

This invention relates to the production of sheets or webs from fibrous materials, and more particularly to the fabrication of sheets or webs from the fiber material of animals, such material, for instance, as tendons, sinews or ligaments.

Sheets or webs fabricated in accordance with the present invention may be made of any desired length or width and since they possess great strength, are readily workable into various forms, and can be manufactured at comparatively low cost owing to the abundance of the raw material and the simplicity of the process, such sheets have a wide range of use and also form an excellent base for use in connection with the manufacture of various products. For instance, the sheet or web has qualities which enable it to be successfully employed as a substitute for leather and rubber in many forms of products at present made from these materials. The sheets may also be employed as a material for the wings of aeroplanes or the like. The material for this use may be reinforced in suitable manner if desired. The sheets, webs or ribbons cut therefrom may likewise be utilized in the manufacture of surgical sutures or ligatures and other forms of strings or cords. We do not however claim the latter products, as such, in the present application, such products being specifically claimed in our co-pending application Ser. No. 178,682, filed July 5, 1917.

The present invention has, therefore, for its general object, the fabricaton of a sheet or web of this type, which may, if desired, be reinforced,—dependent on its use—and capable of employment as a complete product, as a base for the production of other manufactures, or as a portion of a composite sheet, and consists in the sheet or web and its methods of production, as more fully hereinafter described and more particularly pointed out in the appended claims.

In the annexed drawings wherein we have illustrated our invention in a more or less conventional manner,—

Figure 1 is a perspective view of a natural tendon, the view conventionally illustrating the well-known fascia lata, some of the adherent flesh, fatty matter, muscle, etc., having been removed to expose the fiber of the tendon.

Fig. 2 is a perspective view conventionally illustrating the cleaned and plumped fibers from which the sheet is to be formed.

Fig. 3 is a side elevation showing one manner in which the fibers are arranged prior to pressure in sheet form.

Fig. 4 is a view similar to Fig. 3 showing an arrangement of the fibers in preliminary sheet form prior to the formation of the final sheet.

Fig. 5 is a perspective view of the finished sheet formed from the fibers.

Fig. 6 is a sectional view showing one form of reinforced sheet fabricated in accordance with the invention.

Fig. 7 is a conventional illustration partly in section showing a step in the process of manufacturing the sheet.

Practically all of the animal tendons, sinews, or ligaments may be utilized in sheet manufacture, depending more or less on the particular use to which the sheet is to be put, it being readily understood that some tendons, sinews or ligaments may be better for a particular kind of manufacture than others. But it will also be understood that in general all are capable of sheet or web production when the general methods herein set forth are utilized.

For the purpose of explaining the invention, we assume the fabrication of a sheet or

web from the well known fascia lata, a tendon especially adapted for the production of a sheet base according to the present invention.

The structure of this material as indicated by the letter *a* in Fig. 1, as supplied to manufacturers, not only has the longitudinally and transversely extending fibers *b* in bundle form, but it also contains more or less adherent flesh, fat, muscle, etc., *c* and in many cases the skin which surrounds the tendon structure. As the sheet to be fabricated is preferably formed from the longitudinally-extending fibers *b*, the material is initially treated to reduce the tendon to a condition where these bundles of fibers can be readily segregated.

This result can be provided in various ways, a preferred method, however, being to place the tendon into a vat containing enzyms and a weak alkaline solution (caustic soda, for example) where it remains for a suitable period—for example, approximately twenty-four hours. During this soaking operation the tendon becomes more or less softened, in addition to which the flesh, fat, muscle, etc., are more or less removed or rendered suitable for ready removal.

The soaked tendon is then removed from the vat and subjected to a fiber-loosening action, as by hammering or beating.

This successive soaking and fiber-loosening action may be repeated, using a clean solution with each repetition, until the undesirable parts are removed and the fiber so loosened as to permit of ready separation of the bundles of longitudinally-extending fibers from those extending transversely, the latter being generally discarded in the sheet manufacture owing to the short lengths, although capable of employment in other relations. Obviously, the number of vat-soaking treatments may be varied to meet the character of the material.

The material at this stage is somewhat softened, but, after segregation of the desired bundles of longitudinally-extending fibers, these fibers are subjected to a further softening action, the material being given what is known as a "plumping" treatment, generally by placing the material in a vat containing a stronger alkaline solution (omitting the enzyms), the material remaining therein for a suitable period—approximately twelve hours for example—when it is removed ready for the sheet or web producing operation.

At this stage the fibers are soft, still maintaining a more or less fibrous formation with each fiber swollen as indicated at *d* in Fig. 2, but the condition is such as will permit of ready separation of the fibers from each other to any extent desired. It has been found that even where the softening has reached a stage where the fiber structure may be torn transversely under pulling strains, the "plumped" fibers are suitable in the production of the sheet or web.

Should it be found that the ends of the bundle are insufficiently treated to permit of ready separation of fibers, we prefer to shear off such ends, thus leaving each fiber capable of separation.

We have found that when "plumped" in this manner, each fiber, if subjected to pressure, will flatten out into sheet form, the width of the sheet depending on the thickness of the fiber, the inherent more or less sticky or slimy characteristic of the fiber material at this stage permitting the formation of a thin or film like sheet *e* of a substantially uniform texture and with its edges more or less irregularly shaped as indicated in Fig. 5, the spreading action apparently being more or less outwardly from the center, so that the sheet is generally of substantially uniform character intermediate its edges. And this same general effect is present where two or more unseparated fibers are employed, the sheet being increased in width but having this same characteristic of substantially uniform texture, even though the connected fibers may be positioned in the press in such manner that the fibers do not have the same positions relative to each other and to the direction of pressure application throughout their length. These facts appear to indicate that when the fibers are subjected to pressure the normal arrangement of fiber structure is more or less broken down and assumes a different arrangement varying more or less from its original condition, but still retaining the desired cohesion of the structure. These results are further evidenced by the fact that in the web production, presently described, in which the length is produced by overlapping fibers as indicated in Fig. 3, it is found that the overlapped portions have this same characteristic of the substantially uniform texture with the desired cohesion between the separate fibers retained, the structures of the overlapped fibers apparently uniting into a more or less homogeneous structure varying more or less from the initial structural arrangement of the fiber. This resultant action under pressure permits the formation of the sheet or web *e* of the present application.

If it is desired to form a sheet of the length of the fiber, one or more of the plumped fibers are laid between layers of canvas or felt *f* and subjected to pressure of suitable amount in an appropriate press as conventionally illustrated in Fig. 7. This not only produces the sheet formation but

the canvas or felt layers also absorb more or less of the moisture present in the "plumped" fibers, leaving the formed sheet sufficiently strong to be readily handled for further treatment. The sheet may be allowed to dry in the condition left by the pressing action thus described, or it may be placed between plates having smooth faces and subjected to pressure to produce a smoother surface to the sheet, and then dried. Drying of the sheet may cause a slight shrinkage, but this does not materially affect the sheet texture, the sheet having the desired strength and being capable of the desired manipulation.

A web of greater length than the normal length of a natural tendon, sinew or ligament may be produced by uniting overlapping fibers lengthwise, and this uniting action as indicated in Fig. 3 may take place before a preliminary initial pressing action or after the sheet *d'* is produced as indicated in Fig. 4, it being preferred, however, to provide the uniting by a sheet-uniting action since the overlapping positioning can be more readily provided with the flat sheets. However, it will be understood that the plumped fibers can be arranged in the overlapping relation as indicated in Fig. 3 and thus produce the sheet form and web concurrently. To explain the general operation we assume that the web is being formed from sheets.

In forming the web we preferably provide an overlapping length slightly greater than fifty per cent. (50%) of the length of the sheet, a sheet having one end overlapped by a sheet for a distance extending slightly beyond the medial point in the sheet length, the succeeding sheet overlapping from the opposite end on the opposite side of the sheet and extending inwardly slightly beyond the center of the sheet as indicated in Fig. 4. This practically produces a double thickness of sheets at all points excepting at the extreme ends of the overlapping sheets where the additional overlapping length produces a three-layer formation.

This overlapping positioning takes place while the sheet is in its moist condition—it may be in immediate succession to the initial pressing action. The positioned sheets are then placed between layers of canvas or felt *f* in Fig. 7—the positioning of sheets may take place on one of the layers—and the batch placed in a press and pressure applied. After the pressure application—if it is not desired to provide the smooth surface by subjecting the united sheets to pressure between plates having smooth faces—the web is dried. The web may, if desired, be mounted on a reel prior to drying or subsequent thereto, as desired.

Where the web is formed direct from the plumped fibers, the same overlapping positioning is had and the positioned fibers subjected to the pressure action.

While we prefer to employ the canvas or felt layer structure in the initial pressing, it will be understood that other types of layers or pressure faces may be employed, and, if desired, the uniting of sheets into web form may take place between smooth surfaced plates.

As heretofore pointed out, the overlapped fibers are apparently more or less broken down under the pressure action and a new arrangement formed while preserving the desired cohesion. We have found that where sheets are positioned in this manner, the application of the pressure increases the width of the sheet more or less in accord with the number of overlapping thicknesses. In testing dried webs thus formed of sheets, we have found that when sufficient pulling strain is had the web may be torn transversely but that such tearing line is generally at a point spaced from the ends of overlapping sheets.

As heretofore pointed out, the invention is applicable for use in producing sheet material serviceable in the formation of wings for aeroplanes or the like.

Sheet material for this purpose may be produced by the overlapping methods of producing webs, heretofore pointed out, the width being produced by lateral overlapping in addition to lengthwise overlapping.

However, it may be preferable to reinforce the sheet by the use of suitable fibrous material which may be in sheet or web form as indicated at *g* in Fig. 6, and may, if desired, be of comparatively large or loose mesh.

The reinforcing material may be secured to one or both sides of the animal fiber sheet or web, or it may be interposed between superposed sheets or webs in layer form, a preferred method being to provide a layer of the softened sheets in proper overlapping formation, then positioning a thin sheet or web or large mesh fiber material, and then forming another layer of the softened sheets, thus positioning the mesh material between two layers of softened sheets as indicated in Fig. 6. By subjecting the composite structure to pressure, the sheets of the layers will unite, in addition to which the sheets opposing each other on opposite sides of the mesh layer will unite to a more or less extent through the interstices of the mesh layer, thus incorporating the latter as a part of the composite sheet, strengthening the latter and aiding in maintaining the integrity of the structure.

While the composite sheet is preferably formed by the overlapping sheet formation, the structure may be varied by arranging sheets or webs side by side, slightly spaced,

in contact or with a slight overlapping, the mesh material, however, being preferably continuous throughout the width of the composite sheet. Or the mesh structure may be in web for of less width and extending in the direction of length of the animal fiber web, or extend angular to such direction of length. Possible variations of this general arrangement will be readily seen and made usable by the skilled mechanic, these variations being, of course, made possible by the ability to produce the animal fiber sheet or web formation.

While we have described the invention as employing animal tendons, sinews, or ligaments, it is to be understood that the invention is not limited in this respect, since its general principles may be employed with other animal parts having cohesive characteristics and adapted to be manipulated to produce the sheet form of structure either by employing the complete methods herein described or steps of such method, it being the purpose to protect broadly the general principles involved in the production of a sheet or web of this general character or of the composite form, and such changes or modifications in the method of production as are required or desired to meet the conditions or form of the material or the particular conditions required by a particular use, are considered as falling within the spirit and scope of the broad invention disclosed in so far as the appended claims, when broadly construed, will permit.

The invention also contemplates the use of the tendons of fish—whales, for instance—and the tendons and intestines of fowls as the source of supply, and it is to be understood that such sources are considered as substitutes or substantial equivalents for the "animal" fiber material herein referred to, and therefore fall within the spirit and scope of the invention as claimed.

Having thus described our invention, what we claim as new, is:

1. A fabricated sheet composed of plumped animal fiber material, said material being flattened into sheet form.

2. A fabricated sheet composed of plumped animal fiber material, said material being flattened into a film-like sheet.

3. A fabricated sheet composed of a plurality of plumped and cohesively united fiber strands of tendons, sinews or ligaments flattened into sheet form.

4. A fabricated sheet composed of a plurality of plumped, overlapping and cohesively united fiber strands of tendons flattened into sheet form, said sheet being of greater length than the normal length of the fiber strands of a natural tendon.

5. A thin and flexible fabricated sheet composed of a plurality of plumped, overlapping and cohesively united tendon fibers flattened into a film-like sheet.

6. A fabricated sheet composed of a plurality of plumped and cohesively united fibers of tendons, sinews or ligaments flattened into sheet form and having a reinforcing sheet united therewith.

7. The method of fabricating a sheet from tendons, sinews or ligaments, which consists in treating the tendons, sinews or ligaments to a bath to render them soft and plumped and then subjecting them, while soft and plumped to a flattening pressure.

8. In a method of fabricating a sheet from tendons, sinews or ligaments, the steps which consist in softening and plumping the tendons, sinews or ligaments, and then subjecting them, while soft and plumped, to a flattening pressure sufficient to cohesively unite and reduce the fibers to a sheet form.

9. The method of fabricating a sheet from fiber material of animal tendons, sinews or ligaments, which consists in treating the material to soften and plump the fibers, positioning the plumped fiber strands in overlapping relation, and then subjecting the positioned strands, while soft and plumped, to a flattening pressure to cause them to cohesively unite in the form of a sheet.

10. The method of fabricating sheets from fiber material of animal tendons, sinews or ligaments having cohesive characteristics which consists in treating the material to produce a strand with its structure and elements of cohesion plumped and softened, and subjecting the softened strand to a flattening pressure and concurrently removing moisture.

11. The method of producing sheets formed from fiber materials of animal tendons, sinews or ligaments which consists in subjecting the fiber material to the soaking action of an alkaline solution containing enzyms and a succeeding fiber-loosening action to eliminate undesired material, plumping the treated fiber material to a point of low resistance to fiber separation, and subjecting separated fibers to a flattening pressure.

12. The method of producing webs formed from animal fiber which consists in softening the fiber material and producing flattened sheets of such softened material, positioning the sheets in an endwise overlapping relation while the sheets are softened, and subjecting the positioned sheets to flattening pressure.

13. The method of producing webs formed from animal fiber which consists in softening the fiber material and producing flattened sheets of such softened material, positioning the sheets in an endwise overlapping relation while the sheets are softened,

subjecting the positioned sheets to a flattening pressure, and subsequently drying the web.

14. The method of producing webs formed from fiber material of animal tendons, sinews or ligaments which consists in producing sheets of softened fiber, positioning sheets in an endwise overlapping relation with the extent of overlap not less than fifty per cent. of the length of the contacting sheets, and subjecting the positioned sheets to a flattening pressure.

In testimony whereof we have hereunto set our hands.

PAUL T. WISE.
JAMES F. MALCOLM.
CHARLES T. DAVIS.