Aug. 21, 1951 T. VOLOCHINE 2,565,105

THERMOELECTRIC RADIATION RECEIVER

Filed July 11, 1946

Fig. 1

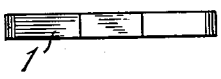


Fig. 2



Fig. 3

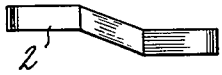


Fig. 4

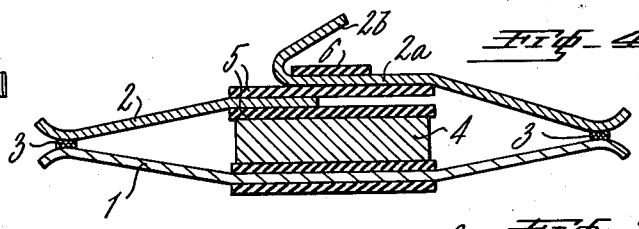


Fig. 5

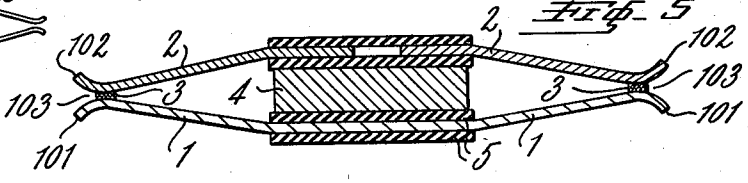


Fig. 6

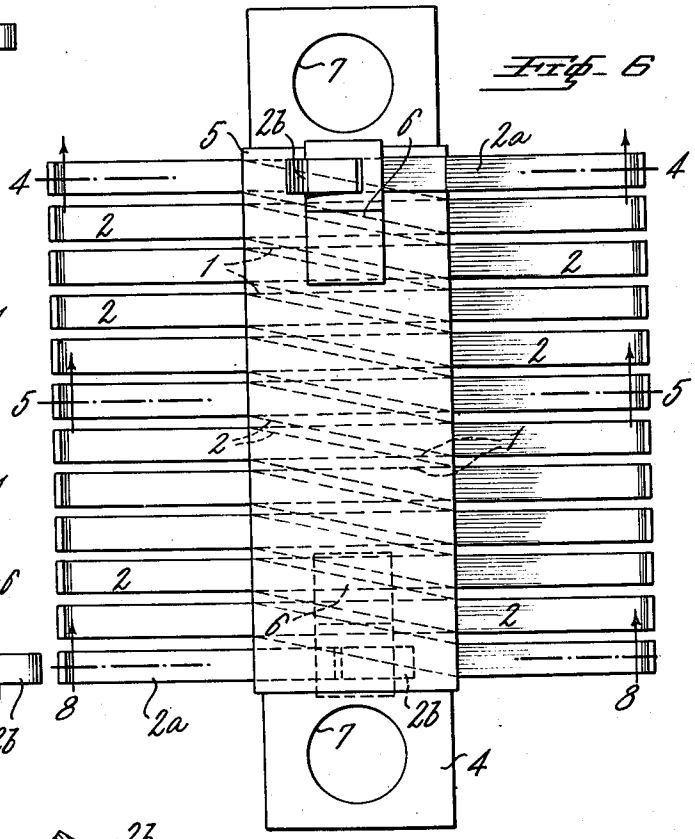


Fig. 7

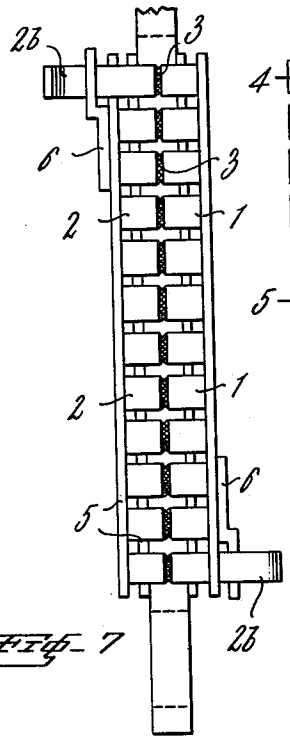
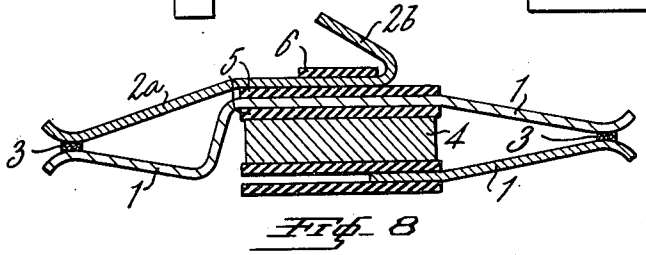


Fig. 8



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UNITED STATES PATENT OFFICE

2,565,105

THERMOELECTRIC RADIATION RECEIVER

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In France July 12, 1945

4 Claims. (Cl. 136—4)

1

The present invention relates to thermo-electric apparatus for the measurement of radiant thermic energy and for a comparison of two radiant thermic energies which energy or energies may be derived either from a source of thermal radiation or from a source of other, e. g. electric, energy which is transformed into radiant thermic energy.

In apparatus of this type, the most difficult problem is that of providing a very great number of active junctions per unit area of the working or energy receiving surface. To solve this problem, many methods and apparatus have been already proposed which, however, have not proved themselves entirely satisfactory.

A solution to this problem has also been suggested in my prior U. S. Patent No. 2,305,396, granted December 15, 1942, wherein there has been disclosed an apparatus giving results superior to those obtainable with earlier devices. This patent is directed to a metallic radiation receiver, a characteristic feature of which is the provision of a large number of wedge-shaped slots on each of two oppositely disposed radiation absorbing surfaces, the walls of each slot enclosing an angle sufficiently acute to afford substantially complete absorption of any thermic radiation falling into the slots in a direction perpendicular to these surfaces; junction points of a number of thermo-couples are disposed either between or within these slots so as to have their temperatures raised by the radiation thus absorbed, thereby giving rise to a potential difference between the junction points located at the exposed and at the sheltered receiver surface, respectively.

The general object of the present invention is to provide means for more effectively utilizing the principles disclosed in my above-identified prior patent with a view to increasing the number of active junctions per unit area, simplifying the manufacture and assembly of an apparatus of this character and further augmenting the proportion of absorbed to reflected radiation so as to approach the characteristics of a perfectly black body.

Although the invention contemplates the provision of an apparatus broadly similar to that disclosed in my above-identified patent, comprising preferably a number of thermo-elements mounted side by side in a suitable housing, it is to be noted that the present improvement resides solely in a modification of the structure of the individual thermo-elements, hence the following detailed description will be confined to a single

2

thermo-element with only passing reference to the overall arrangement.

The invention will be better understood by reference to the accompanying drawing showing, solely by way of example, a thermo-element embodying the present improvement.

In the drawing:

Fig. 1 is a plan view of a metal strip forming part of a thermo-element according to the invention;

Fig. 2 is a side elevation of a single thermo-couple consisting of two strips including the one shown in Fig. 1;

Fig. 3 is a plan view of the second metal strip forming part of the thermo-couple of Fig. 2;

Fig. 4 is a section taken along line 4—4 of Fig. 6, showing an end couple of a thermo-element according to the invention;

Fig. 5 is a section taken along line 5—5 of Fig. 6, showing an intermediate couple of a thermo-element according to the invention;

Fig. 6 is a plan view of a complete thermo-element according to the invention;

Fig. 7 is an end view of the thermo-element shown in Fig. 6; and

Fig. 8 is a section taken along line 8—8 of Fig. 6, showing the other end couple of the thermo-element illustrated.

The thermo-element according to the invention is constituted essentially by a flat, elongated supporting member and two series of extremely fine and thin strips of two suitable metals or alloys, such as, for example, manganin and constantan, these strips being arranged perpendicular to the longitudinal axis of the supporting member in adjacent and spaced relation to one another. In the preferred embodiment about to be described, the strips of one series are rectilinear while the strips of the other series are bent in such manner as to interconnect opposite ends, respectively, of successive rectilinear strips in staggered series relation; by uniting (e. g. welding) corresponding extremities of these two series of strips there is thus provided a continuous bimetallic band of great length whose junction points are located on two straight lines extending substantially parallel to and lengthwise of the sides of the supporting member.

This construction permits to provide a rectilinear thermo-element having an exceedingly high number of active junctions and, by associating several such thermo-elements placed side by side, essentially in the manner disclosed in my prior Patent No. 2,305,396, to obtain in a surface of a thermopile a very great number of

active junctions per unit area. In this manner it is easily possible to provide as many as twenty-four junctions of a surface of one square millimeter.

Another feature of the present invention resides in the simplicity with which thermo-elements having a great number of active junctions can be manufactured. In fact, it is sufficient to secure two series of small, fine and thin strips of different metals to a narrow, elongated support, preferably a metal plate covered with suitable insulating material such as, for example, strips of mica, and to weld together the aligned extremities of corresponding strips along two straight lines as indicated above.

Referring now to the drawing for a more detailed description of the invention, there has been shown a thermo-element comprising a series of rectilinear strips 1 and a series of cooperating strips 2 welded thereto in staggered relation as indicated at 3. The strips 1 and 2 are secured at opposite sides to a supporting member 4 which is formed by an elongated plate provided at its end with mounting apertures 7. The strips 2 are laterally bent and comprise each an inclined central portion and two end portions offset from but parallel to each other, these end portions extending substantially perpendicular to the principal axis of the supporting member 4 and parallel to the strips 1 located on the other side thereof.

With this arrangement the opposite extremities of each bent strip 2 face the right-hand end of one and the left-hand end of another of two adjacent rectilinear strips 1, respectively. The end portions of the strips 1 and 2 are bent toward each other to make contact at the junction points 3, each strip 1 and 2 terminating, however, in two outwardly flared portions 101, 102, respectively, which extend past the respective junction points 3. It will be seen that corresponding terminal portions 101, 102, co-operate to form V-shaped slots or recesses 103 of such configuration as to afford substantially complete absorption of radiant energy impinging in a direction parallel to the plane which bisects the angle at the apex of the V, this angle being sufficiently acute to insure this result. It will thus be apparent that the slots 103 function in essentially the same manner as the recesses 3 or 4 shown in my prior Patent No. 2,305,396.

By joining the strips 1 and 2 together in the manner described, there is provided a continuous bimetallic conductor which surrounds the supporting member 4 in helical fashion. Strips 1 may be made of manganin and strips 2 of constantan, or vice versa.

As will be apparent from the drawing, the welded junctions 3 are located on two straight lines whereby the welding operation can be performed, once the strips 1 and 2 have been fixed on the supporting member 4, in a simple and expeditious manner. At 5 there are indicated the insulating elements, such as thin plates of mica, which are interposed between the strips and the supporting member 4. The outermost ones of the strips 2, designated 2a, are bent over to form terminal tabs 2b and are secured in position by lugs 6 provided on opposite sides of the supporting member 4, the terminal tabs 2b serving to connect the thermo-element of Figs. 6 and 7 in an electric circuit (not shown).

The supporting member 4 may be made of any suitable material without departing from the spirit of the invention. Preferably, however, it

will be made of a metal having good heat conducting characteristics, such as copper, so that the heat received by the weld or solder joints 3 on one side of the thermo-element, when exposed to radiation, is rapidly distributed over or diffused in metallic supporting member 4 and in the metallic frame (not shown) of the thermopile to which the support 4 is connected at its ends through the mounting holes 7, the heat being at the same time transmitted to the junction points positioned on the other side or face of the thermo-element so as to establish and maintain a stable-state condition.

By placing side by side and securing together linear thermo-elements of the above nature, it is possible to obtain in a very simple manner an extremely large number of active junctions per unit area of the working surface of the resulting thermopile.

It will be understood from the foregoing that in such a thermopile a large portion of the radiation impinging upon one of its active surfaces will be received by the V-shaped slots 103. If the angle at the apex of these slots is small, e. g. similar to the corresponding angles of recesses 3 and 4 in my prior patent, above identified, where its magnitude has been given as of the order of one degree, then it can be shown mathematically that more than 99% of all the radiation impinging at right angles to the receiver surface (thus horizontally as viewed in Fig. 6 of the accompanying drawing) will be absorbed and will thus serve to raise the temperature of the adjacent junction point 3.

It may also be mentioned that such radiation as passes between two superposed thermo-elements of the character herein disclosed, thereby reaching the outer surfaces of the bent extremities of strips 1 and 2, will be similarly absorbed in the spaces defined between the strips 2 of a lower and the strips 1 of the next higher thermo-element, with the outer surfaces of the flared portions 101 and 102 intercepting a considerable portion of whatever energy is reflected out of these spaces.

The invention provides thus a new method and an improved construction of thermo-couples permitting to obtain a great number of active junctions on a relatively reduced working surface. Such method and construction permit also to produce thermo-couples in an extremely simple manner.

It is understood that the invention is not limited to the specific embodiment herein described and illustrated and that various changes in the form and the relative arrangement of the parts can be introduced therein without departing from the spirit of the invention.

For instance, the length of the support as well as the length and the width of the strips as well as the number thereof, that is the number of thermo-elements, may be chosen to suit different conditions without departing from the spirit of the invention. Similarly the form of the extremities of the strips and the exact position of the lines of welded junctions may be equally changed.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. In an apparatus for measuring radiant thermic energy, a radiation receiver including a thermopile provided with two oppositely disposed radiation absorbing surfaces, said thermopile comprising a plurality of thermo-elements each constituted by two series of bands made of strips

of different metals, the points of junction of said strips being alternately disposed on said absorbing surfaces, the extremities of said strips being provided with extensions projecting beyond their points of junction and flaring outwardly thereby providing slots between said extensions which are V-shaped in section, said points of junction forming the bottoms of said slots, said extensions enclosing an angle sufficiently acute to afford substantially complete absorption of incident thermic radiation.

2. In a radiation receiver having two oppositely disposed absorbing surfaces, the combination of an elongated member of good heat conductivity, with a thermo-element constituted by two series of strips of different metals joined together at junction points lying alternately on said absorbing surfaces, said strips in their totality forming a band encircling said member in helical fashion, said strips being provided with outwardly flared portions extending beyond said junction joints in pairs defining V-shaped slots, the flared portions of each said pairs enclosing an angle sufficiently acute to afford substantially complete absorption of incident thermic radiation.

3. In a radiation receiver having two oppositely disposed radiation absorbing surfaces, the combination of an elongated member of good heat conductivity, with a thermo-element constituted by two series of strips of different metals joined together at junction points lying alternately on said absorbing surfaces, the strips of one series extending at right angles to the principal axis of said member, the strips of the other series comprising each an inclined central portion and two relatively offset outer portions parallel to the strips of said one series and extending toward respective ones of adjacent strips of said one series to which they are joined, all of said strips thereby forming a band of zig-zag shape, said band

encircling said member in helical fashion, said strips being provided with outwardly flared portions extending beyond said junction points in pairs defining V-shaped slots, the flared portions of each of said pairs enclosing an angle sufficiently acute to afford substantially complete absorption of incident thermic radiation.

4. In a radiation receiver having two oppositely disposed radiation absorbing surfaces, the combination of a rectangular member of good heat conductivity, with a thermo-element constituted by two series of strips of different metals joined together at junction points lying alternately on said absorbing surfaces, said strips in their totality forming a band encircling said member in helical fashion, said junction points lying in a plane of symmetry of said member which is parallel to two major surfaces of said member, said strips being provided with outwardly flared portions extending beyond said junction points in pairs defining V-shaped slots, the flared portions of each of said pairs enclosing an angle sufficiently acute to afford substantially complete absorption of incident thermic radiation.

THEODORE VOLOCHINE.

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