No. 720,186. PATENTED FEB. 10, 1903.

B. SCHWERIN.

APPARATUS FOR ELECTRO-ENDOSMOTICALLY FREEING MATERIALS FROM FLUIDS.

APPLICATION FILED APR. 24, 1902.

NO MODEL.

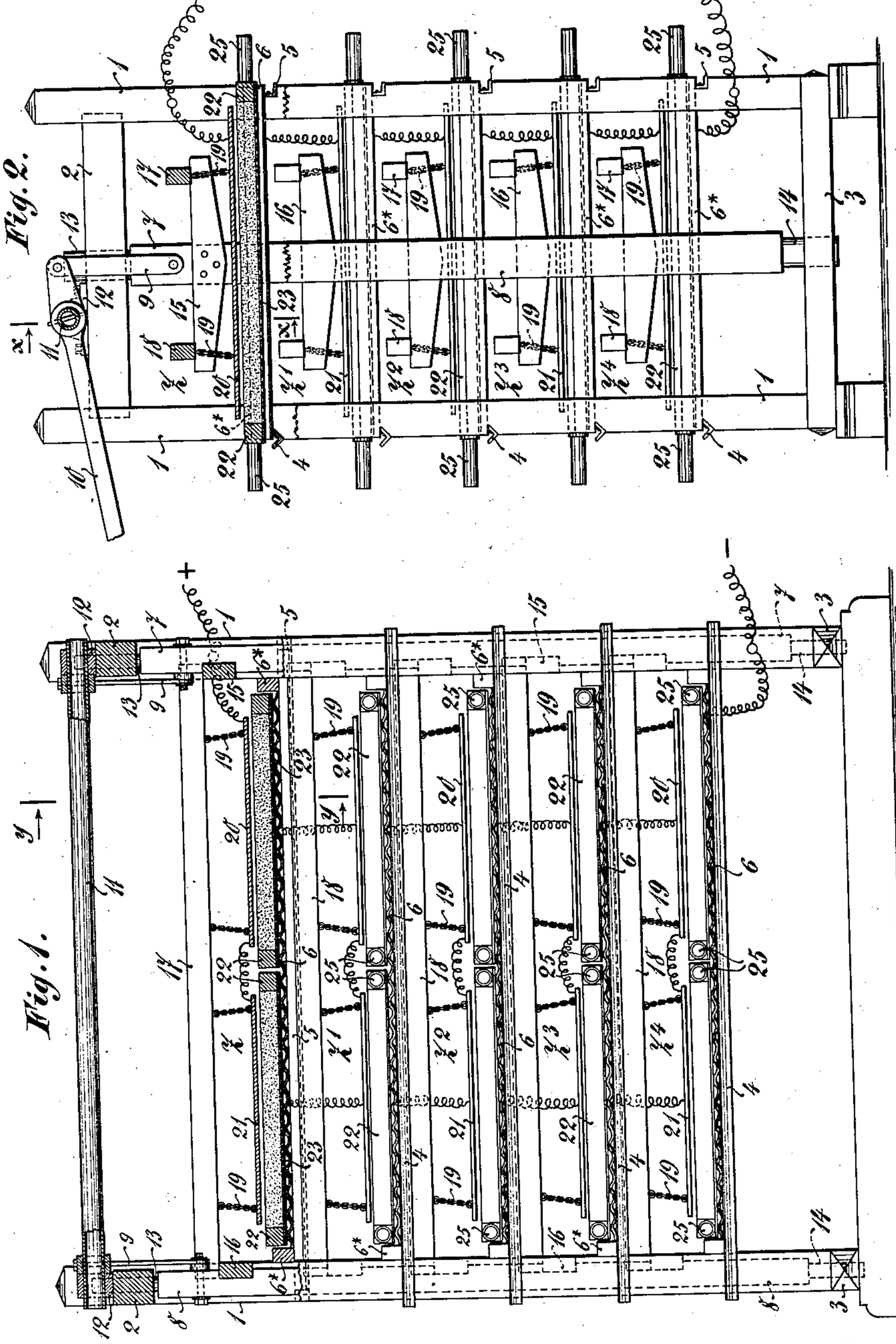

Fig. 2.

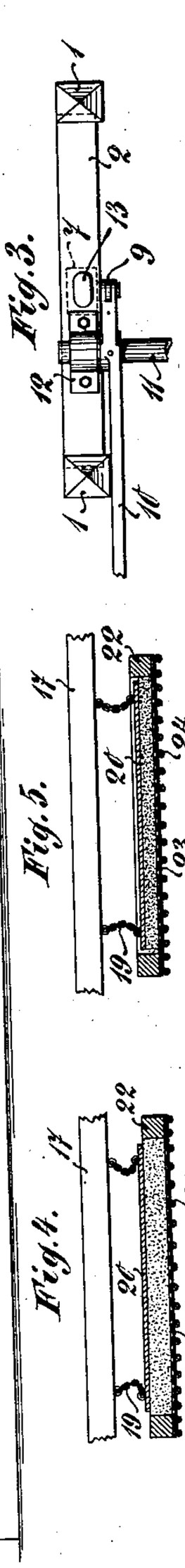

Fig. 3.

Fig. 1.

Fig. 5.

Fig. 4.

Witnesses:
W. Lee Helmes.
Osgood H. Dowell

Inventor:
Botho Schwerin
By Dubois & Dowell,
his attys

UNITED STATES PATENT OFFICE.

BOTHO SCHWERIN, OF BERLIN, GERMANY.

APPARATUS FOR ELECTRO-ENDOSMOTICALLY FREEING MATERIALS FROM FLUIDS.

SPECIFICATION forming part of Letters Patent No. 720,186, dated February 10, 1903.

Application filed April 24, 1902. Serial No. 104,518. (No model.)

To all whom it may concern:

Be it known that I, BOTHO SCHWERIN, doctor of laws and chemist, a subject of the King of Prussia, Emperor of Germany, residing at No. 19 Bernburgerstrasse, Berlin, Prussia, German Empire, have invented a new and useful Apparatus for Electro-Endosmotically Freeing Materials from Fluids, of which the following is a specification.

This invention relates to an improved apparatus for the process of electro-endosmotically freeing mineral, vegetal, and animal substances from water and other fluids, for which Letters Patent of the United States were granted to me under No. 670,350, dated March 19, 1901. In the practical working of said process it has been found that the thickness of the layer in which the material is subjected to the action of the electric current is of great practical importance, as with the increasing thickness of the layer the traveling of the fluid toward the negative electrode is increasingly retarded. Thus, for instance, in proceeding on a large scale with peat in the state of pulp or sludge it has been proved that when the thickness of the peat layer is increased beyond fifty centimeters the said process ceased to give satisfactory results.

The object of the present invention is to utilize this experience as the constructional base of an apparatus for treating large quantities of material in such a manner that the material is subdivided in a number of weak layers, and these are acted upon at a time in or by means of one and the same circuit. This problem has been very practically solved by means of an electric system which comprises a series of removably-superposed horizontal anodes, which are pervious to liquid and constructed to form boxes for receiving the material to be treated, and a vertically-movable cooperating series of horizontally-superposed cathodes, combined with means whereby they can at a time be lowered into contact with the material supported by said box-like anodes and raised therefrom after treatment, each cathode being, moreover, enabled when lowered to contact with the material to individually follow the latter as the same is caused to shrink or contract under the action of the electric current. The said anodic boxes are preferably composed of a frame made out of an electrically-non-conductive substance, as wood, and a bottom constructed with wire-gauze (iron or copper, for instance) fixed to the under side of the frame, which is left open at the top for allowing the cathode to penetrate. To support the said anodic boxes, I provide a multilecular structure constructed with a series of horizontally-superposed bottoms, floors, or partitions, which are impervious to liquid and held in an electrically-non-conductive frame open at its sides, so that a series of superposed chambers or cells is formed to receive a number of boxes. For each anodic box in the respective compartment or cell of said structure a flat positive electrode is so mounted that, on the one hand, all of the positive electrodes can be raised simultaneously within the cells after treatment for removing the boxes and inserting freshly-filled ones and then lowered simultaneously into contact with the material, and, on the other hand, each of these positive electrodes in the lowered position can independently of the others follow the material as it is caused to shrink or contract by the action of the current.

I prefer to build up my structure with corrugated floors, bottoms, or partitions, as by these means the escape to the outside of the fluid driven out from the material through the wire-gauze bottoms is obtained in a very simple manner. Moreover, said corrugated partitions have the advantage that the wire-gauze bottoms of the boxes constituting the negative electrodes thereof are supported in numerous points without materially affecting their perviousness, whereby said electrodes are protected against deformations and their level position secured, which has been found to be of importance for the proper action of the electric current. In most cases the wire-gauze bottoms should, moreover, be stiffened by applying a coarser metal netting against their under side. By constructing said corrugated partitions with metal—such as corrugated iron, zinc, or copper—I secure the practical advantage that the electrical connection of the wire-gauze bottoms of the anodic boxes with the negative pole of the dynamo or other source of electricity can be established by means of said partitions, so that the otherwise

necessary switching on and off of each separate box is obviated and a consequent great saving of time and labor attained.

A further advantage of the described arrangement is that it enables a current-generating machine of a given voltage to be utilized to the best effect, as the cells can be electrically connected in parallel or in series or in a combination of these connections—for instance, a series connection of groups of cells, the cells of each group being connected in parallel.

A form of apparatus embodying the principle of this invention is illustrated in the annexed sheet of drawings, in which—

Figure 1 is a front elevation of an apparatus comprising five cells for receiving two anodic boxes each, the top cell with boxes inserted being shown in section on the line $x\,x$ of Fig. 2; and Fig. 2, an elevation of the right-hand side, showing the top cell and its right-hand box in section on line $y\,y$, Fig. 1. Fig. 3 is a plan of the right-hand side frame. Fig. 4 is a vertical section through one of the anodic boxes, showing the position of the positive electrode at the beginning of the treatment; and Fig. 5, a vertical section through one of the anodic boxes, showing the position of the positive electrode at an intermediate phase of the process.

Two frames, each composed of two uprights 1, an upper cross-bar 2, and a lower cross-bar 3, are vertically erected and at a distance from each other. At the front and rear edges of the same are fixed horizontal bars 4 and 5, respectively, at regular intervals, so that each of the front bars 4 corresponds with one of the rear bars 5. Upon each pair of bars 4 and 5, of which there are five, is fixed a corrugated floor, bottom, or partition 6, preferably of zinc-covered iron, so that a series of five superposed compartments, chambers, or cells $z\,z'\,z^2\,z^3\,z^4$ is formed. Within each of said side frames in the vertical central line thereof a beam (denoted at one side by the symbol 7 and at the other side by the symbol 8) is suspended by a link 9 from a short arm 11 of a shaft 11*, on which is fastened on the other side a lever 10, the bearings 12 of said shaft being secured to and supported by the upper cross-bars 2. The beams 7 and 8 are provided on their upper and lower ends with extensions 13 and 14, respectively, which loosely project through corresponding holes formed in the cross-bars 2 and 3 to serve as guides. When the lever 10 is pressed downward, the beams 7 and 8 are raised, whereas they are lowered when said lever is caused or allowed to return to its upper position. At equal vertical distances from the partition 6 said beams 7 and 8 have secured thereto cross-bars 15 and 16, respectively, so that there is a pair of such cross-bars for each cell. On the ends of each corresponding pair of cross-bars 15 and 16 are secured bars 17 and 18, extending through the cells. From each pair of bars 17 18 are suspended iron plates 20 21 each by means of four chains 19 in such manner that when the beams 7 8 are raised (see Fig. 1) said plates are hanging side by side in horizontal position in the top part of the cells, so that between said plates and the partitions 6, forming the bottoms of the cells, sufficient space is provided for sliding the anodic boxes in or removing them from the cells. The said iron plates 20 21 constitute the positive electrodes of the cells.

The anodic boxes are each composed of a square frame 22, constructed with an electrically-non-conductive material, preferably wood, and a bottom 23, of wire-gauze, (iron or copper,) fixed to the under side of the frame, which is open at the top. The wire-gauze bottoms 23 constitute the negative electrodes of the cells. These anodic boxes are filled up to their top edges with the material to be treated—for instance, peat reduced to the state of a pulp—and the boxes are then placed into the cells, so as to rest on the metal partitions or floors 6. To prevent deformation of the wire-gauze bottoms 23, I prefer to stiffen the same by means of coarser metal nettings 24, applied against their under sides. To facilitate the manipulation of the boxes, they are provided with handles 25.

In the apparatus shown the cells are supposed to have such width that each can accommodate two anodic boxes side by side. It is for this reason that each cell is provided with two cathodic iron plates.

The front bars 4 are angular in section and are fixed to the uprights 1 with their open sides upward, (see Fig. 2,) so as to constitute channels or gutters for receiving and conducting away to a discharge (omitted from the drawings) the fluid driven out from the anodic boxes into the grooves or channels of the partitions 6.

The suspension-chains 19 for the positive electrodes 20 21 are given such length that when said electrodes are lowered upon the material in the anodic boxes their chains are hanging slack, (see Fig. 4,) so that in consequence of this surplus of length of their chains the cathodic plates can follow the material as it shrinks or contracts under the action of the electric current, as shown in Fig. 5, for an intermediate phase of the process.

In Fig. 1 it is assumed that the cells are electrically connected in series. The pair of positive electrodes of the top cell is connected with the positive pole of the current-generator, the negative pole of which is connected with the lowest iron partition 6, while the pairs of positive electrodes of the second, third, fourth, and fifth cells are connected, respectively, with the corrugated-iron partitions of the first, second, third, and fourth cells.

In order to charge the cells with filled anodic boxes, the positive electrodes, if not yet in raised position, are first raised by depressing the lever 10, then the filled boxes are placed upon the partitions 6, and finally the lever 10

is released, whereby the positive plates 20 21 are caused to sink upon and make contact with the material contained in the anodic boxes. The chains 19 are hanging slack. The electric circuit is then closed and water begins to be driven out from the anodic boxes through their wire-gauze bottoms and to drop into the grooves or channels of the corrugated partitions 6, from whence it escapes into the gutters formed by the bars 4, which conduct it to a discharge. (Not shown.) The material in the boxes shrinks or contracts in proportion as the water is driven out, without, however, breaking contact with the positive electrodes 20 21, as the slack of the chains 19 permits said electrodes to follow the sinking of the material in close contact with the latter. As soon as the obtainable or desired percentage of fluid is removed from the material the circuit is first opened, then the lever 10 is depressed to raise the positive electrodes from the boxes, and the latter are then withdrawn from the cells, which are then supplied with freshly-filled boxes.

By connecting with a two-hundred-and-twenty-five-volt-current-generating machine three apparatus of the kind described and connected in series, each apparatus comprising five cells connected in parallel and each cell containing two anodic boxes five centimeters in height, ninety centimeters in length, and eighty centimeters in width, a three-hours action results in removing from peat-sludge forty to fifty per cent. of its contents of water, the system requiring at the beginning a current density of about four amperes, which decreases progressively, so as to be reduced to about two and one-half amperes at the end of said period of time.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. In apparatus for electro-endosmotically freeing materials from fluids, the combination, with a source of electricity, of a series of superposed positive electrodes which is movable up and down in its entireness and of which each member is movable individually, and a series of pervious negative electrodes for supporting the material to be treated, the members of said negative series being removably arranged between the members of the positive series, substantially as and for the purpose stated.

2. In apparatus for electro-endosmotically freeing materials from fluids, the combination, with a source of electricity, of a series of superposed positive electrodes which is movable up and down in its entireness and of which each member is movable individually, a series of stationary corrugated floors arranged between said positive electrodes and a series of removable pervious negative electrodes for supporting the material to be treated, the members of said negative series being supported by said corrugated floors, substantially as and for the purpose specified.

3. In apparatus for electro-endosmotically freeing materials from fluid, the combination, with a source of electricity, of a series of superposed positive electrodes which is movable up and down in its entireness and of which each member is capable of sinking individually, a series of stationary corrugated metallic floors arranged between said positive electrodes, and a series of removable pervious negative electrodes for supporting the material to be treated, the members of said negative series being supported by said corrugated metallic floors, substantially as and for the purpose stated.

4. In apparatus for electro-endosmotically freeing materials from fluids, the combination, with a source of electricity, of a series of superposed stationary corrugated floors, a series of removable pervious negative electrodes resting on said floors and consisting each of an open box provided with a bottom of wire-gauze stiffened by coarse metal netting applied against its under side, and a series of superposed positive electrodes which is movable up and down in its entireness and of which each member is capable of individually following the material as it contracts under the action of the electric current, substantially as and for the purpose stated.

5. An apparatus for electro-endosmotically freeing materials from fluids comprising a structure open at its sides and subdivided in a number of superposed cells by horizontal corrugated partitions, removable pervious electrodes constructed for containing a layer of the material to be treated and resting on said partitions, positive electrodes arranged in the intervals of said corrugated partitions, means for moving the series of positive electrodes up and down in its entireness, means for allowing each positive electrode to individually follow the material as the latter contracts under the action of the electric current, electrical connections between the electrodes and the poles of a source of electricity, and means for conducting away the fluid driven out from the material into the channels of said corrugated partitions, substantially as and for the purpose stated.

6. An apparatus for electro-endosmotically freeing materials from fluids comprising a structure open at its sides and subdivided in a number of superposed cells by horizontal corrugated partitions, removable pervious negative electrodes constructed for containing a layer of the material to be treated and resting on said partitions, positive electrodes in the cells, a sliding frame for raising and lowering the positive electrodes and comprising transverse bars extending through the cells from one side to the other and resting outside of the cells on cross-bars fixed to vertical slide-bars, means for raising and lowering said sliding frame, means for allowing each positive electrode to individually follow the material to be acted upon by it as the same contracts under the action of the electric current, electrical connections between

the electrodes and the poles of a source of electricity, and means for conducting away the fluid driven out from the material into the channels of the corrugated partitions, substantially as and for the purpose stated.

7. An apparatus for electro-endosmotically freeing materials from fluids comprising a structure open at its sides and subdivided in a number of superposed cells by horizontal corrugated partitions, removable pervious negative electrodes constructed for containing a layer of material to be treated and resting on said partitions, a sliding frame comprising transverse bars extending through the cells from one side to the other and resting outside of the cells on cross-bars fixed to vertical slide-bars, means for raising and lowering the sliding frame, positive electrodes suspended from said transverse bars by means of chains having such length as to allow the positive electrodes with the sliding frame in the lower position to individually follow the material as the same contracts under the action of the electric current, electrical connections between the electrodes and the poles of a source of electricity, and means for conducting away the fluid driven out from the material into the channels of the corrugated partitions, substantially as and for the purpose stated.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

BOTHO SCHWERIN.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.