(No Model.)

2 Sheets—Sheet 1.

P. GIRAUD.

THERMO ELECTRIC BATTERY.

No. 483,782. Patented Oct. 4, 1892.

Fig. 1

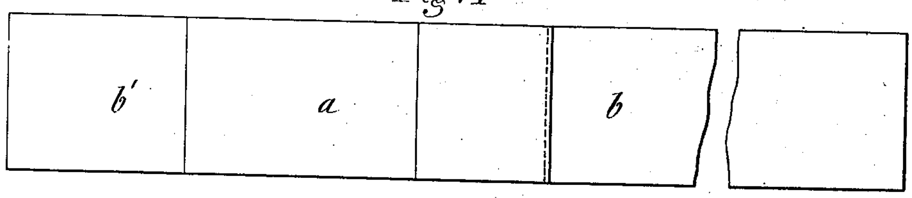


Fig. 2

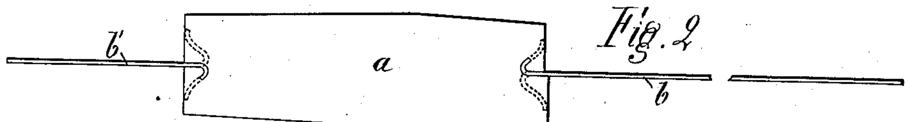


Fig. 5

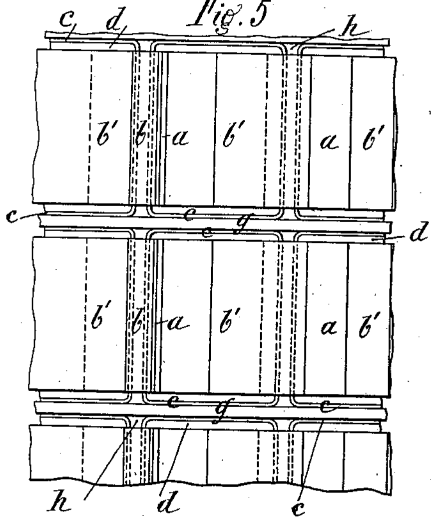


Fig. 4

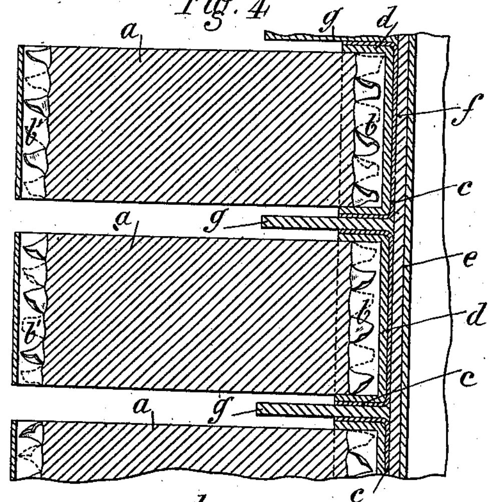


Fig. 6

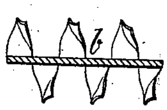
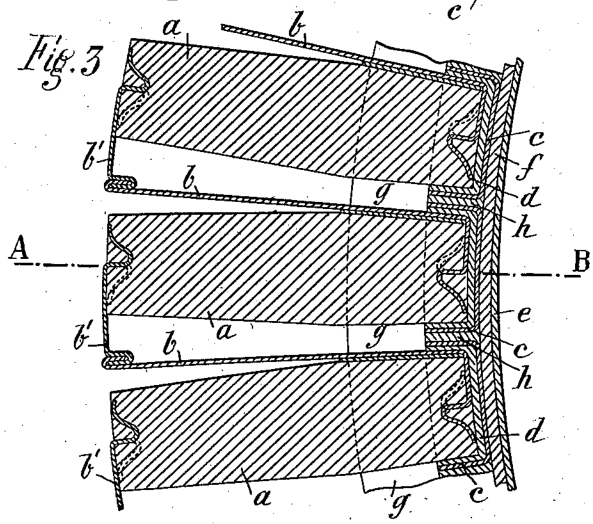


Fig. 3



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(No Model.)

2 Sheets—Sheet 2.

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THERMO ELECTRIC BATTERY.

No. 483,782. Patented Oct. 4, 1892.

Fig. 7

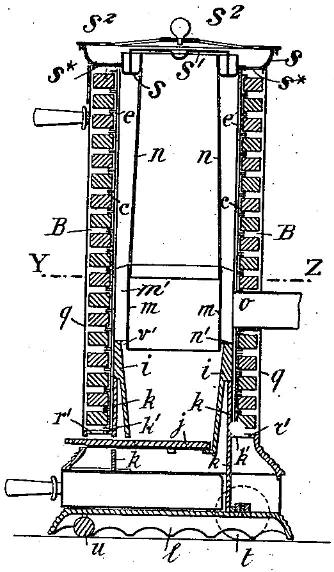


Fig. 9

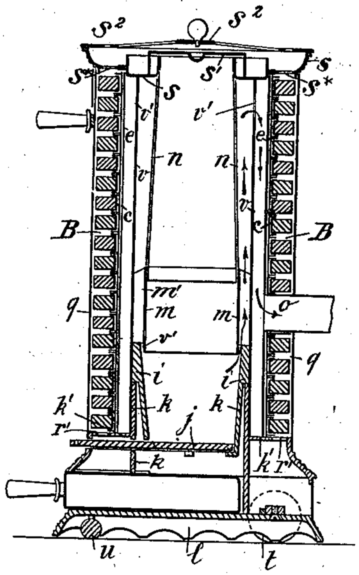
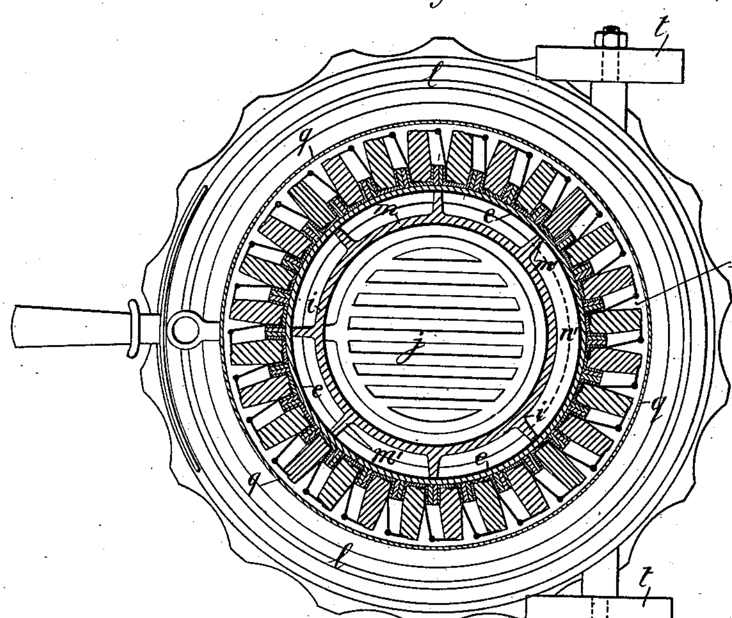


Fig. 8



Witnesses:-
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UNITED STATES PATENT OFFICE.

PAUL GIRAUD, OF CHANTILLY, FRANCE.

THERMO-ELECTRIC BATTERY.

SPECIFICATION forming part of Letters Patent No. 483,782, dated October 4, 1892.

Application filed August 1, 1891. Serial No. 401,378. (No model.) Patented in France April 10, 1890, No. 204,902.

To all whom it may concern:

Be it known that I, PAUL GIRAUD, of Chantilly, in the Department of Oise, in the Republic of France, have invented a new and useful Improvement in Thermo-Electric Batteries, (for which I have obtained patent in France, No. 204,902, dated April 10, 1890,) of which the following is a specification.

I will describe my invention with reference to the drawings and afterward point out its novelty in claims.

Figures 1 and 2 of the drawings represent, respectively, a side view and a plan of one element of a battery constructed according to my invention. Fig. 3 represents a horizontal section of a group of elements connected. Fig. 4 represents a vertical section, in the line A B of Fig. 3, of several superposed elements. Fig. 5 is an end view corresponding with Figs. 3 and 4. Fig. 6 is a detail view illustrating the connections between the elements. Fig. 7 represents a vertical section of a portable stove, serving for the heating of one of the extremities of the thermo-electric electrodes. Fig. 8 represents a horizontal section on a larger scale than Fig. 7, taken in the line Y Z of the latter figure. Fig. 9 represents a vertical section of a modification of the stove shown in Figs. 7 and 8.

Each element of the battery is composed of an electrode *a* and an electrode *b b′*, the electrode *a* being a casting of one of such alloys as are herein specified and the electrode *b b′* consisting of two plates of sheet metal. The elements are formed by placing one end of a plate *b* and one end of a plate *b′*, one in one end and the other in the opposite end of the mold in which the electrode *a* is to be cast, and afterward casting the latter electrode in said mold upon the said ends of said plates. The electrodes *a* are formed of alloy of zinc, antimony, copper, tin, silicium, and cadmium. Certain of these metals—such as zinc and antimony—have already been used in thermo-electric batteries; but my experience has led me to employ them in various practical conditions, from which results, first, that they furnish a greater electro-motive force without increasing the internal resistance of the element, and, second, that I avoid the primitive crystallization (those resulting immediately from casting) as well as the ulterior crystallizations (those produced by the heating of the elements.) The solidity and durability of the elements are thus increased. As to copper, I add it, first, to augment the mechanical resistance of the alloy; second, to diminish its internal electric resistance, and, third, to raise the fusion-point of the alloy. On the other hand, the tin which enters into the composition of my alloy makes it flow better for casting and renders it more homogeneous and more solid. The silicium increases the resistance to breakage. Finally, the cadmium, which I employ in convenient proportions with other metals above mentioned, has for its object to greatly augment the electro-motive force of its elements.

I give as follows the three compositions which I at present employ in the manufacture of the elements:

Composition A for elements of small size: Antimony, 1,450 parts, by weight; zinc, 900 parts, by weight; cadmium, 50 parts, by weight; pure copper, 80 parts, by weight; tin, 40 parts, by weight; silicium, 3 parts, by weight.

Composition B for elements of medium size: Antimony, 1,440 parts, by weight; zinc, 780 parts, by weight; cadmium, 60 parts, by weight; pure copper, 30 parts, by weight; tin, 15 parts, by weight; silicium, 2 parts, by weight.

Composition C for elements of large size: Antimony, 1,830 parts, by weight; zinc, 960 parts, by weight; cadmium, 65 parts, by weight; silicium, 2 parts, by weight.

As I have shown, there may be notably differences between the proportions of the different metals; also, that the copper and tin may be omitted (composition C) when the elements by reason of their large size present sufficient guarantee of solidity. I might even depart to a certain degree from the proportions indicated in the above table. The proportions in which the different metals enter into the alloy may vary, in fact, according to the greater or less effect which it is desired to have and the dimensions of the elements. My experiments have proved to me that the composition of the alloy being the same the electro-motive force of an element varies, first, with the three dimensions given to the element; and second, with the thickness (vertical dimension) of the element, the length and breadth not being changed. Thus, for example, with the same metallic composition the same length and the same breadth an element of two centimeters thickness will have a greater electro-motive force than another of three or five centimeters thickness. The longitudinal electric resistance will also be greater in the former than in the latter.

The changing of the proportions of the alloy has for its end to preserve to the elements, while increasing its thickness, the same electro-motive force, and that without increasing its internal electric resistance. The effect is thus greatly augmented.

Three thicknesses of electrodes *a*, which may be employed with the greatest advantage, are as follows, according to different cases:

Small size, length equals .07 millimeter, breadth equals .02 millimeter, and height equals .02 millimeter; medium size, length equals .07 millimeter, breadth equals .02 millimeter, and height equals .03 millimeter; large size, length equals .10 millimeter, breadth equals .03 millimeter, and height equals .05 millimeter.

These proportions may evidently vary in a certain degree.

As I have above explained, I modify the composition of the alloy according to the dimension of the electrode.

The second electrode *b* or *b'* of each element is preferably constituted of tin-plate or of a plate of pure nickel; but the said electrodes may also be made of sheet-iron having its surface coated with iridium, platinum, or nickel, or made of ferro-aluminium. Each of the plates *b b'*, constituting electrodes, is united with the electrode *a* by an autogeneous solder—that is to say, produced by the casting of the alloy forming the latter electrode.

In order to have a perfect union, and a large surface of contacts, (which it is evident is of great importance,) the extremity of each plate is first divided by several longitudinal slits. Then the tongues thus formed are turned alternately to the right and left and afterward twisted, as may be clearly seen in Figs. 2, 3, 4, and 6, to anchor the said plates into the electrodes *a*. The part of the plate *b* which is next the inner end of the electrode *a* is folded over against that end, then again folded to be applied against the lateral face of the said electrode *a*, a thickness of amianthus or other insulating material being interposed between the last-mentioned face and the said plate. The plates *b* and *b'* of two adjacent elements are lapped and secured together by a solder which will not melt at the temperature to which it has to be exposed. This mode of connection permits the easy replacement of one of the elements in case of damage by unsoldering the two joints between that and the adjacent elements in the same row, and replacing the damaged element by a good one and remaking the connections. The thermo-electric elements of the system above described may apply to all kinds of apparatus emitting heat and capable in consequence of heating one of their extremities, while the other will be maintained cold by any means whatever. I may notably arrange them around steam-boilers, furnaces, &c., in order to utilize the waste heat, and thus to produce electricity without cost while absorbing the heat, which in certain cases is objectionable—for example, on board ships—or else I may affix them around a stove in such manner as to constitute an apparatus, serving both for warming the air of an apartment or of any space whatever, and producing electricity for lighting or other purposes. Figs. 7, 8, and 9 show this application of my elements around a stove, which constitutes an important feature of my invention. I have here supposed the employment of a stove of a portable kind which may be rolled about from one part of an apartment to another. The employment of the stove in this way as a generator of heat permits me to utilize for the heating of the battery all the heat commonly lost from the stove, whence results a perfect utilization of the combustible expended, and consequently great economy. This utilization is more perfect when I employ a stove so constructed that the outer surface is never above a moderate heat, as it is always desirable that the stove shall be such that the solderings of the elements should not be heated to a sufficient temperature to melt them. In my system the thermo-electric battery surrounds the stove exteriorly, the solderings, which should be maintained cold, being toward the exterior and being cooled by a current of air, for example, while those solderings which must be heated are toward the interior and exposed to the heating action of the stove. The elements of the battery are not in contact either with the combustible or the gases of combustion, nor even directly with the walls of the heating apparatus, and this, in connection with the special arrangement of the elements, prevents all deterioration and insures the battery an almost indefinite durability.

The stove represented is composed of two distinct parts—viz., the "stove," properly so called, and a jacket *q*, which surrounds it, with a space B between them to contain the thermo-electric battery. The whole rests upon a base *l*, preferably mounted upon wheels *u*, which permit the apparatus to be moved about.

I will now describe that example of the stove proper represented in Figs. 7 and 8: *i* is a conical cast-iron fire-pot, of which the bottom is constituted by the movable grate *j*, which rests upon a cast-iron cylindrical piece *k*, carried by the base *l*. *m* is a hollow cylinder of cast-iron, situated above the said pot and serving, with the said pot, to contain the incandescent fuel, and *n* is a slightly-conical fuel-reservoir situated above the said cylinder m. The said cylinder m is of a diameter somewhat smaller than that of the bottom of the fire-pot, so that there is an annular opening v' between them interrupted only under the mouth o of the smoke-pipe, where there is a horizontal flange n', which rests upon the top of the pot. The said cylinder m has upon its exterior a series of vertical radial ribs m', the outer edges of which fit to the external cylinder e, which constitutes the exterior wall of the stove proper. This cylinder e and the jacket B both rest on a gallery k', provided on the exterior of the lower cylindrical piece k on the base l. At the top of the cylinder e, reservoir n, and jacket q, which are all carried up to the same height, there is an annular cap-plate s, which covers the space between the cylinder e and the reservoir, and that B between the said cylinder and the jacket q, and in this cap-plate is provided an annular sand-channel for the reception of the edges of the cover s' of the reservoir n, which cover is removable for charging the reservoir with fuel. The cap-plate is also provided with a larger removable cover s^2, which also covers the annular space provided between the exterior e of the stove proper and the jacket q to receive the battery. This larger cover is of spider form to permit the escape of air and heat from the said annular space.

In the above-described example of my invention gases of combustion pass from the fuel in the pot i and the lower part of the cylinder m through the opening v' and circulate within the space between the exteriors of the cylinder m and reservoir c and the interior of the cylinder e and pass out by the smoke-pipe o to the atmosphere, the circulation, first upward and then downward, being produced by the ribs m' and flange n'.

The gallery k', hereinbefore mentioned as surrounding the cylindrical piece k and as supporting the cylinder and jacket q, also supports the battery elements. This gallery has in it numerous holes r' for the admission of air to the annular space B between the said cylinder and jacket, and the cap-plate s has in it numerous small holes for the escape of air from said space. The extremity of each electrode a which is intended to be heated is first plunged into a plaster made of pulverized amianthus and silicate of soda or silicate of potash, preferably silicate of soda, and is then inserted into a little cup c, which may be made by stamping out of sheet metal. This cup serves not only to prevent the metal of the electrode from fusing externally, but also to spread the heat equally around the sides of the end which is to be heated. The plaster of silicate of soda or silicate of potash and amianthus (indicated by d in Figs. 3, 4 and 5,) contributes to assure the electric insulation at the same time that it produces the adhesion of the electrode to its cup c. The cups c, electrically insulated from the external wall or cylinder e of the stove by a sheet of amianthus paper f, are cemented to said wall or cylinder by means of the plaster of silicate and amianthus, hereinabove mentioned. The different horizontal tiers of cups c are insulated one from another by rings or washers of amianthus paper g, (see Figs. 4, 5, and 6,) and between the vertical faces of the said cups of the same horizontal tier there are also interposed small pieces of amianthus paper h. I may employ any other insulating material; but the amianthus paper gives very good results. I may, for instance, employ mineral wool. The cups may be affixed to the cylinder e by any other suitable adhesive cement. The external portions of the battery elements are cooled by a current of air, which, entering through suitable openings provided in the base l, passes through the holes r' of the circular gallery k', and through the three spaces left around each element, finally escaping after having been heated through the holes in the cover s. This circulation of air takes place over all the surfaces of the portions of the elements which requires to be cooled, including the vertical exterior face, because there is a certain amount of space left between this space and the jacket q. To favor the cooling, this jacket is blackened inside and outside.

With the construction of stove which I have just described and which is represented in Figs. 7 and 8 the gases of combustion pass more or less directly to the chimney. It results therefrom that the higher portions of the battery are less heated than the lower portions and furnish a current less intense than the latter. The utilization of the combustible will then be better and the electric result be augmented if the gases remain a long time within the space between the reservoir n and the cylinder e and are obliged to rise to the upper part of the stove. This effect may be obtained by interposing between the reservoir n and cylinder e an additional cylinder v, serving as a baffle. In this construction, which is represented in Fig. 9 of the drawings, the gases of combustion, arriving at the exterior of the winged cylinder m, rise between the reservoir n and the additional cylinder v, which may be made of sheet-iron or cast-iron, passing through orifices v' in the upper part of the said cylinder, descending through the space between the cylinders v and e, and escaping by the smoke-pipe o after having lost the greater part of their heat. In this example the horizontal flange n' of the winged cylinder m, as shown in Fig. 7, must evidently be suppressed, as the additional cylinder v serves the same purpose and in a much more efficacious manner.

Besides the above-mentioned advantages, the additional cylinder v prevents the melting of the elements by any sudden increase of heat which may take place at the level of the hottest portion of the incandescent fuel.

It is obvious that without changing any part of my invention instead of employing in the stove a solid combustible—such as coke or coal—I may also employ a liquid or gaseous combustible.

The stove represented in the drawings may be heated by gas or other hydrocarbon liquid by simply taking out the grate and introducing in its place suitable combustion apparatus.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. An electrode for a thermo-electric battery, composed of antimony, zinc, cadmium, and silicium in proportions substantially as herein set forth.

2. An electrode for a thermo-electric battery, composed of antimony, zinc, cadmium, silicium, copper, and tin in proportions substantially as herein set forth.

3. The combination, with each battery element and the heating-surface to which it is attached, of a metal cup *c*, receiving the inner end of said element and insulated therefrom by a cement which serves to hold the elements in the cup, the said cup serving to attach the elements to the heating-surface and to transmit heat uniformly around that end of the element which is to be heated, substantially as herein described.

4. The combination, with a heating-surface and a series of thermo-electric-battery elements arranged in several tiers against such surface, of a series of metal cups *c*, receiving and insulated from their respective elements and each insulated from the adjacent ones of the same tier and from those of the tiers above and below and being secured to said heating-surface by an insulating-cement, substantially as herein set forth.

5. The combination, with the combustion-chamber and the series of thermo-electric elements with which it is surrounded, of three annular walls *n v e*, arranged one within another between said chamber and said series of elements and forming two annular spaces, the inner of which spaces communicates at its lower part with the combustion-chamber and the outer of which spaces has an outlet in the lower part to the atmosphere, and the middle wall *v*, having openings in the upper part, and the thermo-electric elements being outside of and attached to but insulated from the outermost of said walls *e*, all substantially as herein set forth.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

PAUL GIRAUD.

Witnesses:
ROBT. M. HOOPER.
CHARLES ASSI.