No. 775,187. PATENTED NOV. 15, 1904.

J. A. LYONS & E. C. BROADWELL.

THERMOPILE.

APPLICATION FILED DEC. 9, 1903.

NO MODEL.

Fig. 1.

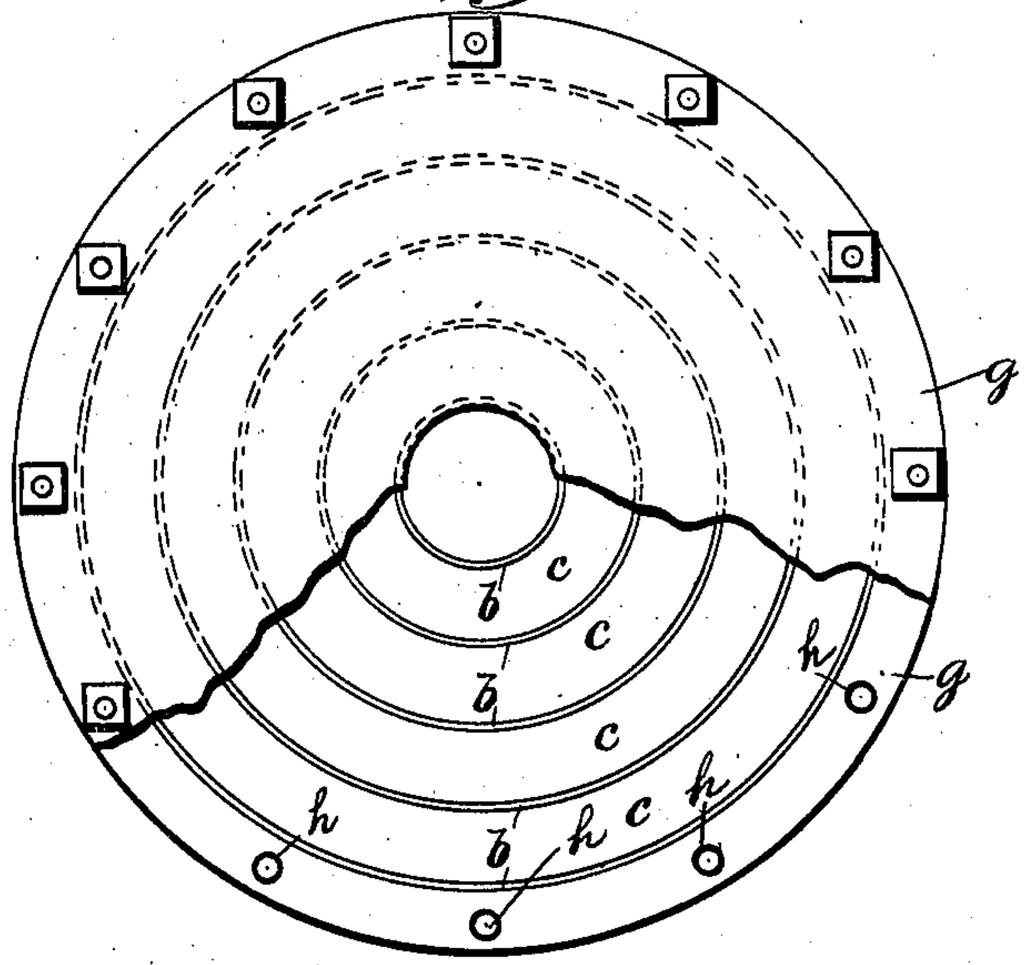


Fig. 2.

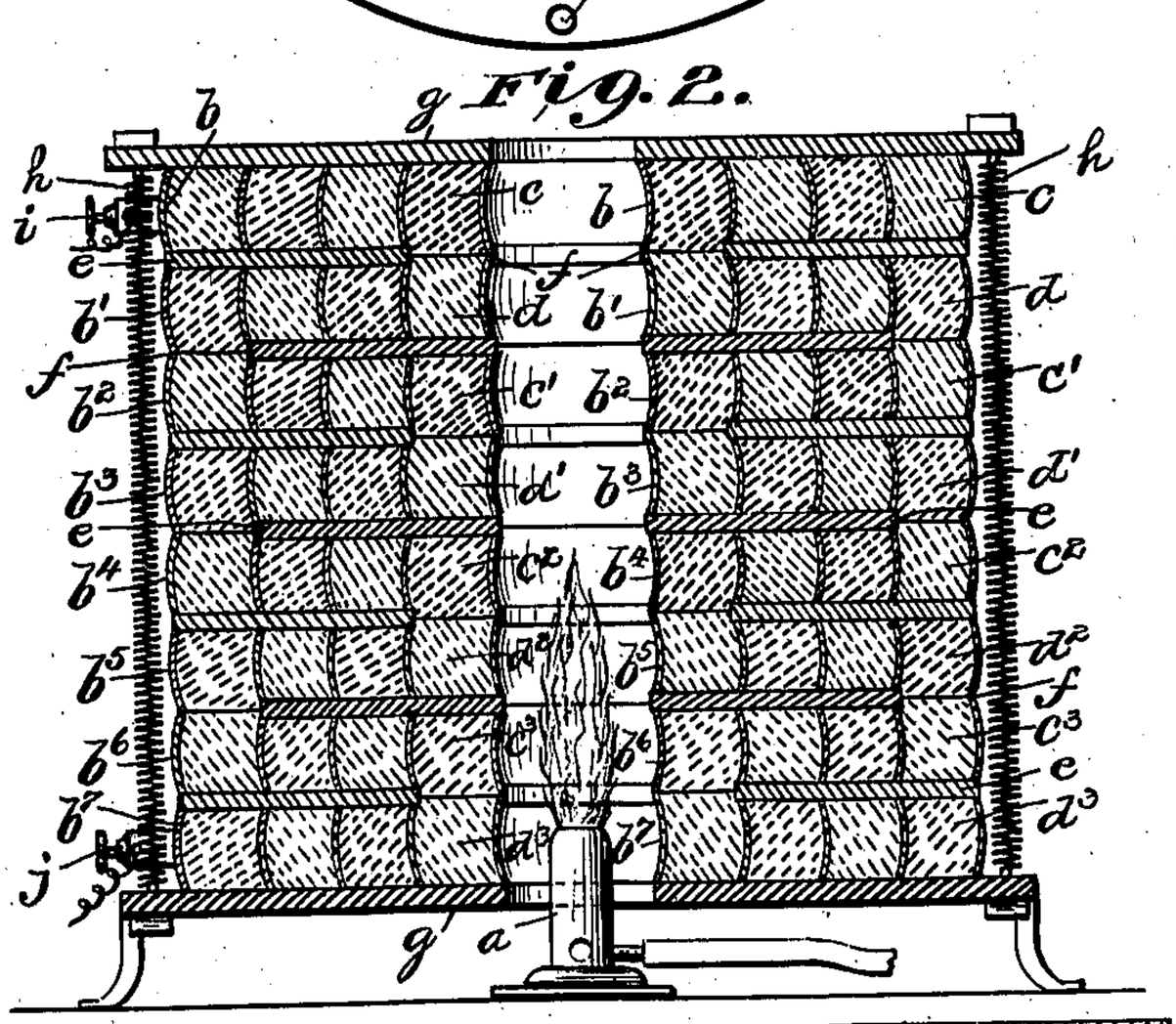


Fig. 3.

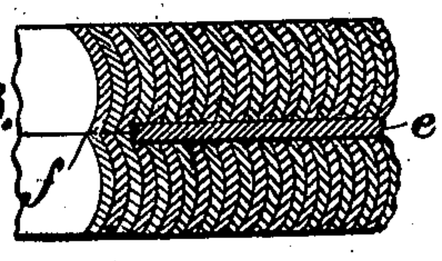
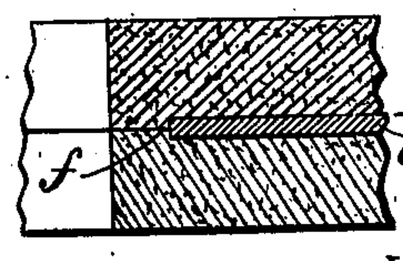


Fig. 4.



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UNITED STATES PATENT OFFICE.

JOHN A. LYONS AND EDWARD C. BROADWELL, OF CHICAGO, ILLINOIS.

THERMOPILE.

SPECIFICATION forming part of Letters Patent No. 775,187, dated November 15, 1904.

Application filed December 9, 1903. Serial No. 184,464. (No model.)

To all whom it may concern:

Be it known that we, JOHN A. LYONS and EDWARD C. BROADWELL, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Thermopiles, of which the following is a specification.

Our invention relates to thermopiles, and more especially to an assembly of thermopile elements of such properties that advantage may be taken of the retardation of heat conduction therethrough and opposition to radiation away from the source of heat, whereby the efficiency of the couples may be increased in the matter of generating electrical power. Generally speaking, this increase in efficiency is gained by forming the elements of the thermopile of thermo-electrically-generative substances having to a great degree the property of opposing heat conduction therethrough and of further aiding this opposition to heat conduction by combining with such substance in said elements another substance which tends to reflect back and concentrate at one point all heat which is carried through by conduction—that is, when heat is applied at one end of a thermo-electric couple made of our improved combination of substances the tendency is to continually force such heat back through the elements of the couple and to concentrate it at the place where applied.

The principle of our invention consists in the retardation and concentration of heat at one end of the elements, whereby a great difference in temperature between the inner and outer ends will be maintained, so as to thereby effect high difference in electrical potential, with economy of heat.

To this end in carrying out our invention we use as the positive and negative elements of a thermopile a system of heat-reflecting bodies in combination with a pervious material, which is preferably a loosely-compressed pulverulent substance, or, if desired, either the heat-reflecting bodies or the pervious substance may be used without the other and the advantages above stated gained.

For a full description of the invention and the merits thereof and also to acquire a knowledge of the details of construction of the means for effecting the result reference is to be had to the following description and accompanying drawings.

While the essential and characteristic features of the invention are susceptible of modification, still the preferred embodiment thereof is illustrated in the accompanying drawings, in which—

Figure 1 is a plan view of the thermopile assembly with the upper collar partially broken away. Fig. 2 is a vertical section through the center of Fig. 1, and Figs. 3 and 4 are respectively portions of a thermopile-couple using only the heat-reflecting bodies and the compressed porous plates or bars.

Corresponding and like parts are referred to in the following description and indicated in the views of the drawings by the same reference characters.

It should be noted that all elements of a similar nature in one layer of the thermopile are designated by the same reference character, the various series of characters designating the series of layers.

Referring to the drawings, *a* represents any source of heat, as a Bunsen burner, which is placed at the center of the thermopile assembly. This assembly is composed of the heat-reflecting bodies and the pervious thermo-electrically-generative bars, hereinbefore mentioned, combined in the following manner: The heat-reflecting bodies are preferably of electrically generative and conductive metal and are represented at b b' b^2, &c., and are preferably placed in a number of layers of approximately concentric rings or bars, although any configuration other than circular may readily be employed. These rings being approximately concentric are therefore in the form and perform the functions of walls or partitions separated from each other by a space of any suitable dimensions, for the purpose to be hereinafter specified. The inwardly-directed surfaces of these sets of partitions or heat-reflecting bodies b b' b^2, &c., are preferably concave transversely, as shown more particularly by Fig. 2, and are also preferably highly polished or treated in some other manner which will enable them to re-

flect any heat thrown against them. Their outwardly-directed surfaces are preferably left convex transversely, and their diathermic and heat-absorbing properties are aided in any suitable manner, as by painting with lampblack or other suitable substance. If desired, these outwardly-directed surfaces may be made plain or angular in configuration without departing from the scope and spirit of our invention. It is thus seen that as heat radiates from the burner *a* outward through the thermopile elements it is continually forced back toward its source by repeated reflections from the heat-reflecting concave surfaces provided by the inner faces of the sets of approximately concentric rings or partitions *b b' b²*, &c., and, furthermore, their convex and darkened outward faces also continually tend to absorb and help force centerward the transmitted heat, so that the difference in temperature between the opposite ends of the thermo-electric couples is by this means increased to a large extent.

It has been determined by experiment and is well known that a given substance when in a pervious condition, as when pulverized and loosely packed or compressed, while still possessing from one-fourth to even one-half of the electrical conductivity of the same material when in the compact and solid state at the same time increases from ten to three hundred times its resistance to thermage or the heat quantity transferred by conduction through solids. To the end that this fact may be taken advantage of we fill the spaces between the concentric rings or partitions formed by the heat-reflecting bodies in alternate layers, as at *c c' c²*, &c., and *d d' d²*, &c., with such negative and positive pervious electrically-conductive and thermally-resistive substances as may be chosen, capable of generating an electrical potential during the transformation of heat into electricity. This pervious substance may be either pulverulent material loosely pressed into the spaces between the approximately concentric rings, or such material may be first hydraulically compressed into firm rings or sections of suitable form before being fitted into their places, in which case to gain the advantages of resistance to thermage it may be first mixed with a suitable powder, such as ammonic chlorid in proper proportion, and this sal-ammoniac afterward dissolved or volatized out when the material has been pressed into shape, thus leaving it porous, and therefore a very poor heat conductor, but still an efficient source of potential and amperage and suitable for use as a thermo-electric element in the capacity as above described. The positive elements are denoted by C C' C², &c., and they are preferably composed of finely-divided copper, each particle thereof being electroplated with bismuth. The negative elements are denoted by *d d' d²*, &c., and may be composed of cuprous sulfid having alloyed therewith about eighteen per cent. of metallic antimony for the purpose of increasing the electrical conductivity. The ends of the elements of the couples are held in electrical contact, and the current of electricity is generated, as in the usual way in thermopiles, by the difference in electrical potential created between the elements by difference in temperature at the ends of the elements. Each ring or partition *b b' b²*, &c., is composed of the same material as that of the respective bar or element in which it is located. These rings are plated with bismuth, and on their outer surfaces they have an almost imponderable coating of platinum or iridium black. Between each of these layers composed of heat-reflecting bodies and pervious material and arranged horizontally are strips *e* of insulating and heat-resisting material, as asbestos, which are so placed as to leave alternate ends of the pairs or couples of thermo-electric elements in contact, as at *f* and as shown more particularly by Fig. 2. At both top and bottom of the apparatus is placed a collar or annulus *g*, of heavy glass, porcelain, or other suitable non-conducting material, which is of sufficient width to overlap both the inner and outer bands or circles of reflecting-bodies *b b' b²*, &c. These collars are drawn tightly together, and efficient contact is insured between the contiguous positive and negative thermo-electric elements by any efficient means, as coiled springs *h*, of sufficient strength and suitable length, which may be spaced at intervals around the circumference of the collars or placed in any other convenient position.

The ordinary electrical binding-posts, to which are joined the wires for the circuit, may be attached at any convenient point at *i* and *j*.

As hereinbefore described, it will be noted that the elements comprising the couples of the thermopile are made compound—*i. e.*, each positive and each negative element is composed of approximately concentric collars or annuli formed of the heat-reflecting bodies and the thermo-electrically-generative bars or plates of pervious substances alternately disposed with relation to one another; but it has been found that either one of these elements may be used without the other and good results may be obtained.

Fig. 3 illustrates a portion of a thermopile wherein only the heat-reflecting bodies in the form of bars or walls are used in forming the thermo-electric couples, and Fig. 4 illustrates a portion of a thermopile using only the compressed and porous bars in its assembly, as hereinbefore described.

Obviously our invention may be used in widely-varying forms, and some features thereof may be used without others.

Therefore, without limiting ourselves to the construction shown and described nor enumerating equivalents, we claim, and de-

sire to obtain by Letters Patent, the following:

1. In a thermopile, a source of heat and a thermo-electric couple adjacent thereto, in combination with means within said couple for concentrating the heat at one end thereof, substantially as described.

2. In a thermopile, a source of heat, and a thermo-electric couple formed of a pervious substance adjacent thereto, whereby the heat conduction through said couple is opposed and the heat concentrated at one end thereof, substantially as described.

3. In a thermopile, a source of heat, a thermo-electric couple adjacent thereto formed of a pervious substance whereby the heat conduction through said couple is opposed and the heat concentrated at one end thereof, in combination with separate means for further aiding such concentration, substantially as described.

4. In a thermopile, a source of heat, a series of thermo-electric couples suitably assembled about said source of heat, each of said couples formed of a pervious substance whereby the heat conduction through said couple is opposed and the heat concentrated at one end thereof, in combination with separate means for further aiding such concentration, substantially as described.

5. In a thermopile, pervious plates or bars of thermo-electrically-generative properties composing the positive and negative elements, substantially as described.

6. In a thermopile, compressed pulverulent material of thermo-electrically-generative properties composing the positive and negative elements, substantially as described.

7. In a thermopile, bars or walls of thermo-electrically-generative properties composing the positive and negative elements, each of said bars or walls provided with a heat-reflecting surface, substantially as described.

8. In a thermopile, bars or walls of thermo-electrically-generative properties composing the positive and negative elements, each of said bars or walls provided with a heat-absorbing surface, substantially as described.

9. In a thermopile, bars or walls of thermo-electrically-generative properties composing the positive and negative elements, each of said bars or walls provided with an inner heat-reflecting surface and an outer heat-absorbing surface, substantially as described.

10. In a thermopile, positive and negative elements of thermo-electrically-generative properties, each composed of a plurality of contiguous bars or walls each one of which is provided with an inner heat-reflecting surface and an outer heat-absorbing surface, substantially as described.

11. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances, each composed of a bar or wall provided with a heat-reflecting surface in combination with a pervious plate or bar contiguous thereto, substantially as described.

12. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances, each composed of a plurality of bars or walls spaced apart, each one of which is provided with a heat-reflecting surface in combination with pervious plates or bars between said bars or walls and contiguous thereto, substantially as described.

13. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances each composed of a plurality of bars or walls spaced apart and each of which is provided with a heat-reflecting surface in combination with compressed pulverulent material between said bars or walls and contiguous thereto, substantially as described.

14. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances, each composed of a plurality of bars or walls each one of which is provided with an inner heat-reflecting surface and an outer heat-absorbing surface in combination with compressed pulverulent material between said bars or walls and contiguous thereto, substantially as described.

15. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances, each composed of a plurality of bars or walls each one of which is provided with a concave, polished inner surface and a convex, darkened outer surface in combination with loosely-compressed pulverulent material between said bars or walls and contiguous thereto, substantially as described.

16. A thermopile having positive and negative elements consisting of thermo-electrically-generative substances, each composed of a plurality of concentric bars or walls each one of which is provided with a concave, polished inner surface and a convex, darkened outer surface in combination with pervious plates or bars between said bars or walls and contiguous thereto, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

JOHN A. LYONS.
EDWARD C. BROADWELL.

Witnesses:
ARTHUR STUART,
ELMER W. BRANDEBERRY.