R. VON BROCKDORFF.

WATER HEATING APPARATUS.

APPLICATION FILED JAN. 5, 1911.

1,002,637.

Patented Sept. 5, 1911.

2 SHEETS—SHEET 1.

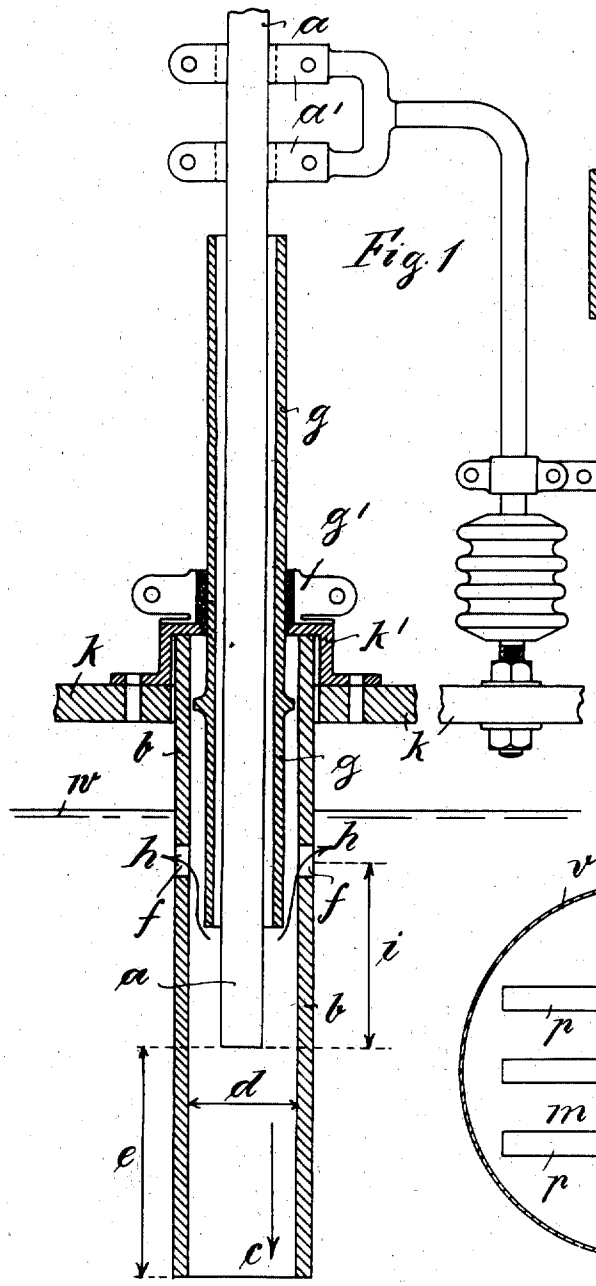

Fig. 1

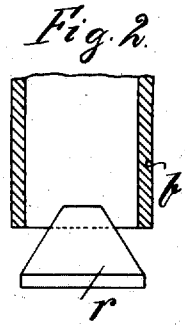

Fig. 2.

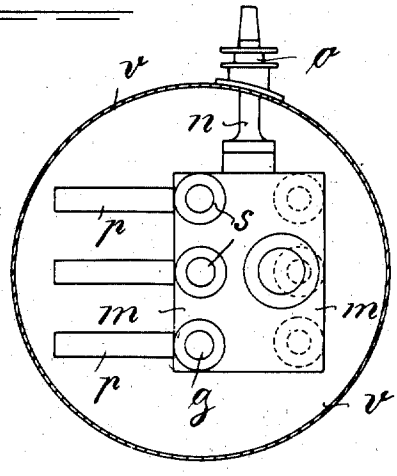

Fig. 5.

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2 SHEETS—SHEET 2.

Fig. 3

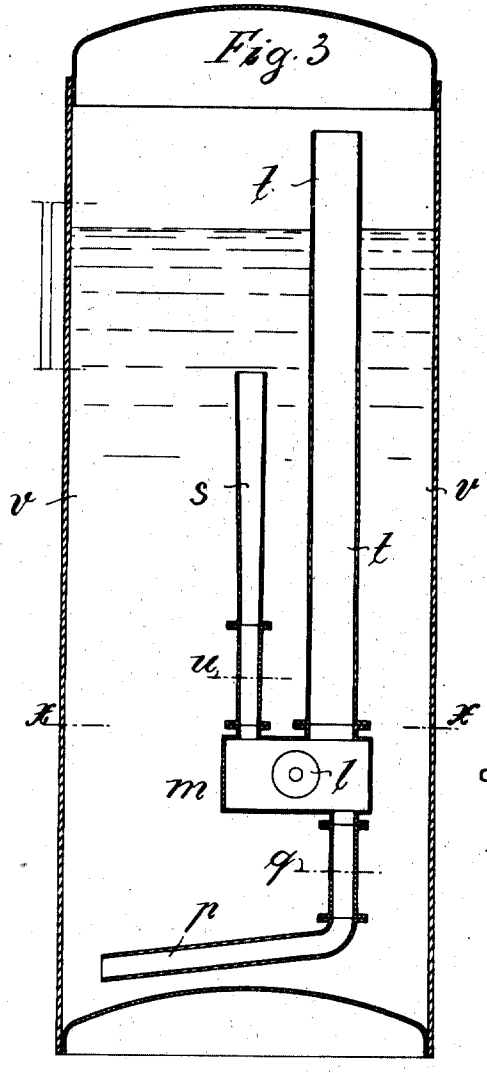
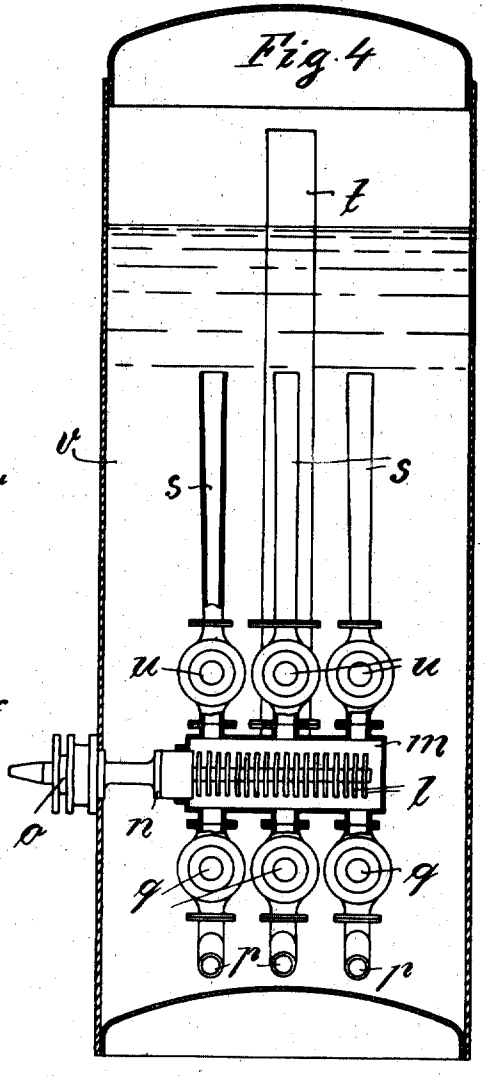


Fig. 4



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UNITED STATES PATENT OFFICE.

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WATER-HEATING APPARATUS.

1,002,637. Specification of Letters Patent. Patented Sept. 5, 1911.

Application filed January 5, 1911. Serial No. 601,029.

To all whom it may concern:

Be it known that I, RUDOLF von BROCKDORFF, a subject of the King of Prussia, and resident of 135 Alexandrinenstrasse, Berlin, Germany, engineer, have invented certain new and useful Improvements in Water-Heating Apparatus, of which the following is a specification.

This invention relates to an electrode for the heating or electrolysis of liquids and is particularly adapted for water heating and steam generating apparatus.

As the heat generated by an electric current in a liquid is proportional to the square of the electromotive force and to the resistance, it is therefore necessary, for liquids of small resistance, to employ currents of great amperage and low voltage. According to this invention the liquid forming the resistance is a column of comparatively small cross-section, and of sufficient resistance to permit of the use of high voltages. The liquid which receives its current from the electrode is contained in a hollow body or tube open at its upper and lower ends or perforated. The liquid owing to the heat generated rises in the hollow body and passes out thereof at the upper end returning again to the hollow body at its lower end. The length and cross-section is capable of being readily varied and thereby the electrode may be adapted to varying requirements.

The invention also comprises means for readily adapting the electrode to water heating apparatus upon an electric locomotive for the purpose of generating steam in a boiler from the working current for application to the heating of the rail-way carriages and such like purposes. The electrode is arranged in an insulating casing and in order to give the greatest possible surface for the passage of the current, it may be in the form of a number of disks or plates placed side by side and if desired made of wire-gauze, or it may be in the form of a carbon-block positioned in a cylinder, or of any other suitable form. The insulating casing for the electrode is in communication with the surrounding liquid through a number of tubes, some of which open above and some of which open below the casing into the liquid. The out-put may thus be readily varied by putting in or cutting out of the circuit the individual tubes and this may be effected by cocks or other cut off devices arranged in the tubes and preferably of insulating material, so that they not only cut off the passage of the liquid through the tubes but also prevent the passage of the electric current. Further it has been found that at high temperatures and with high steam generation there is a liability of disturbing variations in the output, the steam being generated very irregularly so that it varies within very wide limits. In order to avoid such conditions, the tubes are preferably tapered downwardly or other means may be provided, so that the lower cross-sectional opening of the tubes is of smaller area than the outlet opening. Further in order to prevent the steam bubbles generated from breaking the circuit, additional tubes are provided passing from the insulating casing of the electrode and opening above the surface of the liquid, so that these tubes lead a part of the steam direct to the steam chamber.

In order that the invention may be more clearly understood, reference is made to the accompanying drawings which show by way of example two methods of carrying out the invention.

Figure 1 is a vertical section of the electrode, as applied to the heating or electrolysis of a liquid. Fig. 2 is a detail view showing means for varying the lower cross-sectional area of the hollow body or tube surrounding the electrode. Figs. 3 and 4 are vertical sections at right angles to one another of the invention as applied to a water heating apparatus suitable for electric railway trains. Fig. 5 is a cross-section on the line x—x of Fig. 3.

Referring to Fig. 1 of the drawings the electrode a which is of carbon or any other suitable material is surrounded at its lower end by a hollow body b of tubular form and of porcelain, glass or other insulating material. The hollow body b and electrode a dip into the liquid w, which may for example be contained in a heating boiler. The tube b is secured to the cover k of the boiler which may for water heating purposes form the second electrode. The tube b is open at its lower end and is provided in its upper part with perforations f. Surrounding the electrode a and within the tube b is a second narrower tube g which is suspended in position by a clamp g' on a cap k'. The electrode a is likewise suspended in position by means of clamps a' carried by any suitabl

means. On the drawings the annular space between the electrode *a* and the tube *g* is shown open, but may, if desired, be closed. The current from the electrode *a* passes in the direction of the arrows *c* and *h* to the second electrode. The current passing in the direction *c* generates heat in a column of liquid of length *e* and diameter *d* and the liquid therein therefore rises and passes out through the openings *f* returning again to the hollow body *b* at the lower end, so that there is a constant circulation of liquid in the hollow body *b*. If the electrode *a* is freely arranged in the tube *b*, that is without the use of the intermediate tube *g*, then the current will take the shortest way from one electrode to the other through the openings *f*. This is however prevented by the insulating tube *g* which reaches to a point below the openings *f* in the tube *b*, so that the current from the electrode must pass through a column of liquid of small cross-section before passing through the openings *f*, this liquid column being of annular form. The direction of the current is indicated by the arrows *h*. The total resistance to the current is thus the sum of two liquid columns parallelly arranged in the circuit, the one of cylindrical or similar form of length *e* and diameter *d* and the other of annular form of length *i*. The degree of resistance may be varied by adjusting the position of the electrode in the liquid or by relative adjustment of the electrode and the tube or tubes or by adjusting the position of the hollow body *b*. It is also possible to vary the volume of the column of liquid, as shown for example at Fig. 2, in which the lower end of the tube *b* is provided with a conical valve *r* capable of being vertically adjusted, so that the cross-sectional area of the tube *b* at its lower end may be varied according to the position of the conical valve *r*. If desired, the electrode *a* may be provided with an insulating cover or coating apart from the tube *g*. It is also possible to attain the object of this invention by forming the tubular body as the electrode. The tubular body *b* may be of conducting material which is insulated up to that part where the current passes over into the liquid. This insulation may take the form of an insulating coating or a movable tubular or otherwise shaped slidable covering means. If desired, the hollow body *b* may be suspended in the liquid, so that its upper open end is positioned a short distance above the level of the liquid, thereby dispensing with the necessity for the perforations *f*. In this case the rising liquid will stream over the upper end of the hollow body and fall into the liquid and thereby the separation of the steam will be considerably facilitated.

Referring to Figs. 3, 4 and 5 of the drawings, the electrode *l* in this case consists of a number of carbon plates arranged side by side in a porcelain or other insulating box *m*, and secured to a stuffing member *n* passing through a stuffing box *o*, so that it can be drawn out of the boiler *v*. The other electrode is formed by the inner surface of the boiler *v*. The interior of the box *m* is in connection with the surrounding water by a plurality of tubes *p*, entering the box from below. In order to give these tubes a sufficiently large capacity, they must be comparatively long, as the cross-section of the individual tubes admits of only a limited power being applied. For this purpose the tubes are not arranged perfectly straight but are bent or otherwise made, so that the necessary length is obtained. Each tube *p* is provided with a porcelain cut off valve *q* which may be individually accessible from the exterior by means not shown on the drawing and which serves not only to cut off the flow of liquid through the tube *p* but at the same time cuts off the passage of the electric current therethrough owing to its insulating property. Passing upwardly from the box *m* is a plurality of tubes *s* which open into the liquid. Further, one or more tubes *t* of larger cross-section communicate with the interior of the box *m* and the steam chamber above the surface of the liquid. The tubes *t* may be arranged in any convenient manner, so as to conduct part of the steam generated in the box *m* direct to the steam chamber, so that this steam does not pass through the tubes *s* which would in such case be subjected to an overload, as they have to conduct the steam generated within themselves. The steam generated in the tubes *s* is very considerable as the temperature of the water therein is high owing to the preheating of the water, which has taken place in the lower tubes *p*. In order to render the escape of the steam possible without irregularity the tubes *s* are conically formed, so that the cross-sectional area of their outlet openings is greater than that of the inlet openings. The tubes *s* are similarly provided with porcelain or other insulated cut off valves *u*, so that it is possible to regulate the generation of the steam by cutting out the liquid supply and the passages of the current through the tubes *s*.

From the description relating to Figs. 3 to 5 it will readily be understood that the electric current passing from the electrode *l* to the outer casing or electrode *v* is compelled to pass through the tubes *p*, *s* and *t* owing to the box *m* being of insulating material; the current thus rapidly heats the liquid in these tubes and sets up a circulation therein. When it is desired to control the heating or the liquid, one or more of the insulated valves *q* and *u* may be closed, thus preventing a circulation of the liquid through the respective tube or tubes while

at the same time the valves when in closed position form insulators between the electrode *l* and the outer casing or electrode *e*. The liquid columns in the tubes *s* and *p* form the main elements of resistance and in the same manner as in Fig. 1 are arranged parallelly in the circuit, the water rising upwardly in these tubes owing to the difference in temperature and passing out at the upper end in the manner already described with reference to Fig. 1.

It will, of course, be readily understood, that the apparatus hereinbefore described, although primarily intended for use with alternating currents for heating purposes, may equally well be adapted for the electrolysis of liquids, if continuous currents are used.

I claim:—

1. In an apparatus for the heating and electrolysis of liquids by electricity, an electrode immersed in the liquid and a nonconducting hollow body surrounding said electrode and communicating above and below with the surrounding liquid to be heated, so as to enable the liquid to circulate through said hollow body.

2. In an apparatus for the heating and electrolysis of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode and communicating above and below with the surrounding liquid to be heated so as to enable the liquid to circulate through said hollow body, and means for varying the relative positions of said electrode and hollow-body.

3. In an apparatus for the heating and electrolysis of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode and communicating with the surrounding liquid to be heated and means for varying the cross-sectional area of said hollow body.

4. In an apparatus for the heating and electrolysis of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode, upper and lower connections with said hollow body and the surrounding liquid to be heated and means for individually controlling and cutting-off said connections.

5. In an apparatus for the heating of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode, upper and lower connections with said hollow body and the surrounding liquid to be heated and insulated means for individually controlling and cutting-off said connections and adapted at the same time to control the passage of the current.

6. In an apparatus for the heating of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode, upper and lower connections with said hollow body and the surrounding liquid to be heated and means for individually controlling and cutting-off said connections, said connections being wider at their outlet ends than at their inlet ends.

7. In an apparatus for the heating of liquids by electricity, an electrode immersed in the liquid, a nonconducting hollow body surrounding said electrode, upper and lower connections with said hollow body and the surrounding liquid to be heated, means for individually controlling and cutting-off said connections, and means for conducting steam from said hollow body to a chamber above the level of the liquid.

8. In an apparatus for the heating and electrolysis of liquids by electricity, the combination of a vessel for containing the liquid to be heated, an electrode in said vessel, means whereby the electrode may be withdrawn from said vessel and a non-conducting hollow body surrounding said electrode and communicating with the liquid in the vessel, the casing of said vessel forming the second electrode.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

RUDOLF von BROCKDORFF.

Witnesses:

WOLDEMAR HAUPT,

HENRY HASPER.