March 1, 1955 O. E. ANDRUS 2,703,335

SEALED THERMOPILES

Filed April 20, 1953

FIG. 1.

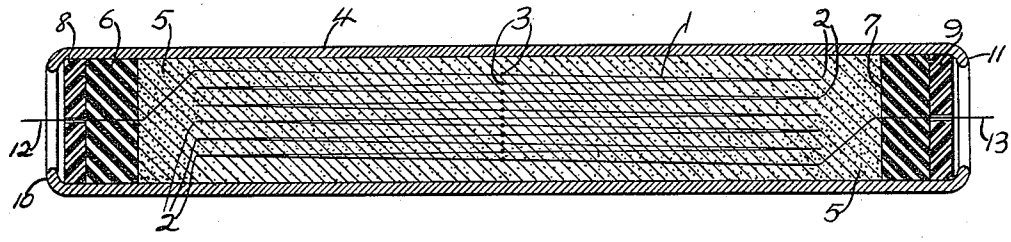


FIG. 2.

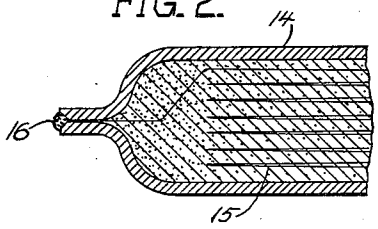


FIG. 3.

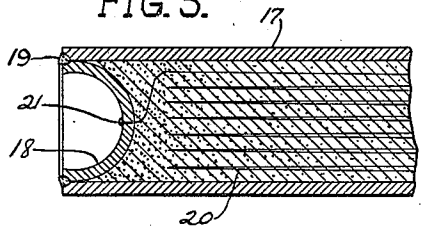


FIG. 4.

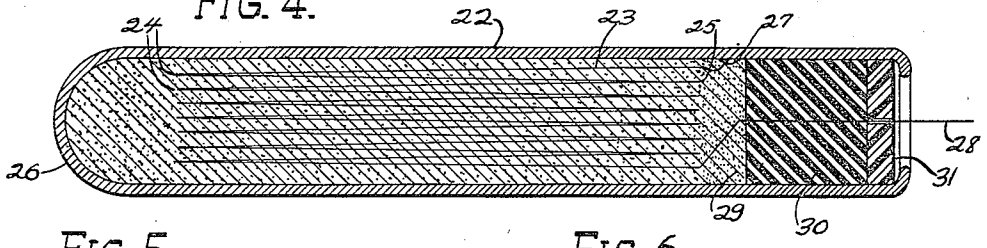


FIG. 5.

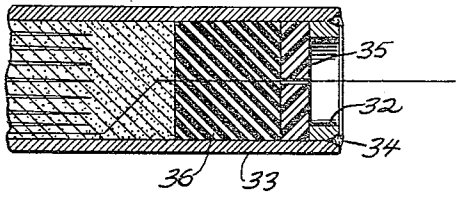
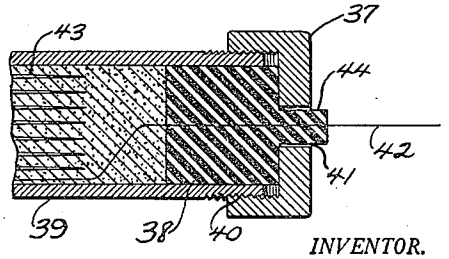


FIG. 6.



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SEALED THERMOPILES

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Application April 20, 1953, Serial No. 349,696

8 Claims. (Cl. 136—4)

This invention relates to a hermetically enclosed thermopile unit.

An object of the invention is to provide a hermetically enclosed thermopile to protect the thermopile from contact with the surrounding atmosphere.

Another object of the invention is to provide a long-life thermopile.

Another object is to provide a low cost and simply constructed thermopile.

A further object of the invention is to provide a compact thermopile unit capable of operating in a small pilot flame such as used in domestic hot water heaters.

In general, the invention is directed to a thermopile made from a composite wire formed by bonding together alternate lengths of metals having dissimilar thermoelectric properties. The wire is insulated and folded to form a compact bundle which is placed in a protective tube. The protection tube is then swaged to a smaller diameter to thoroughly compact the insulation between the conductors forming the thermopile and between the thermopile and the tube to prevent electrical shorting of the conductors. The ends of the tube are substantially filled with a thoroughly compacted insulating material such as granulated glass to further insulate the thermopile and restrain movement of thermopile conductors. The ends are then hermetically sealed by a compacted insulating and sealing member held under compression within the ends of the tube preferably by insulating washers over which the ends of the tube may be crimped.

In the drawing:

Figure 1 is a sectional view of a thermopile illustrating an embodiment of the invention.

Fig. 2 is a sectional view illustrating an alternate means of sealing one end of the tube.

Fig. 3 is another means of sealing the one end of the tube.

Fig. 4 is a sectional view illustrating another embodiment of the invention.

Fig. 5 is a cross-sectional view of an alternative construction for retaining the sealing means in position.

Fig. 6 is a cross-sectional view of another construction for holding the sealing means in position.

Referring to Figure 1, the thermopile 1 is an insulated thermopile preferably constructed as described in my co-pending application entitled "Method of Making a Thermopile," Serial No. 349,697, filed April 20, 1953. An electrically insulated composite wire of alternate equal lengths of metal having dissimilar thermoelectric properties is folded to form a bundled thermopile.

For purposes of illustration, the thermopile 1 of Figure 1 is shown with the cold junctions 2 at both ends of the thermopile and the hot junctions 3 at substantially the center thereof.

The thermopile 1 is placed in the casing 4 with the hot junction 3 positioned centrally of the casing. The casing 4 is preferably a cylindrical tube of a heat-resistant metal; for example, high chromium bearing alloys. The casing 4 is preferably swaged down to a smaller diameter in order to thoroughly compact the insulating material between the conductors so that there will be substantially no relative movement between the conductors of the thermopile or beween the thermopile 1 and the casing 4 under operating conditions. The ends of the tube are substantially filled with a granulated glass 5 or other suitable insulating material. The insulating material is preferably of a heat-resistant variety.

The ends of the casing 4 are hermetically sealed by the cylindrical sealing members 6 and 7 of neoprene rubber, silicone rubber or similar sealing material inserted in the opposite ends of the casing. The members 6 and 7 are placed under compression within the casing 4 to hermetically seal the casing and to maintain the desired compacting of the thermopile insulating material.

The sealing members 6 and 7 may be compressed in any suitable manner; for example, as by swaging the casing 4 about the members or by forcing the members into the casing by means of suitable tools or a combination of such swaging and forcing.

Insulating end washers 8 and 9 are preferably disposed between the sealing members 6 and 7 and the respective ends of the casing 4. The washers are preferably made of fiber, Bakelite or other suitable physically strong insulating material. The ends of casing 4 are crimped inwardly as at 10 and 11 clamping the casing ends over the washers, thereby holding the sealing members under compression within the casing 4.

It is preferable to employ washers 8 and 9 if a rubber-like material having good flexibility and a low durometer reading is employed for sealing members 6 and 7. However, washers 8 and 9 are not absolutely necessary if a material having a high durometer reading is used. It is also possible to use a combination sealing member and washer made as a single unit of adjoining material having the desired degrees of flexibility.

One terminal 12 of the thermopile 1 extends through sealing member 6 and washer 8 and the other terminal 13 extends through the sealing member 7 and washer 9. With the sealing members 6 and 7 under compression, as previously described, they tightly surround the terminals of the thermopile 1 and hermetically seal the ends of casing 4 against the surrounding atmosphere.

Although the swaging of casing 4 has been described as being performed before the ends are sealed, it may be subsequently performed; for example, the swaging of the tube may be the last operation in the making of the thermopile unit.

Fig. 2 illustrates an alternative means of sealing one end of the casing. The one end of the casing 14 is swaged down upon a terminal of the thermopile 15. The end of the casing is hermetically sealed as by weld 16, which also bonds the terminal of the thermopile to the casing. With the construction illustrated in Fig. 2, the casing 14 is one of the terminals of the thermopile for connection in an electrical circuit, not shown. The opposite end, not shown, of the casing is sealed as illustrated in Figure 1 and described above.

Fig. 3 illustrates another embodiment of the invention wherein the casing is employed as one of the terminals of the thermopile. In Fig. 3, one end of the casing 17 is sealed by welding or otherwise securing a cup-shaped end plug 18 to the casing 17 as by circumferential weld 19. A terminal of the thermopile 20 is welded to the plug as by weld 21. The opposite end, not shown, of the casing 17 is sealed as described above with respect to Figure 1. With the construction of Fig. 3, the casing 17 is one terminal of the thermopile 20.

The embodiments illustrated in Figs. 2 and 3 are the same as that in Figure 1, except for the above described differences.

In the embodiment illustrated in Fig. 4, the protective casing 22 is a thimble-shaped tube such that a cross-sectional view, as illustrated, is substantially an elongated U shape.

Thermopile 23 is illustrated in Fig. 4 with the hot junctions 24 at one end and the cold junctions 25 at the opposite end; preferably constructed in accordance with my previously noted co-pending application entitled "Method of Making a Thermopile," Serial No. 349,697 filed April 20, 1953. Although the thermopile 23 is shown with the hot and cold junctions at opposite ends of the thermopile, it may also be constructed with the hot junctions at the center and cold junctions at both ends as previously described and as illustrated in Figure 1. Some advantages of locating the hot junctions of the thermopile centrally of the thermopile as illustrated in Figure 1 are: a thermopile of reduced cross-section,

lesser stress on the welds at the hot junctions, better heat dissipation for a maintenance of minimum cold junction temperatures, and improved heat addition at the hot junctions.

Prior to the insertion of thermopile 23 in the casing 22 a quantity of powdered glass 26 or the like is introduced in the closed end of the tube to insulate the hot junctions 24 from the casing 23.

The thermopile 23 is inserted in the casing 22 with the terminal 27 preferably welded to the tube and the terminal 28 extending through the open end of the tube. The terminal 27 may extend through a small opening in the casing and be welded thereto.

The casing 22 is then preferably swaged to a smaller diameter to thoroughly compact the insulating material between the conductors and between the casing 22 and the thermopile 23, as previously described with respect to Figure 1.

A quantity of powdered glass 29 or the like after the swaging is completed is inserted in the casing 22 to cover the cold junction 25 after which the open end is sealed as previously described with respect to Figure 1. A rubber-like plastic seal 30 and fiber washer 31 are forced into the open end and held in a position sealing the tube by crimping the open end of the tube inwardly. The terminal 28 extends through the plastic seal and fiber washer to the exterior of the casing 22.

The sealing member and washer may be restrained within the casing otherwise than by crimping of the casing. For purposes of illustration, alternative means are shown in Figs. 5 and 6.

In Fig. 5, a preferably annular member 32 is secured to the inner surface of casing 33, as by circumferential weld 34. The annular member 32 restrains the fiber washer 35 and the compressed sealing member 36 from movement out of the end of the casing 33. Other than for the above noted changes, the embodiment illustrated in Fig. 5 is the same as the previously described embodiments.

The cap 37 of Fig. 6 illustrates a further means of retaining the insulation and sealing member 38 within a casing 39. The cap 37 has an inner cavity with the sides thereof threaded as at 40. The outer surface of the casing 39 is correspondingly threaded at its end to receive the cap 37. When the cap 37 is tightened down it forces the sealing member 38 within the casing thereby asserting a compressive force on the sealing member 38 to hermetically seal the casing end. The cap 37 has an aperture 41 through which the terminal 42 of thermopile 43 extends. The sealing member 38 has an annular extension 44 which lines the aperture in the cap 37 and insulates the terminal 42 from the cap. Sealing member 38 is any suitable material with a high durometer reading so that it will remain within the casing 39 without a washer, as previously noted with respect to Figure 1.

Other than for the above noted differences the embodiment of the thermopile unit of Fig. 6 may be constructed in accordance with the previously described embodiments.

It is within the scope of the invention to form the thermopile, and hermetically sealed container in other shapes such as a doughnut instead of the illustrated rod-shape. In this case the cold junctions might be on the terminal side of the doughnut-shaped unit whereas the hot junctions might be on the diametrically opposite side.

Although the swaging of the thermopile casing is the preferable method of compacting the electrically insulating material within the casing, it may be otherwise compacted as by an inner concentric expanded tube. Further, if the casing is swaged, it need not necessarily be of a uniform final diameter.

Various embodiments of the invention may be employed within the scope of the following claims.

I claim:

1. A hermetically sealed thermopile unit which comprises a thermopile to be protected from the surrounding atmosphere, a casing with said thermopile housed therein, said casing being provided with an opening, means to electrically insulate said thermopile to prevent electrical shorting of the thermopile elements against the casing or against each other, a sealing member under compression within the casing at the opening of said casing, a terminal of said thermopile extending through said sealing member to the exterior of the casing, and means to retain said sealing member under compression within said casing whereby said opening remains hermetically sealed.

2. A hermetically sealed thermopile unit, which comprises a thermopile to be protected from contact with the surrounding atmosphere, a casing having a tubular opening with the thermopile housed in the casing, a thoroughly compacted electrically insulating material disposed in said casing to prevent electrical shorting of the thermopile elements against the casing or against each other and to confine the thermopile elements against relative movement, a terminal of said thermopile passing through the tubular opening, a sealing member under compression within the tubular opening hermetically sealing the opening, and means to retain said sealing member in position.

3. In a hermetically sealed thermopile unit, a thermopile, a heat resistant metallic tubular casing with said thermopile housed therein, a thoroughly compacted electrically insulating material in said casing to insulate said thermopile from said casing and the thermopile elements from one another to prevent shorting of the thermopile elements, means to seal one end of said casing, a flexible sealing and insulating member under compression in the opposite end of said casing, an electrically insulating washer disposed adjacent and exteriorly of said sealing member, a terminal of said thermopile extending through said sealing member and said insulating washer, and means to retain said insulating washer in position within said casing.

4. In a hermetically enclosed thermopile unit, a thermopile with hot junctions substantially adjacent each other, a heat-resistant metallic casing having open ends with said thermopile housed therein, a thoroughly compacted electrically insulating material disposed within said casing whereby said thermopile is insulated from said casing and the elements of said thermopile are insulated from each other to prevent electrical shorts of the thermopile elements, means to hermetically seal an end of said casing, an electrically insulating and sealing material disposed under compression in the opposite end of said casing to hermetically seal the casing, an electrically insulating washer within said casing adjacent the exterior surface of said insulating and sealing material, a terminal of said thermopile extending to the exterior of the casing through said insulating and sealing material and said washer, and a member secured to the wall of said casing and abutting said washer whereby said washer is held against outward movement and said sealing material is held under compression within said casing.

5. A hermetically sealed thermopile unit comprising a metallic tubular casing with one end crimped inwardly, a thermopile housed within said casing, an electrically insulating material tightly compacted within said casing to insulate the thermopile from the casing and the thermopile conductors from each other in order to prevent electrical shorting of the thermopile conductors with each other or with the casing and to prevent relative movement therebetween, an insulating and sealing material disposed under compression between said thermopile and said crimped end, an insulating washer disposed between said insulating and sealing material and said crimped end, a lead terminal of said thermopile extending through said electrically insulating and sealing material and said washer to the exterior of said casing, and means to hermetically seal the opposite end of said casing.

6. A hermetically enclosed thermopile unit comprising a tubular heat resistant metallic casing, a thermopile housed within said casing, means to hermetically seal one end of the casing, a pliable sealing and electrically insulating material under compression within the opposite end of said casing, said insulating material having an annular extension protruding outwardly therefrom, a cap having an aperture therethrough to accommodate said annular extension, said cap having a cavity with the inner side walls thereof threaded, said casing being correspondingly threaded to receive said cap whereby said sealing and insulating material is held in position within the casing, and a terminal of said thermopile extending to the exterior of the casing through said sealing and insulating material.

7. A hermetically enclosed thermopile comprising a

heat resistant metallic casing with a longitudinal cross-section which is essentially U-shape, a thermopile housed in said casing, thoroughly compacted electrically insulating material within said casing insulating said thermopile from said casing and insulating the conductors of said thermopile from one another to prevent electrical shorting of the thermopile conductors, a flexible sealing and electrically insulating member under compression in the open end of said casing, a lead terminal of said thermopile passing through said sealing member to the exterior of said casing, and means to retain said sealing member under compression within the casing.

8. A hermetically sealed thermopile unit which comprises a casing provided with a tubular opening, a thermopile housed within said casing with a terminal extending through said opening, means to electrically insulate said thermopile to prevent shorting of the thermopile elements against the casing or against each other, a sealing member held under compression within said tubular opening to hermetically seal the opening, and said sealing member having a limited degree of flexibility whereby it remains under compression within said casing.

References Cited in the file of this patent

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