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THERMOELECTRIC COUPLE AND METHOD OF MAKING SAME

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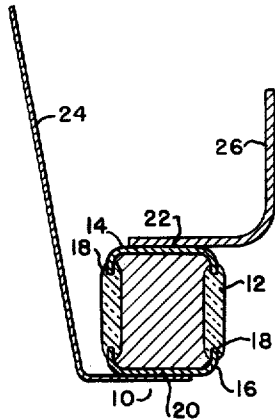


FIG. 2

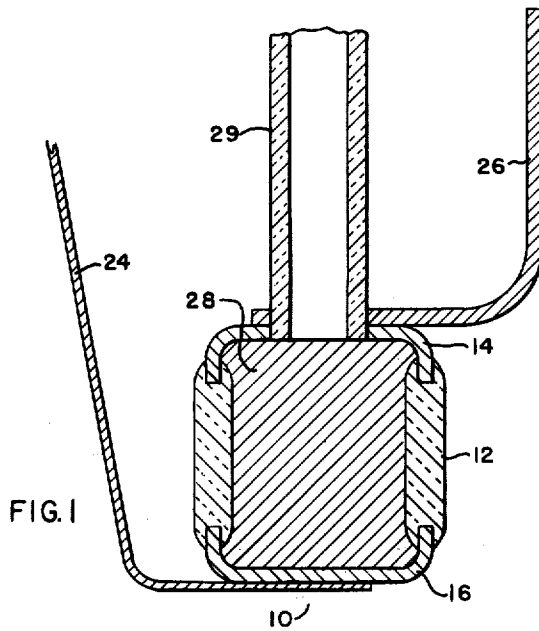


FIG. 1

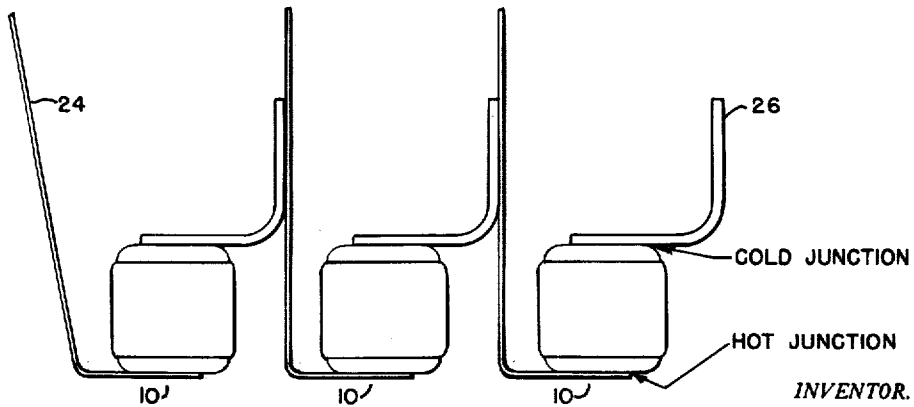


FIG. 3

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THERMOELECTRIC COUPLE AND METHOD OF MAKING SAME

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2 Claims. (Cl. 136-4)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to thermocouple generators and more particularly to an improved method of making them.

As is well known, thermocouples are formed from positive and negative elements connected at one end to form a hot junction, the opposite free ends of the elements forming the so-called cold junction.

Among the different elements for thermocouples that have been produced are alloys formed from zinc and antimony in predetermined proportions with small percentages of additional agents. These alloys have been found to be highly efficient when used as the positive element of the thermocouple in the conversion of thermal energy to electrical energy. The composition of such an alloy is described in U. S. patent to Telkes, No. 2,229,482 issued January 21, 1941.

In employing this particular alloy as the positive element certain difficulties have been encountered in its fabrication and assembly. The usual procedure which is generally followed is to prepare this alloy in a crucible or container under a protective atmosphere such as nitrogen or helium and to cast the alloy into a suitable mold. In this method it has been found extremely difficult to prevent the rapid oxidation of the alloy even under this protective atmosphere. Oxidation of the metals during casting usually results in a higher electrical resistance of the alloy and in high resistance contacts to external connections, thus lowering its thermo-electric efficiency.

Furthermore, the Zn-Sb alloy is mechanically weak and brittle and therefore the fabrication and construction of the thermocouple should avoid any mechanical strain, especially when the alloy is in an operative position as one element of the thermocouple. It has also been found that the Zn-Sb element described is somewhat unstable to the extent that after it has been in use for a period of time as the positive element of the thermocouple an extrusion of zinc and oxidation of the elements take place at the cold junction, due to thermolytic action and exposure of the elements to the atmosphere, with an accompanying decrease in efficiency of the thermocouple.

It is therefore an object of this invention to provide a hermetically tight thermocouple as-

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sembly resulting in a thermocouple having high efficiency and long life.

It is a further object of this invention to provide a method of assembling the elements of a thermocouple with a minimum of oxidation of one of these elements.

It is another object of this invention to provide an adequate housing for one of the elements of this thermocouple.

Other objects of this invention will become apparent from the following description when taken in conjunction with the accompanying drawings in which:

Fig. 1 is a view in section of one method of assembling the thermocouple;

Fig. 2 is a view in section of a thermocouple generator utilizing the assembly as shown in Fig. 1.

Fig. 3 is a perspective view of the thermocouple of Fig. 1 assembled as a thermo-electric generator.

Referring to Fig. 2 there is shown a thermocouple assembly 10 consisting of a glass cylinder 12 having metal ends 14 and 16 in the form of caps. The metal ends 14 and 16 are fitted into recesses 18 at both ends of glass cylinder 12 which are of sufficient depth to insure a satisfactory hermetic and airtight seal between the metal caps and the glass cylinder 12. The metal caps 14, 16 are preferably made of a metal composition known as Kovar and the glass cylinder 12 is made of a glass known as Corning No. 705-2. It is to be understood that for the purposes of this invention the composition of the glass cylinder 12 and the metal caps 14, 16 need be only such that the metal caps 14, 16 and the glass cylinder 12 have substantially the same coefficient of expansion and that the metal caps 14, 16 be of electrically conductive material while the glass cylinder 12 be of suitable insulating and heat resistant material.

At the hot junction 20 a strip of Kovar, Copel or Constantan or a similar metal 24 having a negative thermal E. M. F. to the alloy or metal to be placed in the assembly 10 is welded to the metal cap 16 and similarly at the cold junction 22 another strip of conductive metal 26 preferably copper is welded to metal cap 14. Within the assembly 10, itself, is housed an alloy or metal 28 having a positive thermal E. M. F. to metal 24.

Thus, in the particular embodiment of the invention as shown in Fig. 2, the thermocouple assembly 10 consists of an hermetically tight container formed by side walls 12 and end caps

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14, 16, a positive thermo-electric element 28 completely filling the container, a negative thermo-electric element 14, 16 disposed at the ends of the container and in good electrical contact with positive element 28; the disposition of element 14, 16 being in the form of metal caps, as shown, so as to make an airtight hermetic seal at the open ended insulated side walls 12, and at the same time forming the hot junction 20 and the cold junction 22 of the thermocouple.

Referring to Fig. 1 this invention is illustrated by reference to a particular method for producing the desired thermocouple. The glass cylinder 12 and small beakers or other suitable vessel not shown are placed in a vacuum furnace, thus eliminating any oxidation that would occur by the use of ordinary methods of casting. The beakers are then tilted to pour the molten metals into cylinder 12 through entrance tube 28. After cooling, the entrance tube 28 is ground off flush with the cylinder 12 and then sealed by the metal caps 14, 16. Conductor 26 is then welded to metal cap 14 and the negatively thermal metal 24 is welded to metal cap 16. The entrance tube 28 need not necessarily be in the position as shown but may be placed at any convenient point on the container 10 so as to afford a means for pouring the molten metal into the container.

Instead of casting the Zn-Sb alloy as described above the Zn-Sb alloy can be produced by placing well mixed granules of zinc and antimony in the predetermined proportions into assembly 10 which already has metal cap 16 sealed into position, then sealing the remaining open end of cylinder 12 with metal cap 14, and then subjecting the mixed granules to sufficient heat in a vacuum furnace or any other suitable oxide-free heating means to effect a fusion of the granules without oxidation. Furthermore, it has been found that the fusion of the mixed granules in a vacuum effectuates a physically and electrically tight bond between the positive thermo-electric element 28 within the assembly and the negative thermo-electric element 14, 16 forming the ends of the assembly. Pursuing either method the assembly 10 is utilized both as the mold for casting the Zn-Sb alloy and as an hermetically tight housing for the alloy during the functioning of the thermocouple as an operative device.

The metal strips 24, 26 are in the shape as shown in order to facilitate the series electrical connections of each thermocouple when used as a thermo-electric generator, as shown in Fig. 3.

This method of assembling a thermocouple may be used in making thermocouples with other ele-

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ments than those mentioned. For example, an alloy of tellurium may be substituted for the Zn-Sb alloy.

By means of the method described hereinbefore the oxidation of the Zn-Sb alloy during casting is eliminated resulting in a lower electrical resistance and a higher electro-motive force. An adequate and rugged housing is provided for the brittle alloy. The hermetically tight seal at the junction points of the assembly prevents the extrusion of zinc due to thermolytic action and also prevents oxidation of the elements at their junction during use, all of which results in a thermocouple having a relatively high efficiency and long life.

While the invention has been described with reference to several particular embodiments, it will be understood that various modifications may be made therein within the scope of the appended claims without departing from the field of invention.

I claim:

1. In a thermocouple having first and second electrically dissimilar elements, a housing having side walls of an insulating material and end walls of an electrically conductive material having substantially the same coefficient of expansion as said side walls, said first element substantially filling said housing and electrically contacting said end walls, said end walls forming said second element, the edges of said end walls protruding into and sealed within said side walls hermetically sealing said first element within said housing, and a strip of said second element welded to one of said end walls forming the hot junction of said thermocouple.

2. In the thermocouple defined by claim 1, said side walls being cylindrical in shape and said end walls being cup shaped.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
434,640	Mestern	Aug. 19, 1890
773,838	Wightman	Nov. 1, 1904
2,144,558	Bahls	Jan. 17, 1939
2,280,137	Wiegand	Apr. 21, 1942
2,289,152	Telkes	July 7, 1942
2,290,902	Wiegand	July 28, 1942
2,480,404	Flindley et al.	Aug. 30, 1949
2,490,196	Beach	Dec. 6, 1949

FOREIGN PATENTS

Number	Country	Date
168,977	Great Britain	Sept. 9, 1921