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LEATHER PULP AND PRODUCTS MADE THEREFROM

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This invention relates to leather and more particularly pertains to the treatment of animal hides and skins to reduce them to pulp consisting mainly of their ultimate physical units, their fibrils and from which pulp may be produced sheet leather and other leather products having greater uniformity of physical characteristics and greater commercial value for many purposes than the original hides and skins and the leathers heretofore produced therefrom.

It is well known that animal hides and skins have fibrous structures, physical properties and chemical compositions which vary widely over the area and through the thickness of any single hide or skin. For example, in one chrome-tanned calf-skin examined, the tensile strength varied from 653 to 5689 pounds per square inch of cross-section in a linear distance of only twenty inches, and the resistance to stretch varied similarly. It was also observed that the density of the leather fibres varied throughout the skin and that the tensile strength of any portion of the skin varied with the density of the fibres. This typically wide variation in the strength and fibrous structure of animal skins and hides is very objectionable to the production of commercially valuable leather products.

In accordance with the present invention, this objectionable feature among others, in the manufacture of leather goods is overcome. This is accomplished by reducing animal hides and skins mainly to their ultimate physical units, or fibrils, without reducing their length or strength or damaging them, and then bringing these separated hide fibrils together again without the use of binding materials of any character to form leathers possessing greater uniformity of structure, physical properties and chemical compositions than any leathers heretofore produced. The fibrils of an animal skin or hide are the very fine threadlike processes of protein jelly which make up the fibres of which the hide is composed. When the hide fibrils are completely separated from each other, the maximum surface of each fibril is exposed thus providing the maximum areas of contact between the fibrils when they are again brought together, the maximum total adhesion between the fibrils with resulting great strength and toughness of the leather produced by the reassembling of the fibrils, and the maximum uniformity of structure.

Numerous attempts have heretofore been made to reduce animal hides and leather to pulp in various forms of paper mill beaters, but I am not aware that it has heretofore been proposed to

separate animal hides or leather into their constituent fibrils to produce pulps from which leather products of greatly improved characteristics may be produced. The prior art methods for beating hides and leather to pulp in ordinary paper mill beaters have produced only pulps of a heterogeneous character, not reduced to fibrils, but reduced only to lumps of various sizes incapable of being manufactured into leather sheets or other leather products possessing uniform structure and physical characteristics. For this reason the prior art methods require that binding materials of various kinds be used with the pulps to fabricate leather sheets and other products to provide the required strength and durability for the intended use. With the pulps produced in accordance with my invention, no binding materials are required to produce leather products of uniform structure possessing great toughness, strength and durability.

In the past, failure to produce hide or leather pulps of a homogeneous character has been due to the wet condition of the material during the beating operation, in which water is used in amounts very much greater than the quantity of material.

In order to reduce animal hide to its constituent fibrils by a beating action to produce a pulp of a homogeneous character so that sheet leather and other products of uniform structure and physical characteristics may be produced therefrom, I have discovered that the hide must be sufficiently dry and also sufficiently resistant to the absorption of water to prevent the fibrils from becoming soft and easily cut by the beating action and to prevent chemical changes that make the ultimate sheet brittle.

I have discovered that when animal hides and skins are chrome-tanned and the chrome-tanned leather is thereafter dried, it wets back to the condition of the original wet leather prior to drying with exceeding difficulty, or in other words, once the chrome-tanned leather has been dried, it possesses great resistance to the absorption of water. For this reason the fibrils of the dried chrome-tanned leather remain tough and resistant to cutting during the beating operation in the presence of water but these fibrils lend themselves very readily to complete separation by abrasive action such as is obtained by a beating operation. The greater the extent to which chrome-tanned leather is dried before beating, the more readily does it lend itself to separation into fibrils by the abrasive action of a beater and the more resistant it becomes to the cutting which

shortens and damages the fibrils. The best result is obtained by reducing the leather to complete or "bone" dryness before beating.

I believe I am the first to discover the importance of separating animal hides and skins into their constituent fibrils without damage to them, and the first to discover the necessity for maintaining the fibres of the hides and skins in a sufficiently dried condition during the separating operation and the first to discover the necessity of chrome-tanning the hides and skins and subsequently drying them prior to the separating operation for the purpose of producing hide or leather fibril pulps from which may be fabricated leather products possessing uniform structures, physical characteristics and chemical compositions with consequent strength and durability.

Chrome-tanned leather of any character may be used, but in order to make the pulps and leather products of my invention most economically it is desirable to utilize waste chrome-tanned leather, such as cuttings, trimmings and shavings which otherwise possess little or no value. It is also desirable to use leather after it has been chrome-tanned but before it has been fatliquored, colored and finished as in the methods commercially used in making finished leather. The greatest supply of leather waste of this character is to be found in the shavings and splits removed from the skins after tanning and before fatliquoring, coloring and finishing in order to render them more uniform in thickness and to make the flesh sides of the skins smooth. This waste leather material as produced in the tannery usually contains water in excess of 50% of its weight.

My investigations of the action of various paper mill beaters upon the dried chrome-tanned leather shavings suspended in water have led to the discoveries that the time for separation of the leather into its fibrils varies according to the type of beater used and that damaging effects upon the leather pulp may be produced when beating is too long continued which will adversely affect the characteristics of the leather sheet or other products produced therefrom. It is essential, therefore, that the separation of hide or leather into its fibrils be accomplished in the shortest time and before such harmful and damaging effects appear.

By way of example I have found that the well known commercial type Niagara beater is not suitable for reducing chrome-tanned leather into its constituent fibrils on a commercial scale, because long before the separation is effected the pulp has been damaged by chemical changes and the cutting of the fibrils. On the other hand, I have found that a small amount of leather (about 2½ lbs.) can be beaten to fibrils in a small Niagara laboratory beater in five or six hours before any damaging effects are produced, for the reason that the number of passes of face bars over bed plates per pound of leather in this small beater is vastly greater than in the commercial sizes of beaters. In this small laboratory beater, the beating action was completed by about one million sweeps of face bar one foot wide over a bed plate per pound of dry leather. I have conceived of a beater which will be adequate to effect the reduction of chrome-tanned leather or animal hide to its constituent fibrils on a commercial scale without damaging effects. Such a beater consists essentially of a large number of beater rolls of relatively small diameter arranged in series, which are capable of providing a very large number of passages of face bars over bed plates per

pound of leather per minute. Such a beater would perform an amount of work per unit of time of a very much higher order of magnitude than an ordinary beater. I have also observed that the Noblewood mill, manufactured by the Noble & Wood Machine Company of Hoosic Falls, New York, is of the nature of a beater of my conception which is adequate for the purpose. This mill consists essentially of a single beater roll having two hundred or more one foot face bars on its periphery with twenty or more adjustable bed plates or shoes disposed about the roll periphery. The beater roll may rotate about its axis at about 1800 R. P. M. The leather in relatively finely divided form in the presence of water is introduced into the beater at one end of the circular row of bed plates and passes between the roll and the face bars thereon and is withdrawn from the beater at the other end of the row of bed plates. The leather in the presence of water in sufficient quantity may be passed in this manner through the beater as many times as necessary to effect the degree of separation desired. With a beater of this character nearly eight million sweeps per minute of one foot face bars over a bed plate would be obtained which would be sufficient to complete the beating of from about eight to sixteen pounds of dried leather per minute depending upon the pressure exerted upon the leather during its passage through the beater.

Theoretically, the best results are obtained by the complete reduction of the hide or leather to its constituent fibrils with each fibril entirely separated from all the other fibrils, but satisfactory results may be obtained where the fibril separation is less than complete, that is to say, where some of the fibrils have been separated only partly or not at all from some of the other fibrils. Accordingly, where the expression "separated fibrils" or other term or terms pertaining to fibril separation is employed herein, it will be understood that the meaning of these expressions or terms is not limited to complete fibril separation but that they also include within their meaning, any substantial reduction of the hide or leather or the fibers thereof to fibrils.

My process for producing the pulps of this invention may be stated as follows: The raw animal hides or skins are subjected to the well known operations ordinarily considered to be necessary prior to the tanning of the hides, such as washing, soaking, liming, unhairing, scudding, bating and pickling. The treated stock is then chrome-tanned, by any well-known method. Chrome-tanned leather produced by any of the well-known methods may be utilized, although chrome-tanned leather of a particular composition, hereinafter set forth, produces better results than other compositions. Instead of starting with the raw hides, waste chrome-tanned leather of any character, large quantities of which are available, may be used. The chrome-tanned leather is then thoroughly dried by any suitable means. Before or after drying, the leather is then reduced, if necessary, to somewhat finely divided form, in a suitable device, such as a rag beater. This comminuted chrome-tanned leather is then reduced to its constituent fibrils, in the presence of water, by the beating operation hereinbefore described which will produce the fibril separations well within the time, beyond which the beating should not continue due to the injurious effects on the pulp and final products, as previously mentioned. The resulting pulp, consisting of separated fibrils of animal

hide, or chrome-tanned leather, or mainly so consisting, suspended in water, may then be formed into sheet leather on a sheet forming machine, such as is used in the paper industry or the pulp may be formed into any desired article by any method suitable for leather pulps, such as molding, etc.

The properties or qualities of the leather pulps of the present invention and the finished products produced therefrom will vary according to:

1. The chemical composition of the leather used;
2. The extent to which the leather has been dried;
3. The proportion of water to leather used in beating;
4. the time consumed in beating;
5. The temperature of water in the beater;
6. The temperature of the pulp while being formed into a sheet;
7. The acidity, or pH value of the pulp water, and
8. The addition of other materials.

With respect to the chemical composition of the leather used, chrome-tanned leather of different chemical compositions may be utilized but the leather which I have found best suited for the production of the pulps of my invention showed by analysis the following approximate chemical composition, given in grams per one hundred grams of skin protein: chromic oxide as Cr_2O_3 5.2; acid sulfate as H_2SO_4 6.3; animal fat 2.6; sodium chloride as NaCl 7.9; and sodium sulfate as Na_2SO_4 5.2. Leather of this composition may be produced by any one skilled in the art by suitably varying the treatment during chrome-tanning. When 5 lbs. of leather of this composition, previously dried, was reduced to fibrils in 95 lbs. of water, the pH value of the liquid was 3.25. Chrome-tanned leather of composition very different from this produced pulps of less freeness and sheets and other products that were weaker and more brittle.

Concerning the extent to which the chrome-tanned leather should be dried, I have found that the best results are obtained by drying the leather completely before beating because with complete or "bone" dryness the leather is separated more nearly completely into its constituent fibrils, the pulp is made freer and the sheet made from the pulp is more uniform in structure, finer in texture and stronger. Any suitable means may be employed for drying the leather. The mere air drying of chrome-tanned leather renders it possible to separate it more or less completely into its constituent fibrils by adequately beating it.

When the proportion of water to pulp in the beater is very great the chemical changes that tend to make the ultimate sheet brittle are accelerated. When the proportion is too small the pulp circulates with great difficulty. With the Noblewood mill the best results are obtained by a mixture of leather and water in which the weight of the leather is from two to six percent of the total weight of the mixture.

As the time of beating is prolonged adverse changes in the leather occur, as heretofore described. I find it best to complete the beating action in the shortest possible time and not to exceed the time beyond which continued beating will adversely affect the pulp and final product.

An increase in the temperature of the leather pulp in the beater is accompanied by an increase in the rate of change making for brittleness of

the sheet made from the pulp. Preferably therefore, the beating is carried out at temperatures below 100°F .

After the beating operation it may be advantageous in some instances to raise the temperature of the leather pulp because such increase in temperature increases the degree of freeness of the pulp. However, if the temperature is raised too high or maintained for too long a time at an elevated temperature, there is an increase in tendency for changes to occur which make the sheet produced from the pulp more brittle. Accordingly, the temperature of the pulp should be raised only to the extent necessary to produce the desired degree of freeness of the pulp.

The control of the acidity or pH value of the leather pulp is important both in the beater and when the pulp is run onto the sheet forming machine. The acidity or pH value of the pulp markedly affects the action of the beater, the freeness of the pulp and all of the properties or qualities of the sheet formed from the leather pulp. The determination and control of pH value is standard practice in many industrial chemical operations so it is deemed unnecessary to describe these methods here. A detailed description is given in chapter 4, vol. 1 of my book "The Chemistry of Leather Manufacture". So far as the action of the beater is concerned, I have found the optimum pH value of the pulp to be 2.9 as determined by the hydrogen or glass electrodes. However, this value did not prove to be the optimum value for freeness of the pulp or for the maximum strength and other properties of the leather sheet formed therefrom. By studying the effect of pH value of the pulp over a wide range, I have found that an optimum pH value of 4.3 results in increased freeness of the pulp and in increased tensile strength of the sheet formed therefrom and in general the quality of the sheet. Preferably, therefore, the beating operation is carried out at a pH value of the pulp of about 2.9 and after the beating action the pH value of the pulp is raised to about 4.3 so that by this method the advantage of optimum pH value for both the beating and the later operations is obtained. It will be understood that by varying the pH value of the pulp between 2.9 and 4.3, variations can be produced in flexibility of the sheet produced from the pulp and in its general texture which makes it desirable to vary the pH value when special properties in the sheet are desired. At pH values much below 2.9 the leather becomes gelatinous, at pH values of the pulp from 4.3 to 7.0 the leather tends to become brittle while at pH value much above 7.0 the leather becomes gelatinous.

The leather pulps of my invention can be made into sheets and other commercially valuable leather products without binders or the addition of any other material. However, the properties of both the pulp and the products made therefrom can be varied as desired by the addition of certain other materials.

When the terms "animal hide" or "hide" are used herein and in the claims, it is understood these terms include within their scope, animal "skins", unless the latter are also specifically mentioned.

In accordance with this invention, pulps consisting of animal hide or leather reduced substantially to fibrils are provided, which pulps may readily be fabricated into leather products possessing structures, physical characteristics and

chemical compositions very much more uniform than those of the skins or hides from which the pulps and products are fabricated. An almost infinite variety of commercially valuable products may be made from the pulps of the present invention. Sheet leathers of high quality and uniformity of any desired practicable thickness may be produced on sheet forming machines now used in the paper industry. Conduits, flooring and wall board may be fabricated from these pulps and they may also be moulded into a great variety of commercially valuable articles.

Inasmuch as variations in the methods herein disclosed or in the several steps thereof or in the beating apparatus described or in the treatment of the pulps and the materials produced therefrom may be made without departing from the principles of the invention, it will be understood that no intention is entertained to limit the invention except by the scope of the appended claims.

What I claim is:

1. Pulp having a fibrous constituent of animal origin consisting essentially of separated fibrils of animal hide or skin.
2. Pulp having a fibrous constituent of animal origin consisting essentially of separated fibrils of leather.
3. Pulp having a fibrous constituent of animal origin consisting essentially of separated fibrils of chrome-tanned leather.
4. An article of manufacture having a fibrous constituent of animal origin consisting essentially of reassembled, previously separated fibrils of animal hide or skin.
5. An article of manufacture having a fibrous constituent of animal origin consisting essentially of reassembled, previously separated fibrils of leather.
6. An article of manufacture having a fibrous constituent of animal origin consisting essen-

tially of reassembled, previously separated fibrils of chrome-tanned leather.

7. The method of reducing chrome-tanned leather substantially to fibrils which comprises drying the leather to a point between bone and air dryness, making a pulp from the dried leather in water, and subjecting the pulp to a fibril separating action of a character to reduce the leather substantially to separated fibrils without producing such chemical and physical changes in the fibrils as to cause gelatinization or other harmful effects to a measurable degree.

8. The method of reducing chrome-tanned leather substantially to fibrils which comprises drying the leather to a point between bone and air dryness, making a pulp from the dried leather in water, and subjecting the pulp to a fibril separating action characterized by a number of surface contacts on the order of magnitude of one million strokes of one foot face bar over bed plate per pound of dry leather and limiting the time of such treatment so that such chemical and physical changes in the fibrils which cause gelatinization or other harmful effects to a measurable degree are not produced.

9. The method of reducing chrome-tanned leather substantially to fibrils which comprises drying the leather to a point between bone and air dryness, making a pulp from the dried leather in water, and subjecting the pulp to a fibril separating action characterized by the action obtained by the normal operation of a Noblewood mill or a Niagara laboratory beater.

10. Pulp having a fibrous constituent of animal origin consisting essentially of separated fibrils of mineral-tanned leather.

11. An article of manufacture having a fibrous constituent of animal origin consisting essentially of reassembled, previously separated fibrils of mineral-tanned leather.

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