2 Sheets—Sheet 1.

C. WRAY & L. WRAY, Jr.

Thermo-Electric Piles.

No. 197,196. **Patented Nov. 13, 1877.**

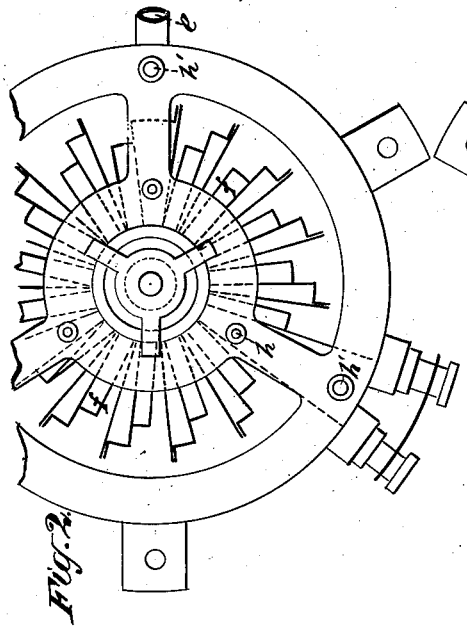

Fig. 2.

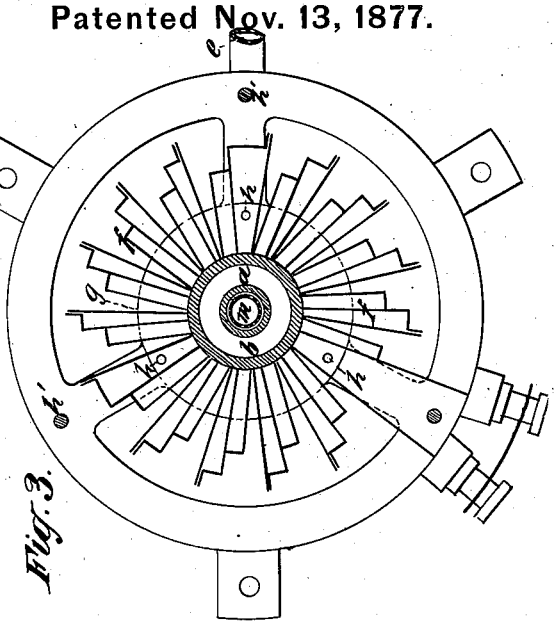

Fig. 3.

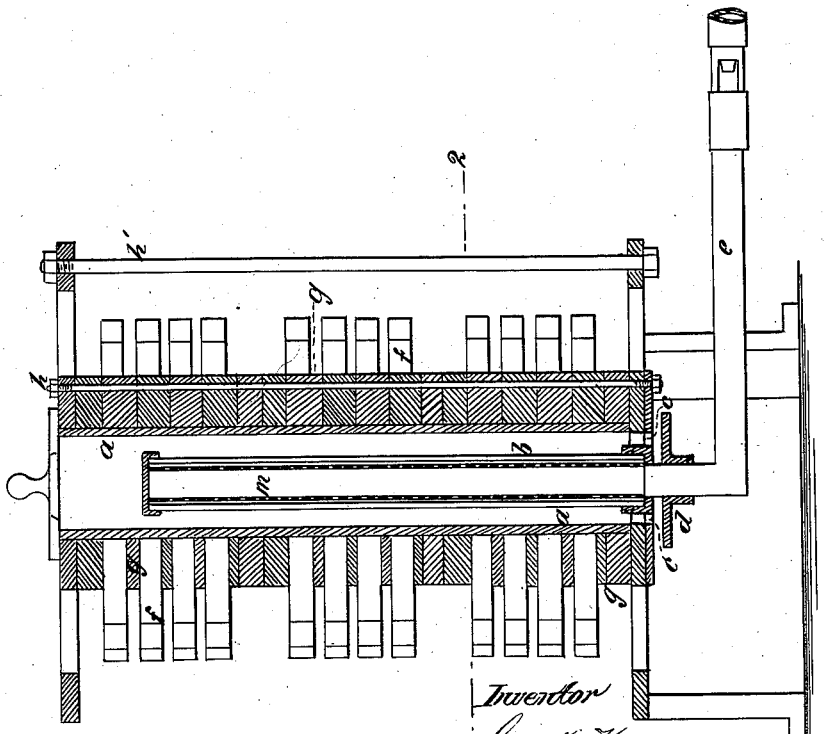

Fig. 1.

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2 Sheets—Sheet 2.

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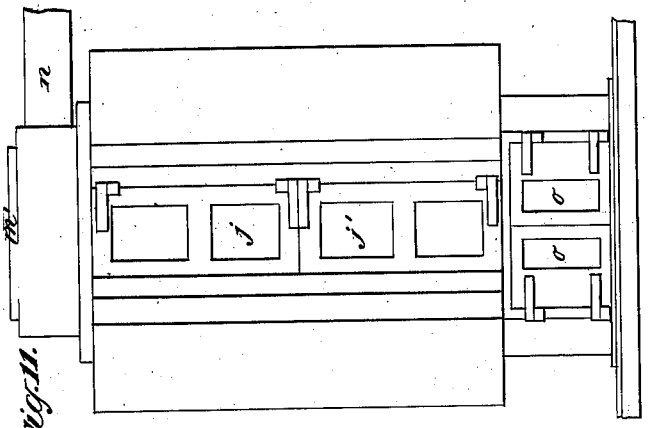

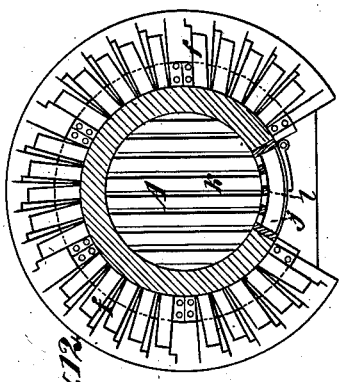

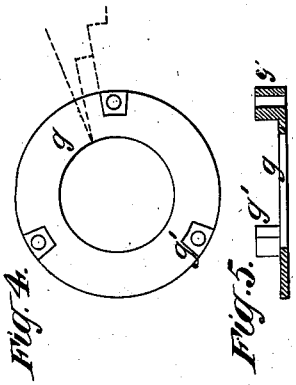

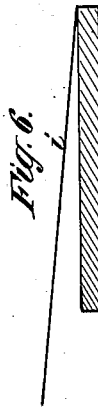

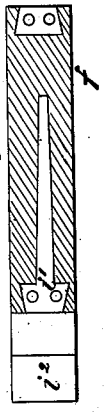

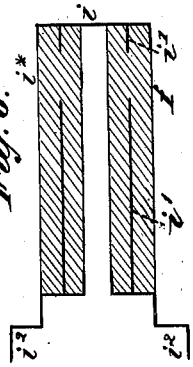

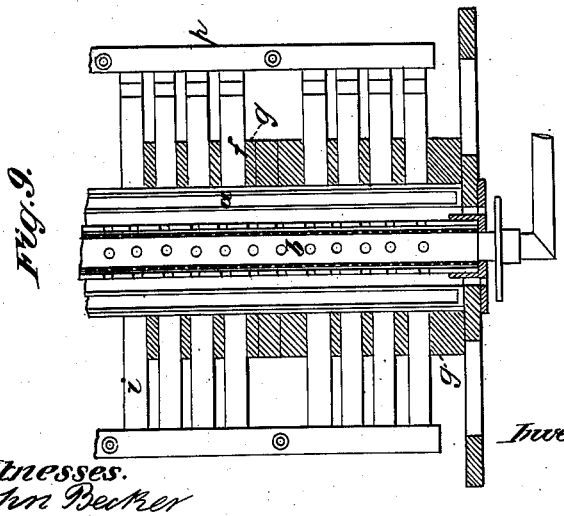

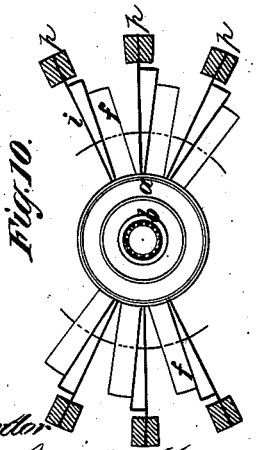

Witnesses.
John Becker
Fred. Haynes

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by their Attorneys
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UNITED STATES PATENT OFFICE.

CECIL WRAY AND LEONARD WRAY, JR., OF RAMSGATE, ENGLAND.

IMPROVEMENT IN THERMO-ELECTRIC PILES.

Specification forming part of Letters Patent No. **197,196**, dated November 13, 1877; application filed February 12, 1877.

To all whom it may concern:

Be it known that we, CECIL WRAY and LEONARD WRAY, Jr., both of Ramsgate, in the county of Kent, England, have invented certain Improvements in Thermo-Electric Piles, of which the following is a specification:

This invention of improvements in the construction of thermo-electric piles relates to that class of electrical apparatus known as "thermo-electric piles or batteries," and in which the thermo-electric bars or couples are arranged or built up in horizontal series around a heating-chamber.

All electric piles of this description hitherto constructed have certain defects, some of which are of so serious a nature as to render the piles comparatively useless for all practical purposes.

To remedy these defects is the object of the present invention, and the mode in which we effect this is shown in the accompanying drawings, in which—

Figure 1 is a vertical section of a thermo-electric pile constructed according to our invention. Fig. 2 is a plan or top view of the same, and Fig. 3 is a horizontal section of the pile, taken in the line 1 2 of Fig. 1.

In carrying out our improvements we form the heating-chamber of a casing, *a a*, preferably of a cylindrical or oval form, and made of fire-clay or other suitable material, and of any convenient diameter, and which may be made in sections, if desired. A Bunsen or other burner, *b*, is placed concentrically inside this cylindrical or other casing, so as to leave an annular space between the burner and the cylinder or casing, to which space the external air, heated or otherwise, may be admitted through openings *c c*, Fig. 1, at the lower end of the cylinder or other casing *a*.

In order to regulate the admission of air to the annular space inside the cylinder *a*, an adjustable plate, *d*, is fitted to the gas-supply pipe *e* in such a manner that it may be screwed up or down thereon; and in order to more equally distribute the gas or inflammable vapor supplied to the burner, and also to prevent the annoyance caused by the explosions which frequently occur in this class of burner on lighting or turning off the gas or vapor, we employ a wire-gauze cylinder, *m*, which we place concentrically inside the burner *b*, as shown at Fig. 1.

The thermo-electric bars or couples *f f f f* are arranged or built up radially or otherwise around the heating-chamber *a a*, so that one end of each bar or couple *f* shall abut against and be in contact with the outside of the cylindrical or other casing *a*, as shown at Figs. 1 and 3.

If preferred, the heating-chamber may be formed of metal, in which case we coat or cover the outside of the metal heating-chamber with mica or other suitable non-conducting substance, and the bars *f f* will abut against and be in contact with the mica or other suitable substance.

Instead of the cylinder *a* and burner *b*, (shown in Fig. 1,) we sometimes employ a heating-chamber made of iron or other suitable metal, and consisting of a cylindrical or other shaped double vessel, (hollow in the center,) containing a heating medium or fluid, such as oil, or a mixture of glycerine and chloride of calcium, or an easily-fusible metal, which, on being heated by burning gas or other means, becomes sufficiently hot to heat the ends of the bars or couples up to the desired point; but in this case, and whenever we use a metal to form the heating-chamber, we coat or cover the outside of the said metal tube or chamber with mica or other suitable non-conducting substance.

By constructing the apparatus in either of these manners, the injurious effects caused by the influence of the external air and the damp, and also by the direct action of the flame of the gas or vapor on the inner ends of the bars or couples, are avoided.

The next improvement relates to the mode of building up the horizontal series or layers of thermo-electric bars *f f;* and consists in placing between each series or layer of bars an annular disk, plate, or frame, *g*, of a non-conducting substance. One of these disks or plates *g* is shown in plan at Fig. 4 and in section at Fig. 5. It will be seen that each one of these disks or plates *g* is provided on one side with triangular or other shaped blocks or projections *g' g' g'*, of which there may be any convenient number. These blocks *g'* are in-

tended to support the weight of the disks, plates, or frames *g*, carrying the bars *f* above them. It will be evident that the blocks or projections *g' g'* may, if desired, be made separate from the circular disks or plates *g g*, and may be built up thereon.

If desired, the tiers or bars *f f* may be divided into or built up in sections, vertical or otherwise, containing any convenient number of tiers or layers of bars.

In Fig. 1 the pile is shown as composed of three sets of bars, and if more or less power be required for any particular purpose, a section or sections may be added to or taken from the apparatus, so as to increase or diminish the power of the pile, as desired. Thus a great saving will be effected in the transport of the apparatus and in the cost of repairing the same should any of the parts become broken or useless.

Binding-rods *h h* are made to pass through some of the blocks or projections *g' g'* on the disks or plates *g*, for the purpose of holding together the tiers of bars *f f*, forming the sections of the pile. The pile of bars thus made is placed on a foundation-plate, and is covered at top with another plate. The two plates are then connected together by vertical tie or binding rods *h' h' h'*, which will hold the several parts of the apparatus firmly together.

The next improvement relates to the form or forms given to the ends of the positive bars or plates *i i*; our objects being, first, to obtain a good metallic connection with the negative bars or plates *f f*; second, to increase the electro-motive force of the current; third, to lessen the resistance; fourth, to very greatly strengthen the bars; and fifth, to secure a continuity of current even should a bar become fractured.

Moreover, by constructing the positive bars or plates *i i* in the manner shown and hereinafter described, a large surface with but small electrical resistance is obtained, without unduly weakening the ends of the negative bars or plates *f f*. The form or forms which we give to the ends of these bars or plates *i i* as answering best to the above requirements, will be better understood by referring to Figs. 6 and 7, which represent longitudinal, vertical, and horizontal sections of one of these compound bars drawn on an enlarged scale.

It will be seen that the form or forms which we give to the ends of these bars or plates *i i* is that of a dovetail or dovetails having one or more perforations therein according to the size of the bars *f f* and to the dovetail or dovetails on the connecting-piece i^2, intended to connect the outer or cool end of the negative bar *f* to the end of the positive bar of the next pair. We provide an elongation or tongue, i^1, of varying length, according to the length of the bar *f*; but in no case should the tongue be sufficiently long to touch the dovetail at the heated end. After these positives *i i* are cut to the desired form or forms, they are coated (by electricity or otherwise) with any suitable metal or metals, for the purpose of preventing the oxidation or decomposition of the metal of which they are made, and also for obtaining a more perfect metallic connection between the positive and negative bars; but we do not bind ourselves always to employ this coating of the positive bars. The bars or plates may be made of any of the thermo-electric series of metals, substances, or alloys, and may also be constructed of any desired form or size.

The positive and negative bars or plates are connected together by casting the latter on the former in suitable molds.

We would here remark that it should be clearly understood that the terms "positive" and "negative" will naturally interchange or vary, according to the metals employed and their relative position (electrically) to each other, as is well known.

When the metals, substances, or alloys of which the bars are made are difficult to unite properly with each other, such as antimony and bismuth, we cast the positive and negative bars in pairs on a piece of iron or other suitable metal which will serve to connect them and carry the current. This form of compound bar is shown at Fig. 8. The positive bar i^x is made of a brittle positive metal—say, bismuth—and the negative bar *f* is made of a brittle negative metal—say, antimony—and the two are connected together, as also the several pairs, by means of the thin iron or other metal plate *i i*, made with dovetails and elongated tails i^1 i^1, which are cast into the thick bars, as shown at Figs. 6, 7, and 8.

In heating the pile of bars in these machines, coke or other fuel may be used instead of gas, in which cases some of the parts will necessarily be modified in construction to suit the fuel to be so employed.

Fig. 11 is an external elevation of an apparatus which is intended to be heated by means of coke or other solid fuel which is capable of being burned in a suitable fire-place provided with fire-bars. Fig. 12 is a horizontal section of the same.

When the thermo-electric pile is intended to be heated by coke, charcoal, coal, or other suitable fuel, we construct the heating-chamber, by preference, of fire-clay or other refractory material, either in one piece or in sections, and of any desired form or size. In the drawing this chamber A is of a cylindrical form. Should this chamber be constructed of such a refractory material as iron or other metal, an insulating material is interposed between it and the ends of the bars—that is to say, the metal may be surrounded by an envelope of of talc or other suitable substance. Around and abutting against the outer sides of this furnace or heated chamber A the thermo-electric bars or couples *f f* are arranged radially or otherwise in tiers or in sections, as before mentioned, so that they may receive the heat given out by the refractory material while the fire is burning.

An entirely novel and distinctive feature in this particular apparatus is the manner in

which the fire-chamber A is constructed. It is provided with a vertical opening which extends from top to bottom, and is provided with a door or doors, *j j'*, for obtaining access to the interior of the fire-place and ascertaining from time to time the condition of the fire, and for regulating the same. These doors serve also for facilitating the removal of clinkers, and for general stoking purposes.

The fire-chamber is also provided with fire or grate bars *k*, as well as with vertical bars *l*, at the vertical opening, and some of these bars are made movable. The fire-chamber A is provided likewise with a lid or cover, *m'*, at the top, and chimney *n* to carry off the products of combustion and smoke.

The doors *j j'* may be made of iron lined with fire-clay or some similar material, and some of the panels of the doors may have openings made therein and covered with talc, so that the attendant may be enabled to see the state of the fire and how the combustion is proceeding, without opening the door. The ash-pit is also provided with doors *o o*.

It will be seen on referring to Fig. 12 that the bars *f f* are divided into five vertical sets arranged radially round the fire-place A. Each layer of bars of which these vertical sets are composed is divided from those above and below it by means of segmental pieces *g*, made of earthenware or some other suitable non-conducting material, and at each end of these segments are the blocks or projections *g' g'*, for supporting the segmental piece immediately above, so as to take the weight off the bars *f f*, as in the former instance. Each vertical set of bars is held together by means of pairs of rods, which pass through the blocks *g'*, as at *h* in Fig. 1, so that any of the vertical sets of bars can be removed without interfering with the others, and the whole apparatus is held together between top and bottom plates, which are secured together by the binding or tie rods *h' h'*.

The arrangement of apparatus shown at Figs. 11 and 12 will be found convenient when great power is required, and when the apparatus is intended to be stationary; but the arrangement shown at Figs. 1 and 2 will be found more convenient when only a moderate power is required, and it can be moved with greater facility and less liability to derangement than the other. In some cases, as when it becomes necessary to remove the apparatus from one place to another, it is desirable to support and hold steady the outer ends of the thin positive bars *i i*. This is effected by connecting them to wooden uprights *p p*, as shown at Figs. 9 and 10. In these figures the outer ends of the thin metal bars *i i* are shown as being clamped or nipped between two wooden bars, which are drawn together by means of short screw-bolts; but, if preferred, the projecting ends of the thin positive bars *i i* may be temporarily attached to the sides of wooden uprights by means of pins, nails, or screws.

Having now described our invention, and having explained the manner of carrying the same into effect, we claim—

1. The combination of the cylindrical or other shaped casing *a*, made of or coated with earthenware or other suitable insulating material, and constituting a central cylindrical or other suitably-shaped heating-chamber, with any number of thermo-electric bars *f* arranged radially around it in such a manner that their inner ends will abut against and be in direct contact with the heated surface of the central heating-chamber or its insulating envelope, as and for the purpose substantially as herein set forth.

2. The central cylindrical or other suitably-formed heating-chamber, constructed with a vertical opening, which is closed by doors *j j*, as shown at Figs. 11 and 12, when the said chamber is heated by means of solid fuel, such as charcoal, coal, or coke.

3. The combination of a number of thermo-electric bars in horizontal layers or vertical series, with horizontal insulating disks or plates between them, and provided with blocks or projections to support the superincumbent weight, the whole being arranged and bound together as herein set forth, so that a thermo-electric pile may be formed of any convenient number of sections, according to the required power, instead of being formed of a large number of loose or separate thermo-electric bars, as heretofore.

4. The combination, with the separating or insulating disks, plates, or frames *g*, of the blocks *g'*, which may be either fixed on or form part of the said disks, plates, or frames, or may be detached therefrom, and separately built up thereon, for the purpose of supporting the superincumbent weight, and relieving the thermo-electric bars *f* from undue pressure, as shown and described in reference to Figs. 4 and 5.

5. The combination, with the negative bar *f*, of a positive bar, *i*, provided with an enlarged or dovetailed end, as and for the purpose herein set forth.

6. The combination, with the negative bars *f*, of connecting-pieces i^2, provided with elongated tails or ends, which are inserted in the negative bars, as and for the purposes herein set forth and described in reference to Figs. 6, 7, and 8.

Dated the 13th day of December, 1876.

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