UNITED STATES PATENT OFFICE.

HENRY L. BREVOORT, OF BROOKLYN, NEW YORK; GERTRUDE L. BREVOORT, EXECUTRIX OF SAID HENRY L. BREVOORT, DECEASED, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO THE ELECTRO WATERPROOFING AND DYE FIXING COMPANY, OF NEW YORK, N. Y.

PROCESS OF ELECTRICALLY TREATING FABRICS FOR WATERPROOFING OR OTHER PURPOSES.

SPECIFICATION forming part of Letters Patent No. 558,717, dated April 21, 1896.

Application filed July 1, 1890. Serial No. 357,567. (No specimens.)

To all whom it may concern:

Be it known that I, HENRY L. BREVOORT, a citizen of the United States, residing in the city of Brooklyn, county of Kings, State of New York, have made a new and useful Improvement in Processes of Electrically Treating Fabrics for Waterproofing or other Purposes, of which the following is a full and accurate description.

My invention consists in a novel treatment of fabrics, threads, cords, or ropes of cotton, wool, silk, or other animal and vegetable substances, in the shape of fabrics or otherwise, by an electric current passing from a metallic conductor placed against one side of the goods when wet, through the said goods, and to a conductor of metal or carbon placed against the other side of the same, whereby they are rendered water-repellent and other useful properties are conferred upon said fabrics.

I will refer to the sides of the goods being treated as positive and negative. By the positive side of the goods I mean that side which is to be against the plate or roller connected with the carbon of the battery (the negative element) or the like pole of a dynamo. By the negative side of the goods I mean that side of the goods which is against the conductor connected to the zinc (the positive element) of a battery, or the equivalent pole of a dynamo.

In the practice of my process I proceed as follows: I take the goods which I desire to treat—say, cotton sheeting, for example—and I wet the same with water which is preferably neither alkaline nor acid. I then place the wetted fabric between two conductors. The one on the negative side may be of metal or carbon or any material which is a conductor of electricity. The one on the positive side must be a metal capable of being oxidized, preferably aluminium or tin. The conductors, if they are in the shape of plates, should be accurately made, so that their opposing surfaces will press upon the goods at all points. Their shape is immaterial so long as this condition is present. If the conductors are rollers, they should be accurately turned, so as to bear upon the goods at all points along their length. I now pass a current of electricity from the positive side through the goods to the negative side. This current of electricity will, if of the proper strength and if applied for the proper time and when the conductors are pressing on the goods, confer upon said goods certain desirable properties or characteristics, among which may be particularly mentioned that it will produce a peculiar waterproofed or water-repellent effect thereon, which will be observed when the goods after being dried are again immersed in water. After the electrical treatment the goods are to be removed from between the conductors, which are not to be at any time during the operation in contact or short-circuited, and the said goods are then to be dried in the air of preferably a heated room or in an oven.

It will be found that the goods are waterproofed, or the fibers thereof are made water-repellent, at those points where the conductors were pressed upon them and where the current passed. This waterproofing is produced, I believe, by the formation on the positive conductor of a metallic oxid of some kind produced by the liberation of nascent oxygen on the said positive conductor due to the electrolytic action of the current on the water with which the goods are saturated, and which oxid enters into the goods or the fibers of the goods aided by the current, and probably is combined partly chemically and partly mechanically with the fibers, thereby making the same waterproof or water-repellent by the presence of the oxid in or on the fiber or in or on the goods. The strength of the current applied will depend upon the character of the goods submitted to treatment. I have produced satisfactory results with cotton cloth using one volt, and also with one hundred volts, the period of treatment being shortened by the increased voltage of the current. I have likewise used voltages between these two extreme limits, and have had most satisfactory results with small conductors, say plates two inches in diameter using a current of thirty volts.

Each specific piece of goods offers a differ-

ent resistance to the passage of the current when in a wet condition, and different goods require different strengths of current. The theory, as I understand it, of the process is that the water absorbed by the fibers or the goods is electrolyzed by the action of the current, nascent oxygen is produced on the metal plate or roller on the positive side of the goods and which is connected with the negative pole of the battery or dynamo, (or that which furnishes the positive current,) and nascent hydrogen is liberated on the negative plate or roller, (which is connected to the positive element.) The nascent oxygen acts on the metal plate or roller on the positive side of the goods, forming some oxid of this metal. This oxid is carried into or onto the fibers in the direction of the flow of the current, combining, probably, with the goods or the fibers of the goods, and forming with or on the fibers a product which renders the various fibers composing the goods, and thus the goods themselves, waterproof or water-repellent. I do not know for certain whether the oxid is mechanically or chemically combined with the fibers, but believe that both effects are obtained. The nascent hydrogen on the negative side will, if the time of treatment is too long, accumulate and then begin to act as a reducing agent, and in case the period of treatment is prolonged beyond the proper time then the nascent hydrogen will reduce the oxid of the metal in or on the goods to the metallic state and the combination or union of the oxid with the fibers will be destroyed by the reduction of the oxid to a metallic state.

When the goods are dried after a treatment prolonged beyond the normal and immersed in water, they absorb the same, in some instances, as readily as if not treated at all. The treatment must be stopped by breaking the current at the proper moment within certain limits, for a further continuance of the current will defeat the desired object, and the goods will cease to be water-repellent when dried, as the hydrogen will have reduced the oxid of the metal used. A treatment of the goods for a period of time which is in excess of that which is required to waterproof them will leave upon the goods the reduced oxid in metallic form, and when this takes place the goods are not waterproofed. The treatment when properly done, and if aluminium or tin are used on the positive side, leaves scarcely any perceptible mark upon the goods, sometimes the oxid being slightly visible when the goods are held up to the light.

It is very advantageous to place a sheet of fabric, such as cotton cloth, around the roller or on the plate on the negative side. By the use of this fabric the evolved hydrogen is mechanically kept from rapidly affecting the oxid in the cloth to be waterproofed, which latter is placed between this sheet of fabric and the plate or roller on the positive side of the goods; and in this way the period of treatment may be prolonged and the operation rendered less delicate, and such exactness is not then required as to time, and the general result is improved. This sheet of fabric may be continuously used until it is worn out and if at any time it is dried is found not to be waterproofed. The fabric treated should have only a sufficient amount of oxid in it to make it waterproof.

The proper strength of current varies with each specific material, its thickness, the time the treatment is to occupy, and the amount of pressure exerted on the goods by the conductors.

A practical test must be made with each new sample of goods and the current which it is proposed to use to determine the time of treatment with the current and pressure to be employed, the operator observing how long a time is required to produce the best effect, and when he perceives an accumulation of material on the surface of the goods, either as an oxid or as a metal, he will know that the treatment has been too long, and will reduce the time or current until the desired result is obtained and only so much oxid has been formed and carried into the goods as will waterproof the same. If an ammeter be placed in circuit, the operator will notice that when the current is first made and passed through the goods, his needle shows a sudden rise indicating a passage of the current through the goods. It will then fall, (due, I presume, to the formation of oxid and gases,) and then if the current is still kept on it will again, in cases where tin and aluminium are used, begin to rise again. This, I suppose, is due to the fact that the oxid is being reduced to the metallic state by the evolved hydrogen, and the current, I have usually found, should be broken when the needle shows a tendency to rise or first begins to ascend after the previous fall. With tin and aluminium plates I have found this to be a good test of the time of treatment under the conditions present when the test is made. The operator may also in order to determine the time necessary with any specific current, or the current with any specific time, make a practical test; and he will find that satisfactory waterproof results will be obtained when such a time of treatment is had as the specific material requires; and, as the current and time will vary with the goods used and with the pressure of the conductors on the goods, it is impossible to lay down any general rule. The operator can readily determine when the hydrogen is exerting its evil effects by noticing at the end of the treatment whether there is a metallic deposit on any part of the goods. He will then know, if he finds such reduced oxid, that the goods have been treated for too long a period of time, and this may also be true when the oxid shows itself in excess. A test, however, for each particular sample of goods with the proposed current and pressure should invariably

be made, as the variations under different conditions are so great that no rule can be given which would be correct for all strength of current, resistance, and pressure.

I have had very satisfactory results with plates between two and three inches in diameter, using thirty volts, a pressure of about fifty pounds, and the time varying from one second to thirty seconds (preferably about fifteen seconds) with various thicknesses of cotton cloth, such as is suitable for undergarments, for example, and various metals—as, for instance, aluminium. This latter metal has given good results under the above conditions in one second on thin cotton goods. The goods can best be treated when the conductors press with considerable force on the goods, though fair results can be obtained by mere contact if the current is sufficient and plenty of time is allowed.

The plate on the positive side should be frequently wiped in order to remove any excess of oxid that may accumulate thereon. If the oxid is allowed to accumulate beyond a certain point, the period of treatment may be reduced; but beyond a certain point the oxid offers such a resistance to the passage of the current that in time no waterproofing can be done by reason of the fact that no current of practical strength can be obtained through the goods.

When plates of antimony are used, the current after the first moment of closing the circuit goes down to practically nothing when wet cloth is between them. A product, I suppose some oxid of antimony, offering so high a resistance is formed which prevents the current from passing. Metals like antimony which form in the presence of nascent oxygen an oxid or substance which so quickly prevents the passage of any practical amount of current cannot be used. Bismuth also is not serviceable. The current used should be a continuous current always passing in one direction, and I have found it advantageous to rapidly make and break the current without reversing its polarity.

If a strip of material is to be treated and plates are used, they can be successively applied. If desired, the goods can be passed between one or more sets of rolls, each set consisting of two rollers. Wiping devices may be permanently attached to such rolls to wipe off the excess of oxid formed on the roller which bears against the positive side of the goods. Each set of rolls may consist of two rollers, the roller of each set which is connected with the positive current being of metal, while the one on the negative side may be composed of the same or any other metal or any convenient conductor, say carbon, the function of the rollers on the negative side being merely to carry the current and support the goods, and they do not contribute in any other way to the waterproofing of the goods, while the rollers on the positive side form in connection with nascent oxygen the oxid and are essential to the process of waterproofing, for from their surfaces is formed the material which renders the goods waterproof.

The metal which I prefer to use upon the positive side depends upon the nature of the effect which it is desired to produce or the property which is to be conferred upon the fabric. If it is desired solely to waterproof the fabric, without staining or coloring the same, I prefer for the positive electrode aluminium or tin; but many other metals may be used.

The different metals require a different treatment as to time with the same current and pressure.

While aluminium, tin, or those metals in general which do not stain white cloth noticeably are to be used when the waterproofing effect only is used, for staining or dyeing the fabric metals such as copper, iron, silver, &c., are to be preferred. Such metals as copper or iron may however be used even when the sole purpose is to waterproof the cloth, provided it is a colored cloth and the alteration in color, due to the treatment by these metals, is not considered objectionable. Lead is not as serviceable for waterproofing as aluminium or tin, although it allows of the passage of a great quantity of current. Zinc gives fairly good results.

The degree of pressure to which the goods should be subjected may vary within very large limits; but it is always advantageous to have firm contact, such as would be obtained from a screw-press or a lever. With rollers the pressure should be regulated by bringing them forcibly together by springs and a screw or screws, so that the goods shall be in forcible contact with the conductors at all points where the current is passing.

As to the amount of moisture to be employed, the goods should be thoroughly wet, though the desired result can be obtained with the goods in a damp condition.

This process has the great merit of making the individual fibers and threads water-repellent, while the pores of the goods are in no way stopped up or closed. Consequently, if used on clothing, it would not prevent evaporation taking place through the interstices between the threads.

I find it best to wet the goods only with water. I have tried various acids and metallic chlorids in the water in which the goods are wet, but find no advantageous results due to their use. In goods heavily dressed with soluble material the process is not as satisfactory, for the waterproofing substance placed on such goods can be partly removed afterward if the soluble dressing is soaked out, though they are water-repellent so long as the goods are subjected only to such an amount of moisture as will not remove the soluble dressing. In goods having a dressing or finish containing grease the waterproofing process is difficult simply because it is difficult to

wet the goods. Once thoroughly wet they can be satisfactorily waterproofed.

The water with which the goods should be wet is such as is commonly supplied in cities, being derived from rivers, reservoirs, wells, or the like, which water acts as an electrolyte, distilled water being unsuitable for the process by reason of its high resistance to the passage of the electric current and to its decomposition thereby.

Besides practicing the process on cotton, linen, woolen, and silk fibers, I propose also to apply it to string, sails of ships, sewing-thread, and the like, treating such materials as they pass over a conducting-roller and between such conducting-roller and one or more aluminium or tin rollers, preferably, on the positive side.

Goods thoroughly waterproofed by this process will withstand considerable washing, particularly if the water is not too hot.

The plate on the positive side of the fabric is the anode, and the plate on the negative side is the cathode, and they can truly be so called in this situation as they are here used as terminals of a source of electric energy at which electrolysis is taking place. I have not so designated them throughout the specification as the terms used fully describe the devices.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with water, placing it between an anode of an oxidizable metal and a suitable cathode, and substantially in contact with the anode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

2. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with water, placing it between and in contact with an anode of an oxidizable metal and a suitable cathode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

3. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with water, pressing it between an anode of an oxidizable metal and a suitable cathode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

4. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with an electrolyte, placing it between an anode of an oxidizable metal and a suitable cathode, and substantially in contact with the anode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

5. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with an electrolyte, placing it between and in contact with an anode of an oxidizable metal and a suitable cathode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

6. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with an electrolyte, pressing it between an anode of an oxidizable metal and a suitable cathode, passing a current of electricity through the moistened fabric, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

7. The process of treating a fabric electrically, as for waterproofing, which consists in moistening the fabric with water, placing it between and in contact with an anode of an oxidizable metal and a cathode of conducting material covered with an absorbent fabric, as cotton cloth, passing a current of electricity through the fabric to be treated, oxidizing the anode, and depositing the oxid on or in the fabric, substantially as described.

Signed in the city, county, and State of New York this 30th day of June, 1890.

HENRY L. BREVOORT.

Witnesses:
GEORGE W. BORCHERS,
HERBERT F. DURBUR.