

UNITED STATES PATENT OFFICE.

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MANUFACTURE OF LEATHER FROM ARTIFICIAL SKIN.

SPECIFICATION forming part of Letters Patent No. 262,584, dated August 15, 1882.

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To all whom it may concern:

Be it known that I, AMBROSE G. FELL, of New York city, in the county and State of New York, have invented a new and useful
5 Improvement in the Manufacture of Leather, which improvement is fully set forth in the following specification.

This invention has for its object the manufacture of a new kind of leather, which in its
10 physical or chemical characteristics shall be very similar to if not identical with that obtained from the skins of animals, and applicable to the same uses, differing therefrom only in its chemical constituents, and in that but
15 slightly. This leather is not termed "artificial," which might imply inferiority, whereas in some respects this new leather is superior to the ordinary material. The material from which my leather is prepared may be termed
20 "artificial skin;" but the leather itself is real leather, for leather, whether produced by the old method of treating hides or by the new process hereinafter described, is for all practical purposes and in chemical parlance identical, consisting of an insoluble, imputrescible,
25 tough, homogeneous sheet of gelatinous tissue or fiber.

In the processes of making ordinary leather the skin of an animal, having been deprived of
30 its extraneous matter by the usual methods, and being ready for conversion into the leather of commerce, consists of a web or tissue of fiber filled in with a substance chemically known as "osseine," and the processes of tanning, to
35 which said skin is afterward subjected, are twofold in their object, first, to convert the osseine into gelatine by a rearrangement of its chemical atoms, and, second, to combine the fiber with the gelatine thus produced, forming the insoluble
40 imputrescible material known as "leather."

In the present invention, instead of the natural homogeneous sheet of fiber and gelatine known as "skin," a sheet of fiber and gelatine
45 is prepared, as hereinafter described, which is also perfectly homogeneous. The improved process, however, affords the great advantage of a choice of fiber best adapted for the intended uses of the ultimate leather, and another advantage gained is the uniformity of
50 the product in thickness and strength. Unless in the course of preparing the substitute for

skin some agent is introduced to take the place of subsequent tanning, the process of treatment may proceed in the ordinary method of converting skin into leather—that is, the artificial skin is subjected to the action of such
55 chemicals as shall render its gelatine insoluble, imputrescible, flexible, and so on. The means employed for this purpose may be any of those ordinarily used in treating natural
60 skins for the same purpose. It is preferred, however, to use the method hereinafter specifically described.

The object of the present invention, then, is to produce a leather which, while possessing
65 all the desirable characteristics of that prepared from the skins of animals, shall, in addition thereto, be uniform in thickness and strength and capable of being made in large or continuous sheets with straight edges, which
70 will enable it to be cut to much better advantage than is possible with the irregular outline of a skin.

In carrying my invention into effect I proceed as follows: A homogeneous pulp of fiber
75 and gelatine is formed by any convenient means, employing any description of fiber, but preferably the long fiber of raw cotton. Now, if simply coating said fiber and filling up the interstices therein was all that the process
80 aimed at, this could be effected by simply dipping, washing, or other application of the gelatine to said fiber; but the object of this process is to effect the combination of the fiber and gelatine into one homogeneous mass, in
85 which the identity of the fiber or tissue is for the time being lost, in the same manner as the fiber of a natural skin is lost previous to tanning. This marks the great difference in the
90 first step of my process as distinguished from the ordinary processes, in which the fiber is merely steeped in or treated by a gelatine compound.

Fiber, whether animal or vegetable, will mix with gelatine solution; but by reason of the
95 atmospheric air, oleaginous, and other elements which occupy the interior of each individual fiber the gelatine is prevented from doing more than merely surrounding said fiber, and this only with difficulty; but by expelling the air
100 and foreign matter from the fiber an intimate and homogeneous union is effected. With this

object in view the fiber is first subjected to the action of boiling water or chemical solution, and having thus displaced the air and other elements, and while it is still wet and hot from
 5 said treatment, it is admixed with the gelatine compound, with which it will now gradually and completely combine.

The artificial skin or mixture of fiber and gelatine is preferably formed as follows: I take
 10 raw cotton or wool or any other loose fiber, and by suitable means form it into a light fluffy web. If cotton is the fiber chosen, it is formed into such a web by means of a machine similar to that usually employed to form cot-
 15 ton-batting; but for the purposes of this process the cotton or other fiber is kept as loose as possible, the width and length of said web being governed by the width and diameter of the drum employed in said machine; or the
 20 fiber may be run off in continuous lengths, as hereinafter shown, and the thickness of the web is regulated by the amount of cotton allowed to accumulate on said drum, as well understood in the art. The cotton deposited on
 25 the drum of the batting-machine is very loose and tender, and cannot be rolled upon itself; nor can it be unrolled without losing its uniformity of thickness. The web from the batting-machine is therefore rolled on some other
 30 material, that known as "burlaps" answering the purpose very well. To accomplish this I provide a roller in front of the batting-machine, and to this roller is conducted one end of the burlaps, and on this the cotton-fiber web from
 35 the machine is laid by revolving the roller, the cotton web and burlaps being wound together thereon, so that a thickness of burlaps will be between each layer of fiber. Care should be taken not to wind the web of fiber too tightly,
 40 as by so doing it would retard the subsequent process. The burlaps should be a little wider than the sheet of fiber and the roller a little longer than the width of the burlaps.

A sufficient length of fiber being wound, the
 45 roll is secured from unwinding by tying with cords—say at twelve inches apart—or in any convenient way, care being taken not to compress the roll too tightly. The roll is then placed in a bath of boiling water, the object of which
 50 is to thoroughly saturate the fiber therewith and displace all the atmospheric air and foreign matter contained in said fiber, for if such result is not accomplished either by these or other means it will be found very difficult, if
 55 not impossible, to effect a complete combination of the fiber with the gelatine, which is subsequently applied. The boiling should continue for one or more hours, according to the thickness of the fiber-web and the size of the
 60 roll. After the boiling has continued a sufficient time the roll is removed from the bath and allowed to drain until most of the water that will run off has done so. The roll is next placed in a bath composed of water, gelatine,
 65 and bichromate of potash. The proportions are not material, and may be varied within

wide limits; but for general practical results I employ the following: water, six gallons; gelatine, eight pounds; and bichromate of potash, three per cent. of the gelatine. The bi-
 70 chromate of potash may be left out at this stage and subsequently applied, and in like manner other agents employed in subsequent steps of the process may be here introduced with advantage under some circumstances. 75
 The object of the chromic salt is to render the gelatine more or less insoluble when exposed to light, or by subjecting it to a high temperature or by lapse of time.

It is obvious that instead of having a sepa- 80
 rate vessel for the second bath the fluid composing the first bath could be drained off and the same vessel used for the second bath; but it is preferred to proceed in the manner described. As to the character of gelatine em- 85
 ployed, although that known in commerce as "glue" answers the purpose well, still, as the strength and durability of gelatine is greatly affected by high temperature and by frequent dissolving, it is preferred to obtain the gela- 90
 tine direct from any of its sources of production, and while still in solution to apply it directly to the purposes of the present processes, thus obtaining a stronger and more durable result. The roll is allowed to remain in this 95
 second bath, which is heated to a temperature of about 120° Fahrenheit for two or more hours, or until the water with which the fiber has been previously saturated is completely replaced by the gelatine compound. The roll 100
 is then removed and allowed to drain until most of the surplus liquor runs off. The fiber, saturated and combined with the gelatine, is next placed upon a sheet of glass or other material, upon which it is unrolled, so as to bring 105
 the gelatinized fiber next to the surface of the sheet or slab. Sufficient pressure is now brought to bear upon the burlaps to force the gelatinous mass into as close contact as possible with the glass or other surface. The fiber 110
 and gelatine are now in the condition of a sheet of pulpy jelly, and if the fiber has become thoroughly combined with the gelatine it at this stage is almost indistinguishable therefrom, having been rendered more or less 115
 transparent by its union with said gelatine.

If a solid and compact leather is desired, more of the gelatine compound is poured over the burlaps and spread evenly thereon, and it will run through said burlaps and mingle 120
 with the gelatinous mass spread beneath it, increasing the proportion of gelatine therein. The burlaps can now be removed. The gelatinous fiber, however, is allowed to remain on the glass or other surface until dry, which will 125
 require twelve hours or more, according to the thickness of the material, temperature, and ventilation. The semi-liquid and pulpy condition of the gelatinized fiber as it is placed on the glass slab is such that it cannot be well 130
 brushed or rolled without disturbing the uniformity of its arrangement, and hence the ne-

cessity of the sheet of burlaps or other material as an intermediate means to allow of distributing the gelatine compound poured on as described. A further degree of solidity can be added to the material by again treating it with the gelatine compound after drying and still further increased pressure.

As a material on which to spread the gelatinous fiber, I prefer glass or other translucent material, so that light can penetrate as well to the lower as to the upper surface of said gelatinous fiber, which, by reason of the presence of the chromic salt contained in the gelatine, renders it insoluble. The exposure to light should be continued after the material has become dry, for it is while dry that the insoluble effect is most readily and effectually produced. The color of the light is also important, as, should the color be blue, for instance, the action will be slow; if yellow, the action will be almost entirely arrested. A material void of color is therefore most desirable, white glass being best.

When glass is used as the surface on which the gelatinized fiber is spread the latter, after it is removed from such surface, presents two surfaces distinctive in their character, that which was next the glass being smooth, compact, and not inclined to shrink when dampened and redried, and the upper surface being even but not smooth, and liable to shrink when dampened and redried. In this respect the material corresponds with the skin of an animal, the smooth side representing the outer or grain side, and the other corresponding with the flesh side of a natural skin. When a non-transparent slab is used upon which to spread the gelatinous fiber the latter should be exposed to the light after drying and removal from the slab.

In drying the mass of gelatinous fiber will be found to have become more transparent and greatly lessened in thickness, the whole of its contraction being in that direction, thereby securing a greater amount of strength in proportion to its thickness. It moreover adheres very tenaciously to the surface on which it is dried. To remove it, however, it is only necessary to moisten the material by washing, immersion, sprinkling, or in any convenient way until softened through its entire thickness, when its removal is readily effected. Water will answer for the purpose; or, if a greater degree of insolubility is required, a solution of alum or other material capable of producing the desired effect may be used. If, however, the chromic salt or its equivalent was not admixed with the gelatine compound comprising the second bath, then this stage of the process affords a convenient opportunity for its introduction. A solution of said salt containing, say, three per cent. of bichromate is used for softening the artificial skin as it lies upon the slab upon which it was dried. When sufficiently moistened it is easily removed by rolling up or in any other convenient way. When the chrome salt is thus

applied the artificial skin should then be exposed to light for a few hours; but if water is used as the medium of removal the skin may be immediately placed in the third bath of tanning preparation referred to below, though a greater degree of compactness is assured by drying it before subjecting to the final bath; or, if the gelatine contains or has been treated with the chrome salt or its equivalent, and thus rendered insoluble and imputrescible, the leather at this juncture may be completed by simply rendering it opaque and flexible by soaking in a solution of lead acetate, and next in a solution of any carbonate—say carbonate of soda—or one of many other methods may be employed. For suppleness glycerine may be added in the last-mentioned step or at some other stage.

Instead of boiling the roll of fiber in water as the initial step in the process, a solution may be employed of alum or salt of iron or any agent capable of rendering the gelatine subsequently employed more insoluble or to facilitate the displacement of the air; or the first bath may be dispensed with altogether, and the fiber instead may be placed in an air-tight vessel and the air exhausted therefrom, and the second bath may be applied to the fiber while in the vacuum; or any other means for removing the air and other contents of the fiber may be employed.

The artificial skin prepared by the process above described is a transparent sheet of gelatinized fiber in a homogeneous mass, the fiber therein being indistinguishable from the gelatine, and this artificial skin bears so close a resemblance to a natural skin, both in appearance and nature, that it may be finished by any of the methods employed for treating skins of animals to produce leather, or with very slight modifications of said treatment. Moreover, in finishing the leather by the ordinary method it will be found that it is not affected, as is the case with the natural skin, by elevation of temperature. Hence the tanning solutions wherewith it is treated may be employed at a high heat, and thus effect in a few hours what would otherwise require several days. If, however, a porous and spongy leather is required, it is preferred to allow more time at a lower temperature.

The tanning preparation for the final treatment is preferably composed of water containing equivalent to, say, five per cent. of tannic acid and twenty-five per cent. of glycerine or other agent capable of imparting flexibility. The tannic acid may be added as such; or bark, sumac, nut-galls, or any other compound or material containing tannic acid or its equivalent may be used instead; but the invention is not limited to the use of tannic acid, since any other agent, material, or compound now known and used for producing the result understood under the general terms of "tanning" and "tawing" may be used instead.

Owing to the aforementioned peculiarity of the contractibility of one side of the artificial

skin and the incontractibility of the side next to the surface on which it was dried, this leather may be grained in like manner to a natural skin, so that when the material is
 5 rolled and rubbed, as understood in the method of graining, the one side contracts and the other side wrinkles to accommodate said contraction, the form of said wrinkles being governed by the direction in which the skin is
 10 rolled and manipulated, according to the skill of the operator. The peculiarity of these wrinkles constitutes the different styles of graining, as well understood in the art.

Many modifications of the process may be
 15 made with desirable results, according to the purposes for which the finished leather is intended. For instance, when the gelatinous fiber is placed on the surface on which it is intended to be dried no additional gelatine solution need be added, in which event the artificial skin, when dry, will be less solid and more spongy and soft.

If a finished leather is desired of such thinness as is impracticable to produce from so
 25 frail and tender a web as that formed with the fiber employed, the following process can be used: Proceed in the manner indicated with the production of the sheet of gelatinous fiber, and place it on the slab of glass or other material, and upon this bring any convenient
 30 pressure, as by a roller, which tends to concentrate the amount of fiber in the body of the artificial skin and forces a larger proportion of gelatine to the two surfaces. Now, when
 35 the skin is removed, as set forth, and while still wet, it will with care evenly split, the concentration of the gelatine on the surfaces strengthening them, and causing the material to split in the middle, where weakest. Having
 40 thus secured as thin a skin as desired, it can be tanned, tawed, or finished by any method in this condition or after application of additional gelatine to its split side, according to the kind of leather required.

Any thickness of leather may be secured by
 45 regulating the thickness of the fiber first employed or by uniting two or more layers of the material at any stage of the process most convenient. The character of the leather may
 50 also be varied by removing from the surface on which it is spread while still wet or by drying direct from the roll. In both cases it will not have a smooth or grain side, but two porous or flesh sides. These may be made smoother
 55 by coating with the gelatine compound; but, as will be readily understood, the coating thus applied does not form a homogeneous mixture with the body of the leather. If the gelatine compound thus applied to the surface is
 60 colored and the material, while still damp, brought in contact with a glossy surface and allowed to dry thereon, the surface of the finished leather will resemble the ordinary patent or enameled leather.

One feature which the leather made according to the above process possesses in common

with leather made from animal-skins is its elasticity when stretched in any direction, especially when damp. This property is due to the homogeneous combination of unbroken
 70 separate fibers with the gelatine, which property could not be had with a broken fiber, as in paper or the pulp whereof it is made, which latter is not adapted to this process, or with a woven or spun fabric, where the warp or
 75 woof would be opposed to such elasticity.

It will be understood that by forming a homogeneous mixture of fiber and gelatine it is not meant that the former is dissolved, so that its identity as fiber is destroyed, since if this
 80 were the case the resulting product would not be true leather, in which the fiber, fibrine, or tissue, although being one substance intimately but mechanically mixed with the gelatine, possesses its individual existence and imparts
 85 its structural characteristics as fiber to the finished article.

In conclusion I would observe that I am aware of Letters Patent of the United States No. 38,785, No. 94,080, No. 153,473, No. 210,079, and No.
 90 247,635, which show the use of gelatine with a tanning agent, either without the use of any fiber whatever or with the use of paper or a textile fabric to the surface of which the composition containing gelatine is applied. I am
 95 also aware of Letters Patent No. 129,217, in which tanno-gelatine is used as a solvent of cellulose, so as to form an elastic gummy mass, which becomes hard, like horn, when thoroughly
 100 dried, the cellulose being used in the form of ordinary paper pulp or raw cotton or otherwise; or starch is used in place of cellulose, it being in its chemical composition isomeric with cellulose, thus producing an insoluble
 105 hard compound. None of these patents show my invention, and I disclaim what is shown in each of them. None of them show a homogeneous compound of unbroken separate fibers with gelatine, said fibers being neither
 110 woven nor spun, as is the case with textile fabrics, nor forming a compact mass of minute broken fibers, as where paper is used. The leather made by my invention is like the leather made from natural skins, in that it contains
 115 numerous ramifying fibers intersecting one another in every position, and not attached together in the form of either thread or warp and woof, which would effectually prevent the product having the elasticity in every direction, the capacity of being split, and of having
 120 its end "skived"—that is to say, fastened—so as to be of even thickness, by shaving the overlapping edges to a bevel and fastening them in the manner familiar in belting, &c., which are among the properties which render
 125 natural leather so valuable a substance. In my leather, as in the natural leather, the fiber is not dissolved in the gelatine or chemically combined therewith; but the fiber and the gelatine form a homogeneous mass, precisely as
 130 in the natural leather, thus clearly distinguishing it from all so-called "artificial leather" of

which spun fibers or woven fabrics form a portion.

Having now fully described the nature of my said invention and explained the manner in which the same may be carried into effect, what I claim is—

1. In the manufacture of leather, the method of forming a homogeneous mixture of fiber and gelatine by displacing the air and other foreign substances from said fiber and applying thereto the gelatine or a compound thereof, substantially as described.

2. In the manufacture of leather, the method of producing an artificial skin or web by boiling cotton or other fiber in water or a suitable solution, as indicated, and applying to said fiber gelatine or a compound thereof, substantially as described.

3. In the manufacture of leather, the method of forming an artificial skin or web by boiling cotton or other fiber in water, applying gelatine thereto, treating said fiber with bichromate of potash or its equivalent, and exposing to light, substantially as described.

4. The method of forming a homogeneous and insoluble compound of fiber and gelatine, consisting in displacing the air and other foreign substances from said fiber, applying gelatine thereto, treating with bichromate of potash or its equivalent, and exposing to light, substantially as described.

5. The method of producing an artificial skin or web by boiling cotton or other fiber in water or a solution, then treating said fiber in a bath composed of water, gelatine, and bichromate of potash, in approximately the proportions specified, drying the gelatinized fiber thus formed on a smooth slab or surface, and exposing to the action of light, substantially as described.

6. The method of producing an artificial skin or web by forming a homogeneous compound of fiber and gelatine in substantially the manner specified, and spreading said compound to dry upon a sheet of glass or other translucent substance, substantially as described.

7. In the manufacture of leather, the method of producing an artificial skin or web by treating fiber while in a roll between burlaps or other material in a bath of boiling water or solution, and in a second bath of gelatine compound, then unrolling the gelatinized fiber thus formed upon a sheet of glass or other material, and allowing it to wholly or partly dry thereon, substantially as described.

8. The improvement in the art of manufacturing leather, consisting in treating fiber in a roll between other material with a gelatine compound, spreading the gelatinized compound upon a suitable surface, as explained, and applying additional gelatine thereto, substantially as described.

9. The improvement in the art of manufacturing leather, consisting in forming a homogeneous mixture of fiber and gelatine, spreading the same upon a suitable surface and sub-

jecting it to pressure thereon, so that the artificial skin or web, when moistened and removed, can be readily and evenly split, substantially as described.

10. The improvement in the art of manufacturing leather, consisting in forming a web or sheet of fiber and gelatine, as explained, treating said web or sheet with a chromic salt, spreading said web or sheet upon a suitable surface—such as glass—allowing it to wholly or partly dry thereon, and removing by the application of moisture, substantially as described.

11. The method of producing a colored or enameled surface upon a sheet or web of gelatinized fiber, such as described, by applying a layer of colored gelatine thereto and drying in close contact with a smooth surface, substantially as set forth.

12. In the production of an artificial skin for the manufacture of leather, the method of treating fiber to exclude the air and other foreign substances therefrom by immersing in a bath of boiling water or suitable solution, as described.

13. Leather composed of a homogeneous mixture of fiber and gelatine, substantially as described.

14. As a new article of manufacture, leather composed of a homogeneous mixture of fiber and gelatine, rendered insoluble by treatment with a chromic salt and exposure to light, substantially as described.

15. Leather composed of fiber and gelatine, and having an enameled surface, substantially as described.

16. Leather composed of a homogeneous mixture of fiber and gelatine, and having two distinct surfaces corresponding respectively to the flesh and grained sides of leather made from natural skins, substantially as described.

17. The process, substantially as described, of making leather by homogeneously combining gelatine and fiber to form an artificial skin, and then tanning the same.

18. Leather composed of gelatine and fiber homogeneously combined so as to form an artificial skin, and subjected to the process of tanning, substantially as described.

19. The process, substantially as described, of making leather by homogeneously combining gelatine and fiber to form an artificial skin, and then tawing the same.

20. Leather composed of gelatine and fiber homogeneously combined so as to form an artificial skin, and subjected to the process of tawing, substantially as described.

21. The process of forming an artificial skin by homogeneously combining fiber and gelatine, substantially as described.

22. Artificial skin formed by homogeneously combining gelatine and fiber, substantially as described.

23. The process of making leather, substantially as described, by combining gelatine and fiber to form an artificial skin, the same being

acted upon by chromic acid or its compounds, substantially as described.

24. Leather composed of gelatine and fiber homogeneously combined so as to form an artificial skin, and acted upon by chromic acid
5 or its compounds, substantially as described.

25. The process of making leather, substantially as described, by homogeneously combining gelatine and fiber to form an artificial skin,
10 the same being acted upon by chromic acid or its compounds, and then tanned or tawed, as set forth.

26. Leather composed of gelatine and fiber homogeneously combined so as to form an artificial skin, and acted upon by chromic acid
15

or its compounds, and then tanned, substantially as described.

27. Leather composed of gelatine and fiber homogeneously combined so as to form an artificial skin, and acted upon by chromic acid
20 or its compounds, and then tawed, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

A. G. FELL.

Witnesses:

WILLIAM P. LEGGATT,
JOHN MCCLURE.