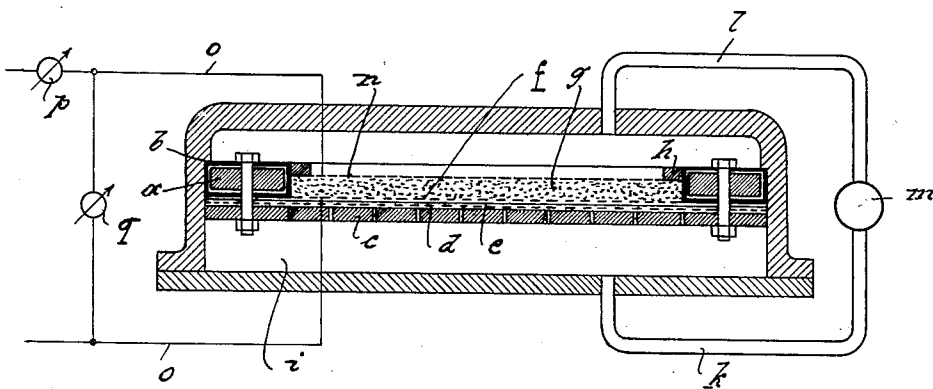


B. SCHWERIN.
METHOD OF AND APPARATUS FOR GENERATING ELECTRICITY.
APPLICATION FILED MAY 12, 1909.

972,029.

Patented Oct. 4, 1910.



Witnesses:
B. C. Rush

J. J. M. Conally

Inventor:
Baltho Schwerin

by J. F. Freeman Watson & Coit
Attorneys.

UNITED STATES PATENT OFFICE.

BOTHO SCHWERIN, OF FRANKFORT-ON-THE-MAIN, GERMANY.

METHOD OF AND APPARATUS FOR GENERATING ELECTRICITY.

972,029.

Specification of Letters Patent.

Patented Oct. 4, 1910.

Application filed May 12, 1909. Serial No. 495,519.

To all whom it may concern:

Be it known that I, BOTHO SCHWERIN, a subject of the German Emperor, and a resident of Frankfort-on-the-Main, Germany, have invented certain new and useful Improvements in Methods of and Apparatus for Generating Electricity, of which the following is a specification.

My invention relates to improvements in a method of and apparatus for generating electricity, and more particularly to that method and apparatus, in which electricity is generated by means of liquids flowing over solid bodies. And the object of the improvements is to provide a method and an apparatus, whereby high electromotive forces can be produced.

My invention is based on the discovery, that the electromotive forces produced in apparatus of this class can be increased by increasing the conductivity of the solid bodies and of the liquid by means of certain electrolytes, while other electrolytes have the tendency to decrease the electromotive forces. Furthermore, experiments have shown, that the electromotive force is increased when increasing the pressure of the liquid forced over the solid bodies, and in this respect, I have found, that the electromotive force is proportional to the pressure of the liquid. My experiments have also shown, that the electromotive forces are increased when making the passages for the liquid as fine as possible, for which purpose the said bodies are preferably used in the form of a very fine powder. And finally, I have found, that in some cases the electromotive force is increased, when using the same liquid in a continuous circuit.

For the purpose of explaining the invention I shall first describe an apparatus embodying the same. The said apparatus is illustrated in the accompanying drawings, in which the figure is a vertical cross-section of the apparatus.

Referring to the example illustrated in the drawings, my improved apparatus consists of a flat iron ring *a* covered with a layer *b* of vulcanized caoutchouc, which at its bottom is closed by a filtering element secured thereto by screws or in another suitable way. The said filtering element consists of a brass plate *c* provided with fine apertures, of a wire netting *d* placed over the latter, of a piece of tightly woven silk *e* providing the filter proper, and of a very

fine wire netting *f* providing one of the electric poles. Upon the latter I place a layer *g* of an osmotically acting substance, and over the latter the second electric pole which consists of a metallic ring *h* fitted into the ring *a* and of a wire netting *n* tightly stretched over the said ring *h* and so located that it contacts with the layer *g* all over its surface. Thereby the electricity produced within the apparatus can be collected without loss. The diaphragm so far described is placed within a casing *i* connected at one side of the diaphragm with a liquid supply *k* and at the opposite side with a liquid discharge *l*. In the preferred form of the apparatus shown in the drawings the liquid supply *k* and the liquid discharge *l* are so connected with each other, that the same liquid will be forced through the diaphragm in a continuous circuit, for which purpose a pump *m* or the like may be provided. Under certain circumstances it is necessary to use the same liquid in a continuous circuit, because between the liquid and the layer of the osmotic substance some kind of an equilibrium is produced which is caused by absorption and solubility. In such cases the same potential is obtained merely, if the same liquid is continuously used over again, while when using a new liquid other conditions are produced. The wire nettings *f* and *n* are connected to a circuit *o* which may include a voltmeter *q* having a high inner resistance, for example 23000 ohms, and a milliamperemeter *p*, which may be provided with shunt connections.

In operating the apparatus, I have discovered the following: Different osmotic substances when used under the same pressure of the liquid generate electricity of different potentials, and even the potential produced by the same substances varies in some cases according to the previous treatment of the said substances. Some substances (electro-negative substances) cause the current to pass through the apparatus in the direction of the liquid. Substances of this property are for example sulfur, the silicic anhydrid, burnt clay, blue ultramarine, non-conductive coal, etc. Other substances (electro-positive substances) cause the current to pass through the diaphragm in a direction opposite to that of the liquid. Substances of this property are for instance red ultramarine, and anthracite. Furthermore, I have found, that the intensity of the

current always follows Ohm's rule. That is to say, it is directly proportional to the electromotive force, and inversely proportional to the inner resistance of the layer, which resistance is dependent on the combined electric conductivity of the layer and the liquid, the thickness of the layer, and the cross-sectional area of the same.

The conductivity of the layer g , and therefore the intensity of the current can be increased by suitable electrolytes without decreasing the electromotive force, which on the contrary is increased in case of high inner resistance. On the other hand, when using improper electrolytes, the voltage as well as the intensity of the current are decreased, and under certain circumstances they are reduced to zero. Suitable electrolytes for electronegative substances are bases and for electropositive substances acids.

Some substances, for instance glass, porcelain, etc. split off electrolytes, which in some cases affect the process favorably, and in other cases are obnoxious. In the latter case, such substances produce a smaller potential than corresponds to their properties, and under certain circumstances they are electrically neutral. In some cases in which the electrolyte produced by the substance favorably affects the process its concentration is so large, that the best conditions are not obtained. The effect of the electrolytes is so conspicuous, that the presumption appears to be justified, that the occurrence of the currents is dependent on the presence of ions.

In experiments made with an apparatus, the layer g (as indicated in the figure) consisted of finely powdered negative coal, the thickness of said layer was 8 millimeters, and the cross-sectional area of the same was 2 square decimeters. The inner resistance was 1500 ohms in case distilled water freed from carbonic acid was used, and it was decreased by means of ammonia. Thereby the intensity of the current was increased almost to ten times the original value, and the voltage was doubled. Therefore, the amount of energy produced under the same pressure was about twenty times the original amount produced in the apparatus without the use of ammonia. If the inner resistance is made too small, the intensity of the current remains the same, while the voltage is decreased. In another experiment, the thickness of the layer g was 4 millimeters, and it consisted also in this case of negative coal. The resistance was decreased by acetic acid. The intensity of the current as well as its voltage were decreased. This result explains the unfavorable results obtained in previous tests.

My experiments have shown, that the electromotive force is increased proportionally to the pressure of the liquid. It also

shows, that the intensity of the current is proportional to the voltage in case the resistance of the layer g and the degree of the saturation of the liquid with the electrolyte remain constant. For example, where a layer of finely powdered quartz was used, having a thickness of 6.5 millimeters and a cross-sectional area of 2 square decimeters, and through which water containing pyridin was forced, the following relations were obtained:

Pressure in atmospheres.	Volt.	Amp.	Watt.	Ohm.
10	4.0	0.01	0.04	400
20	8.0	0.02	0.16	400
40	16.—	0.04	0.64	400
80	32.—	0.08	2.56	400

It appears therefore, that the amount of energy produced is proportional to the square of the pressure. It follows, that even with layers of small cross-sectional areas considerable amounts of electricity can be produced, if the pressure of the liquid is large. The efficiency however is the same whatever the pressure may be, because the amount of water forced through the layer is proportional to the pressure. Therefore the pressure, the amount of water consumed in the process, the voltage, and the intensity of the current are increased at the same ratio. However, I have discovered, that the efficiency is increased, if the passages through which the liquid is forced are made more fine, or if the osmotic substances are more finely powdered. The reason for this fact seems to be that the amount of water flowing through the said passages under a certain pressure is decreased, while the voltage is not altered, provided that the properties of the substance, its specific conductivity, and the character of the liquid are not altered. Therefore, the efficiency, that is the value

$$\frac{\text{Volt} \times \text{ampere}}{\text{Pressure} \times \text{amount of liquid}}$$

is increased, the more finely the substance is powdered. Therefore it is advisable, to powder the substances as finely as possible, so that, when the liquid is passing through the same, they almost have the character of colloid solutions.

I have discovered that suitable electrolytes for electronegative substances are bases, and for electropositive substances are acids. I therefore use a base or an acid as an electrolyte for an electronegative or an electropositive substance, respectively. I consider these two processes equivalents and it is therefore to be understood that the claims are to be construed accordingly.

I claim:

1. The herein described process of generating electric currents which consists in

forcing an electrolyte through a capillary substance, and collecting the electricity from said substance, using as an electrolyte a basic substance, when the capillary substance is an electronegative body.

2. The herein described process of generating electric currents, which consists in forcing the same body of electrolyte in a continuous circuit through a capillary substance and collecting the electricity from said substance.

3. In apparatus for generating electric currents, the combination of an electrically active body having minute apertures, means to force the same liquid through said apertures in a continuous circuit, and means to collect the electricity generated in the apparatus from said body.

4. In an apparatus for generating electric currents, the combination with a casing, of a member in said casing having minute apertures, means for supplying an electrolyte to said casing under pressure and for forcing it through said apertures, and means for collecting the current generated.

5. In an apparatus for generating electric currents, the combination with a member

having minute apertures, of means for forcing an electrolyte through said apertures, and apertured electrodes engaging said member for collecting the current generated.

6. In an apparatus for generating electric currents, the combination with a member having minute apertures, of means for forcing an electrolyte through said apertures, and electrode plates engaging the opposite faces of said member for collecting the current generated.

7. In an apparatus for generating electric currents, the combination with a casing, of a member extending across said casing and provided with minute apertures, and a pump having its inlet and discharge connected to said casing and on opposite sides of said member respectively, and means for collecting the current generated.

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

BOTHO SCHWERIN.

Witnesses:

JEAN GRUND,
ERWIN DIPPEL.