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Patented Feb. 18, 1902.

G. M. WILLIS.
STORAGE BATTERY SEPARATOR.

(Application filed Aug. 10, 1901.)

(No Model.)

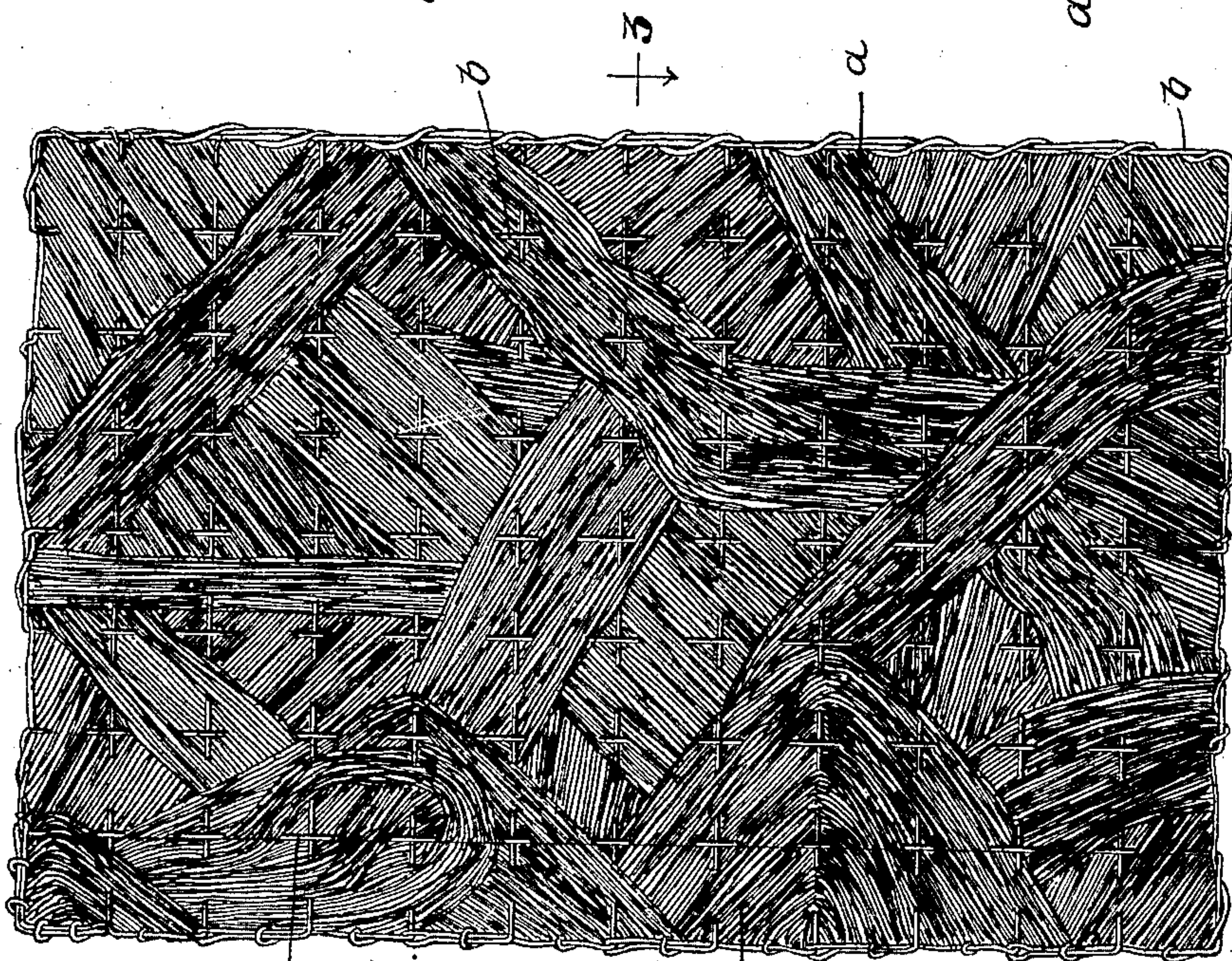
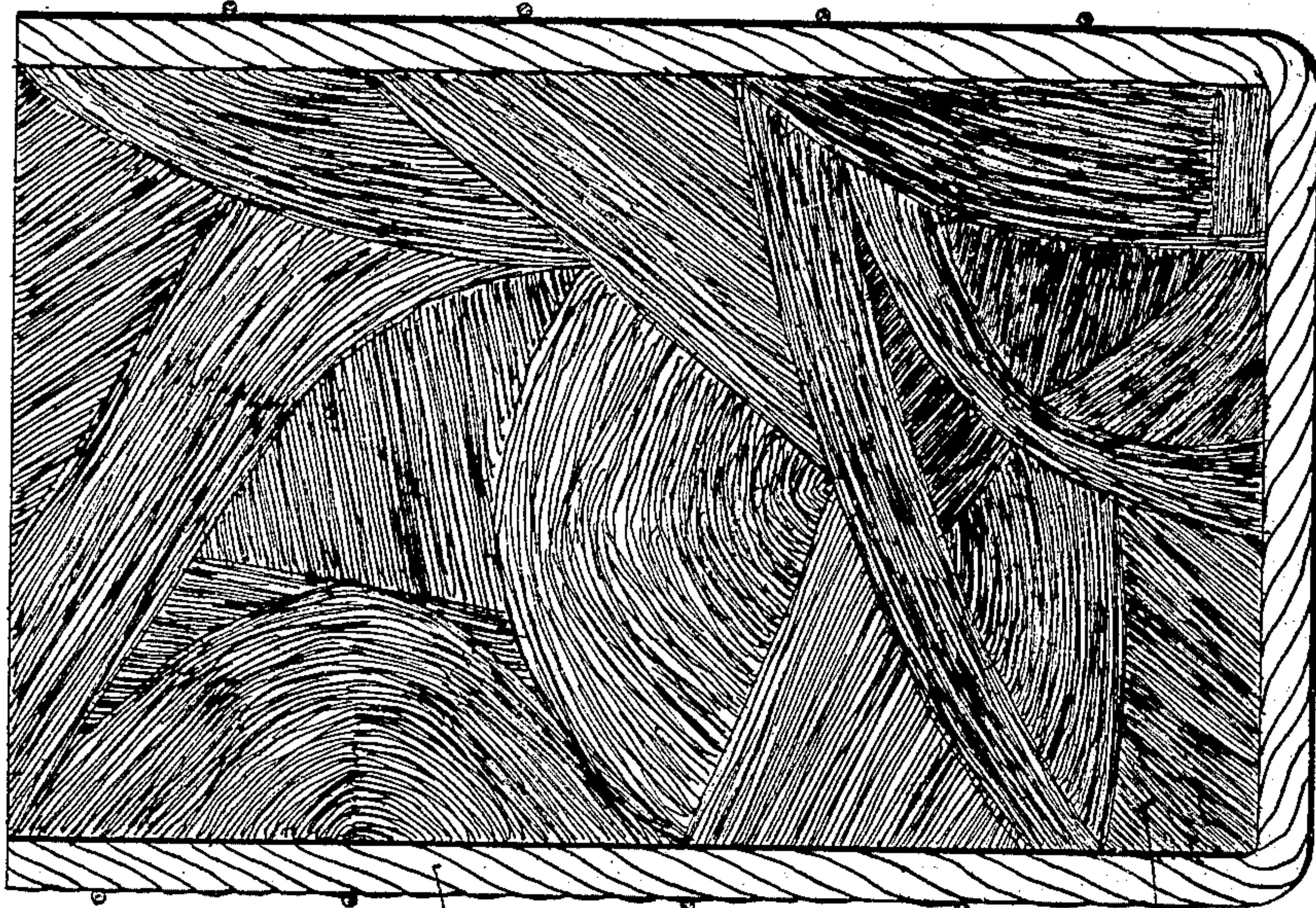


Fig. 1.

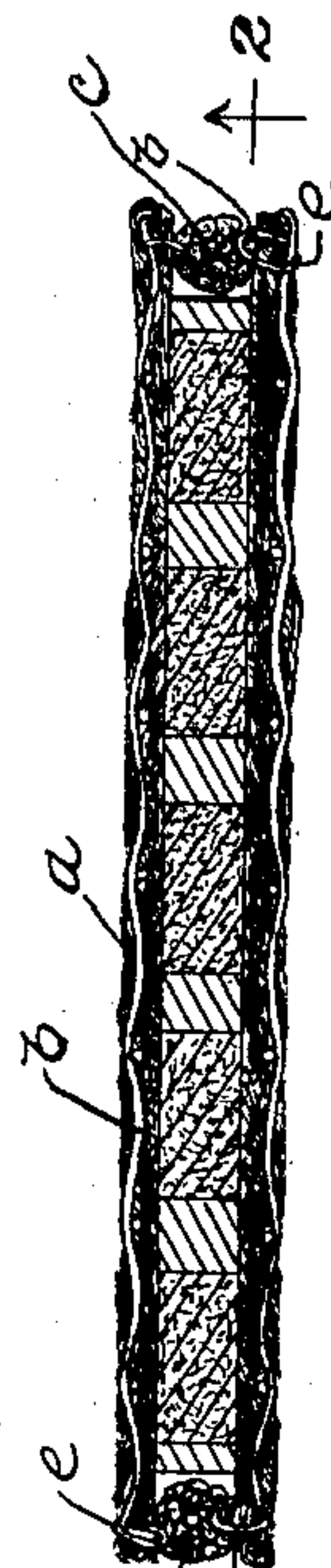


Fig. 2.

Witnesses:
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Fig. 1.

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UNITED STATES PATENT OFFICE.

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STORAGE-BATTERY SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 693,676, dated February 18, 1902.

Application filed August 10, 1901. Serial No. 71,557. (No model.)

To all whom it may concern:

Be it known that I, GEORGE M. WILLIS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Storage-Battery Separators, (Case No. 1,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to storage batteries, and has for its object the provision of an improved form of "separator" for maintaining the active material in the interstices provided in the plates or to maintain the active material that may be otherwise placed. A separator that would perform this function and at the same time maintain the resistance of the battery very low without short-circuiting its elements has been long sought for. The material that is best adapted for the purpose is glass-wool; but the coefficient of friction between the fibers of this wool is so small that no definite relative disposition of the fibers can be made and retained unless the wool has been tightly packed between the assembled battery-plates in accordance with previous practice. This is undesirable in commercial practice for many reasons—for example, the fibers will break. Moreover, the battery-plates cannot readily be removed and replaced after the wool has been once packed in position. Rubber bands have been proposed for fastening the wool in position, which had to be used, however, in combination with perforated sheets of suitable insulating material, as cardboard, the mass of glass-wool being interposed between the cardboard and the battery-plate, the rubber bands surrounding the elements thus assembled. The cardboard is essential, because the glass-wool has so much resiliency as to spring too far away from the battery-plate to permit the plate to be inserted in the place that is to receive the same, the cardboard serving to press the glass-wool to the proper thinness. The cardboard is readily decomposed and introduces considerable resistance and impedes the circulation of the battery fluid. It has also been proposed to employ threads of metal constituting the warp of a fabric, in which fabric the glass consti-

tutes the woof. This fabric is objectionable because of the great expense involved in its manufacture, because of the deterioration to which the lead, which is necessarily fine, is subject, and because of the liability of the threads of lead to short-circuit positive and negative plates. Lead, however, was the only substance that would satisfactorily bind and maintain glass fibers together prior to my present invention.

I am enabled by means of my invention to maintain the advantage arising from the use of glass-wool. The glass fibers of the wool may be of any length suited to the purpose, these fibers being bound together by the strings or fibers of the selected material, preferably non-metallic, or by other means or agency, to form the glass-wool into an unwoven fabric of fibers matted together, which preferably is without stiff backing. Where strings or threads are employed for forming the woolly mass into an unwoven fabric of fibers matted together, they are preferably disposed as in quilting, being preferably arranged at right angles. The advantage of any binder that serves to maintain the glass fiber in its matted state is that it enables the glass-wool to act as a very good filter, preventing the particles that may be detached from the plates from passing through the separators and collecting. I prefer, however, to employ as a binder some material that does not act as a conductor of current, the fabric thereby serving the additional function of a mechanical separator where necessary, or in any event preventing short-circuiting connection between adjacent plates. This binder of non-conducting material is preferably made of asbestos, which for the purpose is formed into a thread that is sewed through the glass-wool. I believe that I am the first to successfully provide a thread of insulating material adapted to unite glass fibers to maintain the same in any desired shape. The glass is preferably a non-soluble silicate of potash, though I do not wish to be limited to the nature of the glass or glassy material entering into any embodiment of the invention. Asbestos is preferred as a binder, as it is plentiful and very flexible, the fibers being very fine. The threads of asbestos or equiva-

lent material are passed among the glass fibers, preferably in a manner to greatly limit the amount of the thread brought into direct contact with the battery-plates, the glass-wool being preferably so bound by the asbestos threads as to place considerable of the glass-wool between the threads and the plates. This separation is particularly desirable where asbestos is employed, as this substance tends to promote polarization, while the glass has a tendency to prevent polarization, thus increasing the working voltage and general efficiency of the battery. Asbestos paper or asbestos cloth, for the reason above pointed out, is impractical for use as a separator.

I will explain my invention more fully by reference to the accompanying drawings, in which—

Figure 1 is a side elevation of a separator, preferably in the form of an envelop designed to contain a battery-plate. Fig. 2 is a sectional elevation on line 2 2 of Fig. 3, the binding-threads being preferably concealed on the interior. Fig. 3 is a sectional view on line 3 3 of Fig. 1, a battery-plate being indicated in position.

Like parts are indicated by similar characters of reference throughout the different figures.

The mass of wool *a*, composed of glass fibers which are preferably long, may be somewhat in the physical form and arrangement of cotton-batting, the fibers having no definite arrangement to promote the effectiveness of the mass as a filter without impairing the circulating characteristic thereof. Each separator is preferably individually formed by selecting a mass of the required area and passing threads *b* through the same, preferably in right-angular directions, the thread being also disposed to form a selvage around the border to prevent the same from being unraveled. These threads are preferably passed through the glass fabric in a manner to present but little or none of their surfaces to the battery-plates. In actual practice very little, if any, of these threads need appear upon the surface of the separator that is adjacent to the battery-plate, as the fibers of the glass-wool are preferably disposed in so many promiscuous directions as to be readily bound together without the necessity of the threads passing entirely through the mat.

While I prefer to employ a non-metallic thread in the form of asbestos as the binding agency, I do not wish to be limited to the means by which the glass fibers are bound together.

I prefer to unite the separators so that each pair will together form an envelop, the separators of each pair being sewed together along the side and bottom margins by means of the binding-thread. I prefer to first place along the meeting edges of the envelop a cord *c*, preferably of asbestos, having the thickness of the battery-plate, this cord acting as a distance-preserving device to afford a sufficient

space for the entry of the plate, which is disposed completely within the envelop formed by the pair of separators. This cord and the separators are bound together by means of thread *e*, which is also asbestos. I prefer to unite the separators in pairs in this manner to form envelops, so that the dislodged particles that fall off the edges may accumulate in the bottoms of the envelops and cannot aggregate to short-circuit the battery elements. Moreover, the employment of the separators in the form of envelops enables the placement of the battery-plates any suitable distance apart. When they are located wide apart, so that the adjacent separators cannot cooperate in maintaining the sides of the envelops close to the plates, cords *f* are preferably wound about the envelops to maintain the required intimacy of contact.

The separator of my invention is preferably formed as an unwoven fabric composed of glass fibers, which fabric I believe to be broadly new with me. There are features of my invention, however, as will be apparent, that may be embodied in separators having other structural characteristics.

I am aware that glass fibers have been woven into mats. By the very nature of the glass fibers, however, large interstices have to be provided between groups of the fibers, as the fibers will not bend at sufficiently sharp angles to form a woven fabric without large interstices. When used as a separator, this structure is objectionable, for the reason that the woven fabric is not a good filtering medium, permitting substances of the battery to pass through the comparatively large interstices, which substances may accumulate and short-circuit or otherwise injure the battery. I have produced a felt formed of glass-wool. By the term "felt" is meant an unwoven fabric of fibers matted together. By using the glass fibers in an unwoven condition no large interstices need be left in the separator, as the fibers of the glass-wool need not be bent at sharp angles in the formation of the separator.

While I have herein shown and particularly described the preferred embodiment of my invention, it is obvious that changes may readily be made without departing from the spirit thereof.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A separator for storage batteries, composed of glass unwoven fabric having asbestos threads passed among the fibers for binding the same, substantially as described.
2. A separator for storage batteries, composed of glass-wool and binding-threads of insulating material passed among the fibers of the glass-wool to form therewith an unwoven fabric, substantially as described.
3. A separator for storage batteries, composed of glass-wool and binding-threads passed among the fibers of the glass-wool to

form therewith an unwoven fabric, substantially as described.

4. A separator for storage batteries, composed of glass fibers formed into an unwoven fabric.

5. A pair of separators for storage-battery use, made of glass fibers formed into an unwoven fabric, the said separators being united to form a container for a battery-plate, substantially as described.

6. A pair of separators for storage-battery use, composed of glass-wool and binding-threads passed among the fibers of the glass-wool to form therewith an unwoven fabric, the said separators being united to form a container for a battery-plate, substantially as described.

7. A pair of separators for storage-battery use, composed of glass-wool and binding-threads of insulating material passed among the fibers of the glass-wool to form therewith an unwoven fabric, the said separators being united to form a container for a battery-plate, substantially as described.

8. A pair of separators for storage-battery use, made of glass fabric united to form a receiving-envelop for a battery-plate, the fibers of the fabric having asbestos threads for binding the same, substantially as described.

9. A separator for storage batteries, composed of glass-wool having binding-threads passed through the fibers thereof to form the said wool into an unwoven fabric, fibers of the glass-wool extending to the exterior so as to be interposed between the binding-threads

and the battery-plate to be separated, whereby the binding-threads are prevented from contacting with the battery-plate, substantially as described.

10. A separator for storage batteries, composed of glass fibers and binding-threads of different material from the glass fibers passing among the glass fibers to bind and maintain the same in the required shape, substantially as described.

11. A separator for storage batteries, composed of glass fibers and asbestos binding-threads passing among the glass fibers to bind and maintain the same in the required shape, substantially as described.

12. A separator for storage batteries, composed of unwoven glass fibers and having binding-threads of different material from the glass fibers for maintaining the said fibers in shape, substantially as described.

13. A separator for storage batteries, composed of unwoven glass fibers and having binding-threads of insulating material for maintaining the said fibers in shape, substantially as described.

14. A separator for storage batteries, composed of unwoven glass fibers and having binding-threads of asbestos for maintaining the said fibers in shape, substantially as described.

In witness whereof I hereunto subscribe my name this 6th day of August, A. D. 1901.

GEORGE M. WILLIS.

Witnesses:

GEORGE L. CRAGG,

HERBERT F. OBERGFELL.