

[54] **TERMINAL FOR THERMOELECTRIC ELEMENT**

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[51] Int. Cl. **H01v 1/12**

[58] Field of Search **136/236, 237; 29/573, 473.1**

[56] **References Cited**

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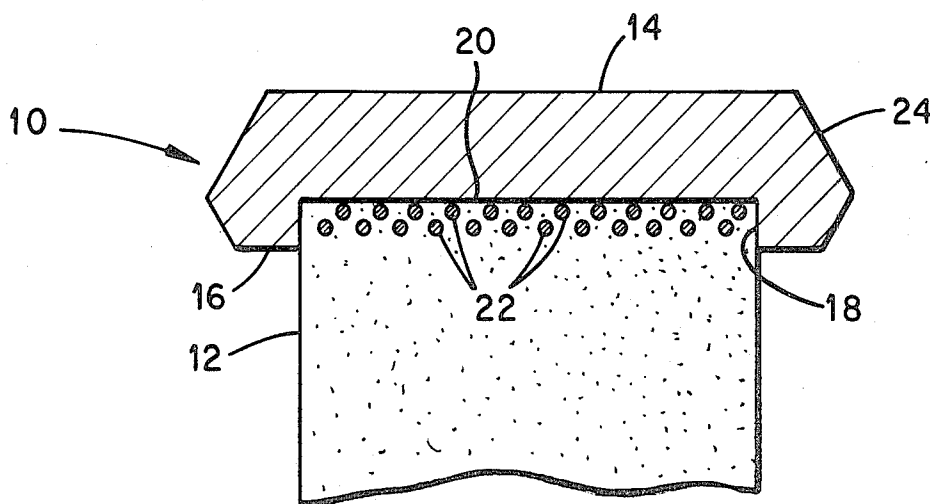
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[57] **ABSTRACT**

A terminal construction for a thermoelectric element. A thermally and electrically conductive cap is provided with a recess, against the bottom of which is welded woven wire screening. Powdered thermoelectric material is pressed into the recess, through the screening and against the bottom of the recess, interlocking mechanically with the mesh and forming a permanent thermal and electrical connection to the cap.

3 Claims, 2 Drawing Figures



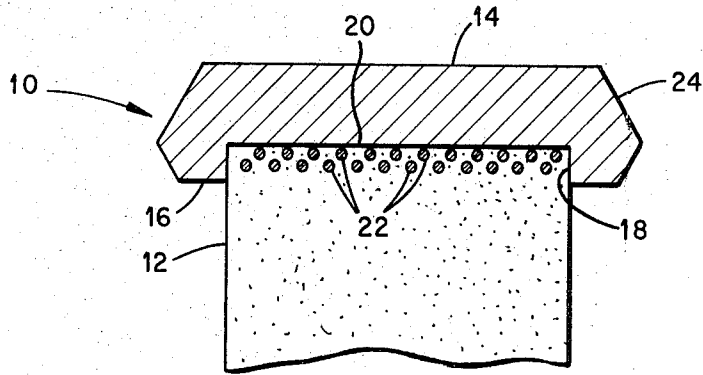


Fig. 1

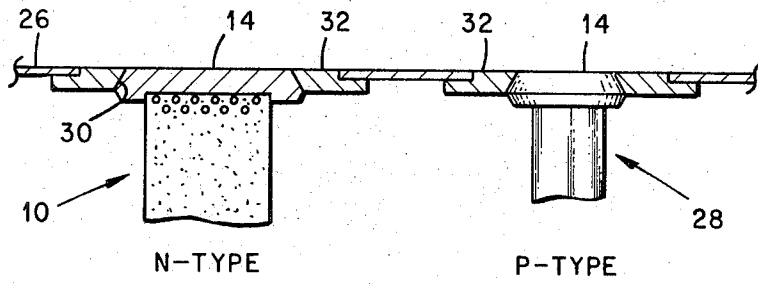


Fig. 2

TERMINAL FOR THERMOELECTRIC ELEMENT

BACKGROUND OF THE INVENTION

The invention described herein was made during the course of, or under, contract No. AT(29-2)-2564 with the United States Atomic Energy Commission.

This invention relates to thermoelectric generators. More particularly, it relates to the thermoelectric elements for such generators, and to the terminals for such elements through which heat and electricity are conducted.

Electrical generators based upon the Seebeck effect, for converting heat directly into electrical energy, have found increasing application as lightweight, simple and reliable power sources aboard space satellites, and for terrestrial use at remote locations or where silence in operation is required. In essence, such generators usually consist of an assemblage of individual pairs of solid state thermoelectric elements, each pair comprised of one N type element and one P type, each element of a pair having a hot end and a cold end, the respective hot and cold ends being connected by a thermally and electrically conductive terminal or cap to the respective hot or cold connector, panel or bus. It has previously been the practice to fasten the thermoelectric material to the end caps by means of a metallurgical bond between the material and the metallic cap. Difficulties have been encountered in the past because of the tendency of the thermoelectric elements to crack where they are bonded to the end caps, due to the disparity between the rates of thermal expansion of the cap and the element. Additionally, the materials of the thermoelectric elements and their end caps have frequently been subject to migration and chemical interaction, with consequent deterioration of the metallurgical bond between the cap and the element. When the materials of the cap and the element have been selected upon the basis of compatibility of their rates of thermal expansion, there has been a chemical or metallurgical incompatibility between the materials, and vice versa.

In a paper by E. J. Steeger and J. E. Craver entitled "Isotec Thermoelectric Generator for Space Power," Proceedings of the Fourth Intersociety Energy Conversion Engineering Conference, held at Washington, D.C. on Sept. 22-26, 1969, published in 1969 by the American Institute of Chemical Engineers, pages 515-521, an end cap construction is shown in which a mesh screen is embedded radially within and near one end of a rod-like thermoelectric element pressed into the end cap and metallurgically bonded to it. The projecting edge of the screen is then welded to the rim of the cap. Thus, the thermoelectric element is conductively connected to the end cap both metallurgically and mechanically. Despite this connective redundancy in the interest of greater reliability, difficulties have arisen in the operation of such thermoelectric generators, entailed by the deterioration of the metallurgical bond.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an improved terminal construction for a thermoelectric element.

It is a further object of the invention to provide a terminal construction affording a more efficient and more durable thermally and electrically conductive connection

to a thermoelectric element, without employing a metallurgical bond.

Other objects and advantages of the present invention will be apparent to those skilled in the art upon reading the ensuing description of a preferred embodiment of the invention.

In the thermoelectric element terminal construction according to the present invention, a recess in one side of the cap is provided with one or more layers of woven wire mesh screening, lying against and spot welded to the bottom of the recess. The powdered thermoelectric material of the element is hot pressed into the cap, through the interstices of the screening and against the bottom of the recess, interlocking with the mesh, by which it is held mechanically in a permanent thermal and electrical connection to the cap. Because of the intimate interlock at many points and the slight ability of the woven screening to yield, some difference in the coefficients of thermal expansion of the thermoelectric element and the metallic material of the cap can be accommodated, the end of the thermoelectric element being mechanically held by the screen in tight electrically and thermally conductive contact with the cap, without a metallurgical bond. Thus greater latitude is provided for the selection of thermoelectric element and cap materials by eliminating the necessity for their selection upon the basis of their formation of a satisfactory metallurgical bond.

DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-section, partly schematic, depicting one end of an N type thermoelectric element having a terminal constructed in accordance with the invention.

FIG. 2 is a cross-section, partly schematic, showing the thermoelectric element of FIG. 1 employed as one of a pair of N and P type thermoelectric elements connected as the hot junction of a thermoelectric couple in a thermoelectric generator panel.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown in cross-section the hot end of a thermoelectric element, generally indicated at 10 and including a rod or bar 12 of powdered thermoelectric material, hot pressed into an end cap or terminal 14. The lower face 16 of the cap 14 is provided with a recess 18 against the bottom 20 of which are laser spot welded one or more layers of woven wire mesh screening 22, schematically indicated, two layers being depicted in this instance and being a preferred number. The cap 14 is provided with a tapered surface 24 about its rim, for the purpose of connecting the element 10 in a thermoelectric generator structure.

Referring to FIG. 2, there is shown a portion of the hot side of a thermoelectric generator, including a thermally and electrically conductive panel or strap 26, connecting a thermocouple pair consisting of an N type thermoelectric element 10 and a P type thermoelectric element 28, the latter being generally similar to element 10 and also having an end cap 14. The caps 14 have their tapered surfaces 24 seated within mating tapered internal surfaces 30, on flanged socket fittings 32 which are inserted in the panel or strap 26, the surfaces 24 and 30 being secured together by laser welding, as necessary, and the fittings 32 being laser welded to the panel or strap 26, in order to insure good thermal and electrical contact. The panel or strap 26 is heated by any suitable source, not shown. For example, it may be

heated by thermal radiation from a radioisotope or other heat source, or by thermal conduction from a heat source through the material of the panel or strap 26.

As is well known to those skilled in the art, a variety of powdered thermoelectric materials are available for use in powder metallurgy techniques. In the embodiment described the N type element 10 may be made of powdered PbTe, vacuum hot pressed at about 600°C with a compression pressure of about 5,000-20,000 psi, into a cap 14 of niobium, iron or other material compatible with the thermoelectric materials and suitable for the purpose. Similarly, the screening 22 may be woven of molybdenum, iron or other compatible and suitable wire of about 0.003 to 0.006 inch diameter, a mesh size of from 40 to 60 per inch being suitable. A suitable material for the P type thermoelectric element 28 is the well-known material Pb Sn Mn Te. The thermoelectric element 28, however, does not per se constitute a part of the present invention. However, the principles of the terminal construction of FIG. 1 are applicable, with selection of appropriate material, to element 28 also, and also to the cold ends of both elements 10 and 28, not shown, as will be apparent to those skilled in the art.

What we claim is:

1. In a thermoelectric element, the combination of: a thermally and electrically conductive cap, said cap being generally in the form of a relatively massive disc having a conductor-engaging surface at its rim, generally parallel front and back faces, and having a relatively shallow open recess extending inwardly from and across said front face, said recess having a bottom extending generally parallel to said front face;

a plurality of layers of thermally and electrically conductive woven wire mesh screen in said recess, extending thereacross and spot welded to the bottom thereof;

and a body of thermoelectric material pressed into said recess, embedding said layers of screen and in contact with the bottom of said recess.

2. The combination of claim 1, in which said cap is made of material composed of one of the group of materials consisting of niobium and iron.

3. The combination of claim 1, in which said screen is made of a material chosen from one of the group of materials consisting of molybdenum and iron.

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