March 9, 1954 J. TURCK 2,671,818

THERMOPILE

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Fig. 1

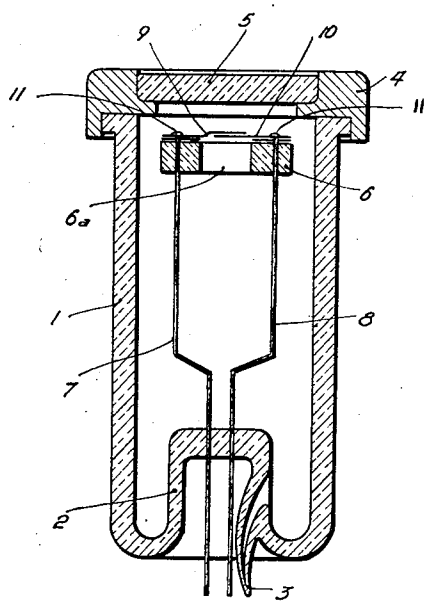

Fig. 2

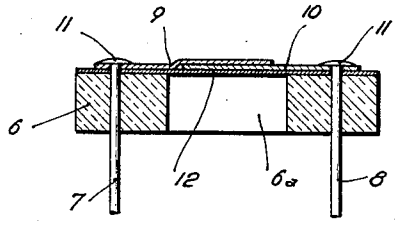

Fig. 3

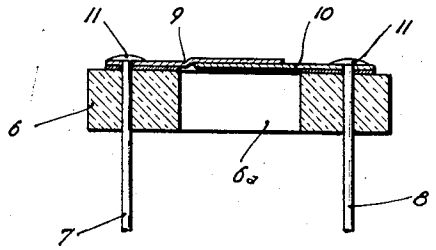

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Fig. 4

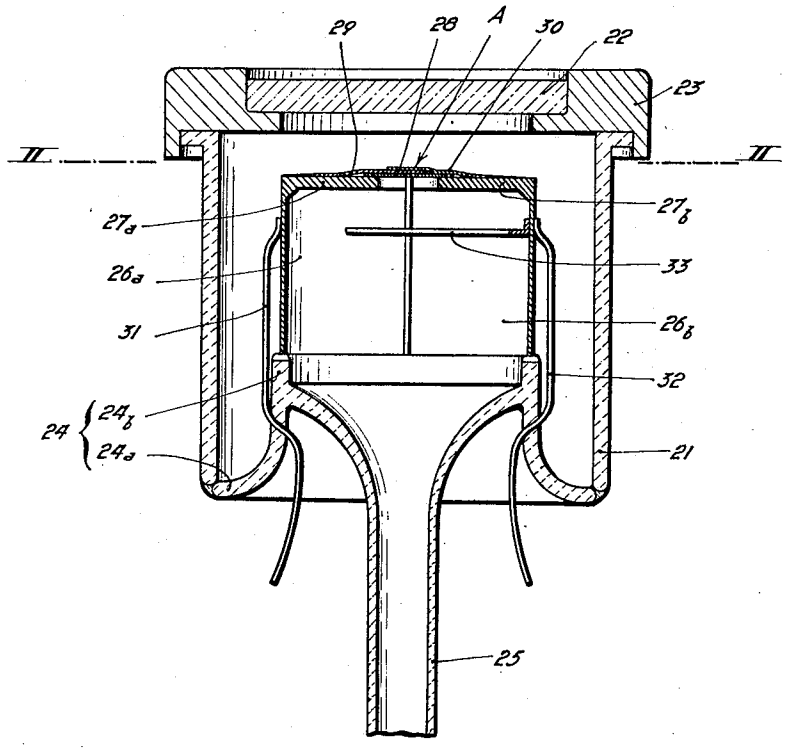
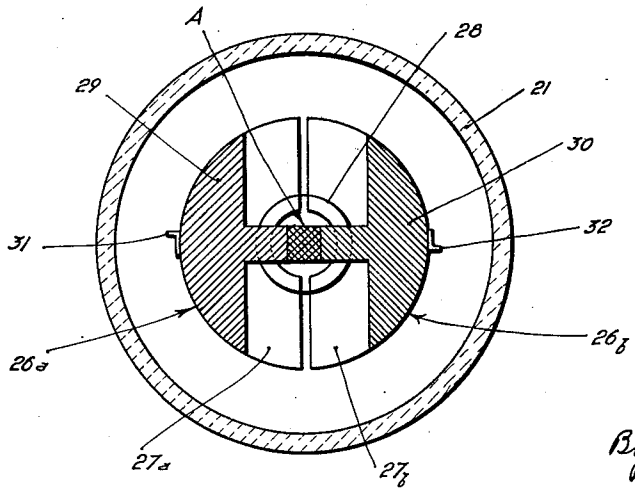


Fig. 5



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Patented Mar. 9, 1954 2,671,818

UNITED STATES PATENT OFFICE

2,671,818

THERMOPILE

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Application September 18, 1951, Serial No. 247,183

Claims priority, application France
September 20, 1950

8 Claims. (Cl. 136—4)

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This invention relates to thermopiles in which the thermo-couple is mounted on a rigid support with a central orifice, in the axis of which is the hot junction of the thermo-couple.

The elements of the thermo-couple in thermo piles of this known type, including the hot junction, rest permanently on a thin film, of synthetic resin for instance, which, in its turn, rests on the support with a central orifice.

The invention covers improvements in this type of apparatus, the purpose of which is to reduce the response time of the pile, to stabilize its operation, to decrease its electric resistance, decrease the heating of the "cold junctions" of the thermo-couple, etc.

One of these improvements in thermopiles of the above-mentioned type is characterized particularly by the fact that the thermo-couple comprises two substantially lamellar branches and is maintained solely by the free ends of said branches on the support with a central orifice, so that the hot junction, properly so-called, of the thermo-couple presents a large surface and does not come into contact with any foreign substance. In such an embodiment the inertia of the couple is considerably reduced and the couple has a low electric resistance.

In order to make such a thermo-couple, of which only those parts situated outside of the hot junction rest on the support with a central orifice, a process is used, according to the invention, which is particularly characterized by the fact that the elements of the thermo-couple are applied on a temporary supporting surface resting on a support with a central hole, and which is eliminated from the said surface after the thermocouple has been brought about, so that the hot junction is left without any support.

In a preferred embodiment of this new process, the latter is particularly characterized by the following features, taken separately or combined with each other:

The temporary supporting surface is constituted by a film of destructible material;

The destructible film is preferably of cellulosic material;

The destruction of the cellulosic film is effected by dissolution;

Dissolution of the cellulosic film is brought about by dioxane vapours;

Another improvement, which can be used alone or in conjunction with the first-mentioned, and which is intended to do away with a bad contact between the elements of the thermo-couple and the outlet conductors, is particularly characterized by the fact that the elements of the thermo-couple are connected over a large surface to conducting supporting means having an extensive surface of contact in the plane of the thermo-couple.

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In a preferred embodiment of the pile with this improvement, the apparatus is furthermore particularly characterized by the following features, taken separately or combined with each other:

The supporting means of the conductors each consist of a metallic half-gasket of which the circular outside edge is integral with one end of a metallic half-cylinder, the other end of which is fixed on an insulating base common to the said supports;

The metallic half-cylinders are arranged with their rectilinear longitudinal edges opposite each other;

The hot junction of the thermo-couple is plumb with the orifice delimitated by the two half-gaskets of which the rectilinear edges are opposite each other;

The insulating base is an annular glass base, preferably made of glass known as "Mo" (a special glass made of alumino-sodic borosilicate with a small amount of lime), and the base of the metallic half-cylinders is welded to the upper edge of the said annular base;

The metallic half-cylinders are advantageously made of "Dilver P," an alloy made of iron, nickel and cobalt;

The emptying stem of the pile enclosure opens substantially in the axis of the annular base of which it forms an integral part;

The outside of the annular base has a collaret on to which the base of the bulb of the pile is welded;

One of the half-cylinders is provided with a metallic radial inside screen placed plumb with the hot junction;

This metal screen is made of nickel;

Each metal half-cylinder is attached by welding to an outlet conductor, preferably made of molybdene, which passes through the collaret of the annular base;

The hot junction of the thermo-couple can be placed upon an insulating film made of synthetic material and occupying only the central part of the unit formed by the two half-gaskets.

This invention furthermore covers a process for manufacturing the active part of the thermopile, perfected as described above, the said process being characterized, in particular, by the fact that a metal cylinder is made with a per-

forated bottom, that the free end of this cylinder is welded on to the edge of an annular glass base, and that thereupon the component cylinder-bottom is cut on a diametrical plane so as to obtain two symmetrical, supporting conductors which are insulated from each other.

On the central part of the flat outside surface of the two half-gaskets formed out of the perforated bottom of the original cylinder, a thin film of synthetic resin is applied, after which the elements of the thermo-couple are placed on the support formed by the two half-gaskets and by the film of synthetic resin, which can subsequently be destroyed, by dissolution in a suitable solvent, for instance.

Other special features and characteristics of the invention will be brought out by the description hereunder, which relates to two preferred embodiments of improved thermopiles according to the invention, but which are given solely as examples, and which are shown diagrammatically on the attached drawing, on which:

Fig. 1 shows a vertical section of one embodiment of the pile as a whole;

Fig. 2 is a vertical section, on a larger scale, of the thermo-couple mounted on a destructible film, before the destruction phase;

Fig. 3 is a view similar to the preceding one, the said film having been destroyed in the region of the hot junction of the thermo-couple;

Fig. 4 is an axial section of a second embodiment of the thermopile;

Fig. 5 is a cross-section thereof along the line II—II of Fig. 4.

In Fig. 1, the thermopile comprises an enclosed space under high vacuum, formed of a cylindrical glass bulb 1 with the base 2 which is welded thereto and which has an emptying stem 3, and opposite this base is a ring 4 sealed to the bulb 1 and carrying a disc 5 made of some material (rock salt, bromide of potassium, iodobromide of thallium, etc.) which is permeable to infra-red rays.

In this space and behind the disc 5 there is a rigid insulating, annular support 6 made, for instance, of the material known as "Plexiglas" (a resin on the basis of polymerized methacrylates), carried on two metal conductors 7 and 8 which pass through the said support and come out of the space through the base 2.

The annular support 6 carries the lamellar metal branches 9 and 10 of the thermo-couple, connected by the welds 11 to the conductors 7 and 8, the hot junction of the couple being plumb with the hole 6a of the support 6.

It is of advantage to make the thermo-couple by placing on a cellulosic film 12 applied on the front (upper) side of the annular support 6 (Fig. 2) metals or alloys constituting the branches of the thermo-couple, preferably under a vacuum.

After the thermo-couple has beeen constituted, the cellulosic film 12 is eliminated, at least in the area of the hot junction of the said thermo-couple (Fig. 3) by dissolution in the vapours of a suitable solvent such as dioxane.

On Figs. 4 and 5, 21 represents the body of the glass bulb of the pile. The front face of this bulb is sealed by a disc 22, of some material which is permeable to infra-red rays (rock salt, bromide of potassium, iodo-bromide of tallium, etc.). The body of the bulb is tightly mounted in a metal annular fitting 23 sealed to the upper edge of the bulb 21.

The disc 22 is preferably welded in the mount 23 by means of a synthetic resin prepared by the reaction of phthalic anhydride on glycerin and

known under the name of "Glyptal," subjected to polymerization under heat. The sealing between the elements 23 and 21 can be effected in the same manner.

At its bottom end the bulb is welded to the outside collaret 24a by an annular base 24 made of so-called "Mo" glass, the axial part of the said base forming a single body with the emptying stem 25.

To the upper edge 24b of the base 24 are welded, by glass-metal welding, the lower edges of the two metal half-cylinders 26a and 26b, the longitudinal rectilinear edges of which are a slight distance from each other and the upper ends of which are integral respectively with the two metal half-gaskets 27a and 27b, the elements 26a, 26b, 27a and 27b being preferably made of "Dilver P."

On the outside surface of the central part of the unit formed by the elements 27a and 27b a thin film of synthetic material 28, is applied. This serves as a support for the hot junction A of the lamellar elements 29 and 30 of the thermo-couple, which are applied to the upper surface of the components 27a, 27b and 26, preferably under a vacuum.

The molybdene conductors 31 and 32, passing through the annular base 24, are welded to the half-cylinders 26a and 26b.

Owing to the arrangement described above, perfect electrical connection, over a large area, is obtained between the elements 29 and 30 of the thermo-couple and the supporting means 26a—27a and 26b—27b respectively.

The supporting means provide for a great mechanical firmness. By reason of their great heat capacity, they maintain the cold junctions of the thermocouple at a substantially low and constant temperature.

To improve the cooling of the hot junction (in absorbing the radiations of said junction) and, consequently, to decrease the time constant, a nickel screen 33 is placed plumb with the hot junction A and fixed to the half-cylinder 26b.

Compared with a thermopile of same size and all other conditions being the same, this improved thermopile has an electrical resistance which is less by half and a far shorter time. In addition, its stability of operation is excellent, in particular by reason of the perfect contact existing between each element of the thermo-couple and the corresponding conductor acting as a support. Furthermore, the unit formed by the two half-cylinders 26a and 26b and the two half-gaskets 27a and 27b constitutes a mass of great calorific inertia which reduces the heating of the cold junctions of the thermo-couple.

It is obvious that the examples of the embodiment of improvements in thermopiles, described above and shown on the annexed drawing, are only indicative and not restrictive and that any changes of detail may be made therein without thereby deviating from the principle of the invention which also covers the new industrial product constituted by a thermopile embodying all or part of the above described improvements.

What I claim is:

1. In a thermo-electric pile comprising a closed bulb under vacuum, two conductors passing through the wall of the said bulb, metallic supporting means arranged within the bulb and connected to the said conductors, and a thermo-electric couple with two lamellar branches resting directly on the said supporting means and electrically connected therewith, the supporting

means comprising two half cup shaped metal cylinders, having a central space in their cup shaped parts, facing one another connected with their circular edges to the bulb wall, by means of a glass-metal welding, and supporting with their cup shaped parts the branches of the thermo-couple so that the hot junction of said thermo-couple is plumb with said central hole, the supporting means providing for a great mechanical firmness of the thermo-couple and having a great heat capacity for maintaining the cold parts of the thermo-couple at a substantially low and constant temperature.

2. A thermo-electric pile according to claim 1, comprising in addition a metal screen supported by one of the half-cup shaped cylinders, for absorbing the radiation of the hot junction of the thermo-couple.

3. A method of manufacture of a thermo-electric pile having a closed glass bulb under vacuum and a thermo-electric couple in said bulb, the branches of which rest on two metal supports fixed to the wall of the bulb and insulated electrically from each other, the step of manufacturing a metallic cup shaped cylinder with an axial hole in its cup shaped end, the step of welding, by a glass-metal welding, the circular free edge of said cylinder onto the wall of the bulb, the step of sawing the cup shaped cylinder into two parts according to a diametrical plane, and the step of placing the two branches of the thermocouple on the two parts of the cup shaped end of the cylinder, so that the hot junction of the thermocouple is placed plumb with the axial hole of the supports.

4. In a thermopile comprising an enclosed space under vacuum, two conductors passing through the wall of the same space, supporting means arranged in the space, connected to the said conductors, and having a central orifice, and a thermo-electric couple with two substantially lamellar metal branches resting on the said supporting means, electrically connected respectively to the said conductors, and having a "hot junction", said hot junction being substantially plumb with the central orifice of the supporting means, in order to provide for large junction area for the said "hot junction" and for their connection with the respective conductors, and in order the hot junction per se being not in contact with any material.

5. In a process for manufacturing the thermo-electric couple of a thermopile wherein said thermo-couple comprises lamellar branches resting on supporting means with a central orifice and so arranged that the hot junction of the thermo-couple is plumb with said orifice, the step of applying a provisory supporting film of destructible material on the front side of the supporting means, the step of building the lamellar thermo-couple on the said supporting film, in such a manner that the "hot junction" of said lamellar thermo-couple is located plumb with the orifice of said supporting means, and, finally, the step of destroying the supporting film at least in the area of the hot junction of the lamellar thermo-couple, so that said hot junction will not further be in contact with any material.

6. A process according to claim 5, in which the destructible supporting provisory film is a cellulosic film.

7. A process according to claim 5, in which the provisory supporting film is destroyed by being dissolved.

8. A process according to claim 5, in which the step of destroying the provisory supporting cellulosic film consists in dissolving it in dioxane vapours.

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