Feb. 27, 1945. W. A. RAY 2,370,326

THERMOCOUPLE

Filed Oct. 20, 1941 2 Sheets-Sheet 1

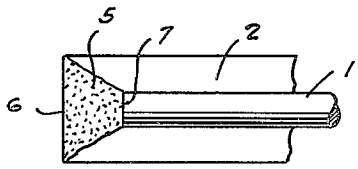

Fig. 3

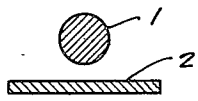

Fig. 2

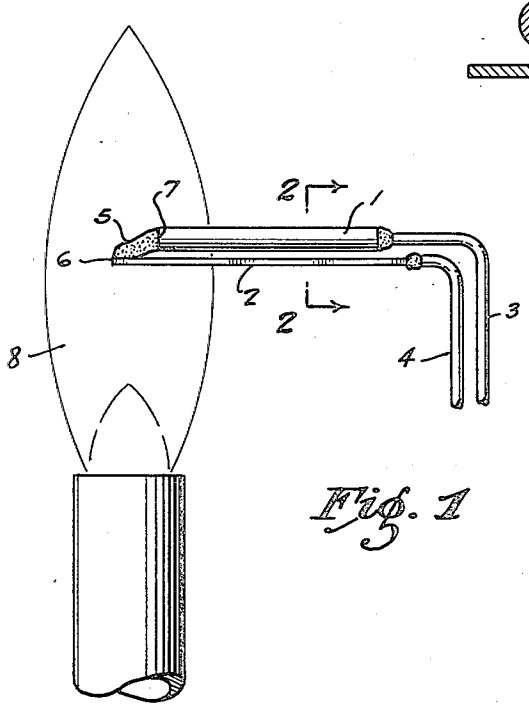

Fig. 1

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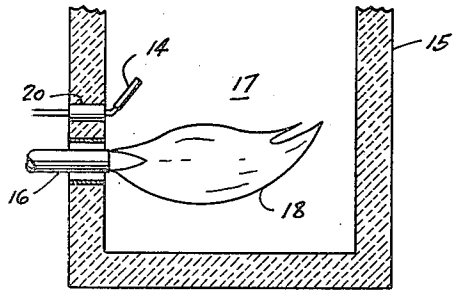
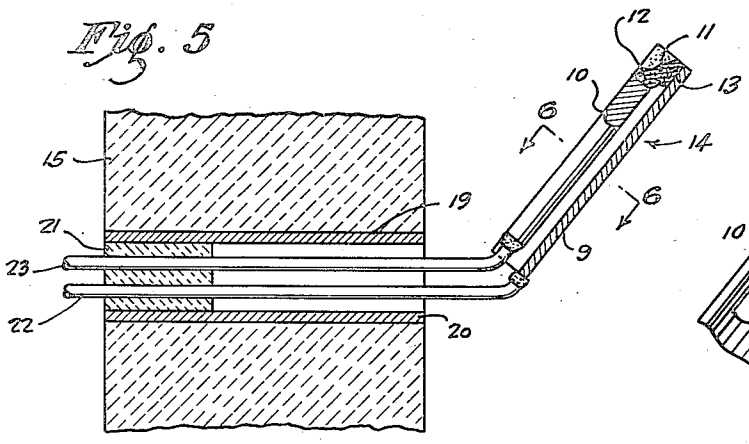


Fig. 4

Fig. 5



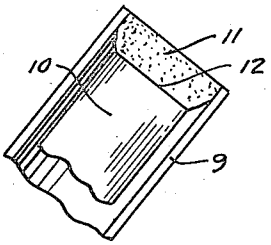


Fig. 7

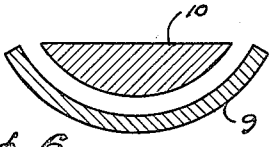


Fig. 6

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THERMOCOUPLE

William A. Ray, Glendale, Calif.

Application October 20, 1941, Serial No. 415,794

9 Claims. (Cl. 136—4)

This invention relates to a thermocouple, and especially to one adapted to perform a controlling function.

This application is a continuation in part of an application filed on November 5, 1940, in the name of William A. Ray, under Serial No. 364,356, and entitled "Thermocouple operated control system."

Thermocouples generate electric power in accordance with well understood principles of thermo-electricity. To create the thermoelectric current, a pair of conductors of dissimilar material (e. g. Chromel and Copel) are joined to form a junction; and similarly copper leads are joined respectively to the free ends of the thermoelectric conductors. If the junction between the thermoelectric conductors has a temperature above the other two junctions, a current is generated, this current being a function of the difference in temperature between the "hot" junction and the cold junctions.

These effects have found wide application in control systems, such for example as the control of fuel to a gas or oil burner. In such installations the thermoelectric device is commonly arranged so that the hot junction is influenced by the heat produced by a flame. By sufficiently sensitive relay apparatus, the relatively minute electric power generated by the thermocouple is effective to control the opening or closing of valves or dampers or other desired controlling functions. However, it is quite possible to utilize the thermoelectric effects, if properly multiplied by a plurality of thermocouple structures, for the generation of electric power capable of direct application.

It is one of the objects of this invention in general to improve such thermocouple structures and particularly by making it possible to utilize relatively short lengths of thermoelectric conductors, which are often made from expensive materials.

In the past, for example, it was considered necessary to extend the conductors from the hot junction to a region of materially lower temperature; alternatively some special cooling is provided for the cold junctions, or even heat insulation material may be used. But even in such circumstances, the conduction of heat between the junctions through the conductors very materially reduces the effectiveness of the couple. By the aid of this invention the hot and cold junctions can be placed quite close to each other, and without the need of heat insulation material. In lieu of relying upon physical separation of the junctions, or upon cooling of the junctions, the conductors are purposely so arranged that the cold junction is shielded by a conductor, so that the cold junction is not subjected to the same degree of heat. And this can be accomplished by a simple and inexpensive arrangement, obviating the need of heat insulation material or the like.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a side elevation on an enlarged scale, of a thermocouple structure embodying the invention, shown as interposed in a flame;

Fig. 2 is a sectional view taken along the plane 2—2 of Fig. 1;

Fig. 3 is a fragmentary top plan view of the thermocouple structure illustrated in Fig. 1;

Fig. 4 is a diagram illustrating a thermocouple embodying the invention but of modified form and in use in connection with a fuel oil burner;

Fig. 5 is an enlarged fragmentary sectional view of the thermocouple structure of Fig. 4 and the manner of its installation;

Fig. 6 is a sectional view taken along the plane 6—6 of Fig. 5; and

Fig. 7 is a fragmentary top plan view of the thermocouple structure illustrated in Fig. 5.

In the form of the invention illustrated in Figs. 1, 2 and 3 there are a pair of thermoelectric conductors 1 and 2 placed in parallel relationship with each other. Both of these conductors may be made of the same metal or alloy; for example Copel. They lie adjacent each other, and are connected at one end respectively to the copper leads 3 and 4.

The conductor 1 is shown as of substantially round or circular cross section. The conductor 2 is shown in the form of a thin flat strip having a width considerably greater than the diameter of the conductor 1. Furthermore, this strip 2 extends somewhat beyond the left hand end of the conductor 1. Between the left hand ends of the conductors 1 and 2 there is interposed a third conductor 5 of metal dissimilar to the metal of

conductors 1 and 2. For example, the conductor 5 may be of Chromel. It is fused or welded or otherwise electrically joined to the corresponding ends of the conductors 1 and 2 to form a pair of thermocouple junctions 6 and 7.

While it is not essential, the cross section areas of the conductors 1 and 2 in this instance are shown as approximately the same.

The conductor 2 serves as a shield for conductor 1 and for the junction 7. Accordingly when the thermocouple structure is interposed in a pilot flame 8 as illustrated in Fig. 1, and with the thin flat conductor 2 below the round conductor 1, the junction 6 attains an elevated temperature as compared with the temperature of junction 7. Accordingly the junction 6 forms the hot junction and junction 7 forms the cold junction. The connections of the copper leads 3 and 4 to the right hand ends of the conductors 1 and 2 are at approximately the same temperature and their thermoelectric effects are neutralized in the control circuit to which leads 3 and 4 are connected.

The thermoelectric generation of electric power by the aid of a temperature differential between the junctions 6 and 7 is caused in a manner that is now well known. These two junctions, occurring at opposite ends of the conductor 5, form the only active junctions in the structure.

The shielding of the cold junction 7 by the conductor 2 is effective to maintain an operative temperature differential between the two junctions 6 and 7. Accordingly, an effective generation of electric power is secured which is capable of being utilized in the control circuit.

The pilot flame 8 may represent an igniting flame for a gas burner or the like. The thermocouple structure however may be utilized with sources of heat other than that of a pilot flame.

The important feature is that the cross sections of the conductors 1 and 2 are sufficiently dissimilar so that one may operate as a shield with respect to the end of the other conductor, where a cold junction is formed.

In the form of the invention illustrated in Figs. 4 to 7 inclusive, the shielding effect is again produced by dissimilarity of the cross section of the two conductors. Thus there is a conductor 9 of thin arcuate cross section. Juxtaposed to the convex surface of the longitudinally recessed conductor 9 is another conductor 10 shown as having a convex surface placed closely and in parallel relation to the adjacent surface of the conductor 9. Both these conductors 9 and 10 may again be formed of the same metal such as Copel. A third conductor 11 formed of material dissimilar to the material of conductors 9 and 10 (for example, Chromel), is fused to the corresponding end of the conductors 9 and 10 to form junctions therewith. As before, the thin flat conductor 9 extends slightly beyond the junction 12. Accordingly, this junction is shielded by the conductor 9 and forms a cold junction. The hot junction 13 occurs at the extremity of the conductor 9.

A thermocouple structure 14 (Fig. 4) of this type is shown as interposed in a furnace chamber formed by the walls 15 of an oil burner furnace. The oil burner tube or jet 16 is shown as projecting into the chamber 17 and as feeding fuel to flame 18. The thermocouple structure 14 in this instance is so arranged that the exterior or convex surface of the conductor 9 faces the flame 18 and shields the junction 12 from the flame. Accordingly the junction 12 remains at a lower temperature with respect to the temperature of the hot junction 13, directly exposed to the radiant heat of the flame 18.

One manner in which the thermocouple structure 14 may be supported by the aid of the wall 15 is illustrated in Fig. 5. In this form the wall 15 (which may be made from a refractory heat insulation material) is shown as provided with an aperture 19 lined for example with a ceramic tube 20. In this tube at the left hand end is telescoped a plug 21. This plug 21 may be appropriately adhered within the tube 20. Through the plug 21 extend the copper conductors 22 and 23 that are fused to the free ends of the conductors 9 and 10 and that provide connections for a control circuit or the like.

While the thermocouple structure is shown in this instance as having its thermoelectric conductors 9 and 10 with longitudinal axes oblique to the horizontal, this arrangement may be varied to comply with the requirement of the installation. The important consideration is that the conductor 9 is interposed between the source of heat and the other thermocouple conductor 10.

What is claimed is:

1. In a thermocouple structure, a pair of thermoelectrically similar conductors arranged side by side, one of said conductors having a longitudinal recess, and the other of said conductors arranged with a surface juxtaposed to said recess, and a third conductor joining said pair to form a pair of exposed junctions, and being thermoelectrically dissimilar with respect to each of said pair of conductors

2. In a thermocouple structure, a pair of thermoelectrically similar conductors arranged side by side, one of said conductors having a longitudinal recess, and the other of said conductors arranged with a surface juxtaposed to said recess, said conductor with the longitudinal recess extending beyond the end of the other conductor, and a third conductor joining said pair to form a pair of exposed junctions, and being thermoelectrically dissimilar with respect to each of said pair of conductors.

3. In a thermocouple structure, a pair of thermoelectric conductors arranged side by side, one of said conductors having an arcuate longitudinal recess, and the other of said conductors having a convex side juxtaposed to said recess, and a third conductor joining said pair to form a pair of exposed junctions, and being thermoelectrically dissimilar with respect to each of said pair of conductors.

4. In a thermocouple structure, a pair of thermoelectric conductors arranged side by side, one of said conductors having an arcuate longitudinal recess, and the other of said conductors having a convex side juxtaposed to said recess, said conductor with the longitudinal recess extending beyond the end of the other conductor, and a third conductor joining said pair to form a pair of exposed junctions, and being thermoelectrically dissimilar with respect to each of said pair of conductors.

5. In a thermocouple structure, a pair of thermoelectrically similar conductors arranged side by side, and having exposed ends, and adapted to be heated by a flame, the end of one conductor extending beyond the end of the other conductor, and a relatively short third conductor joining said ends to form a pair of exposed thermocouple junctions, said third conductor being thermoelectrically dissimilar to each of said pair of conductors, that conductor having an end ex-

tending beyond the end of the other conductor being wider than said other conductor, as well as overlying one of said junctions and forming a shield therefor by being placed so as to interrupt the transmission of heat from the flame to said one of said junctions.

6. In a thermocouple structure co-operating with a flame to generate electrical energy, a pair of thermoelectrically similar conductors, said conductors extending longitudinally in general parallel relation, the width of one conductor in a direction transverse to the other conductor being greater than the width of said other conductor, said one conductor overlying the other so that the edges of said one conductor extend transversely beyond the other conductor, and a third conductor joining said pair, and being thermoelectrically dissimilar to each of said pair of conductors to form a pair of exposed thermoelectric junctions.

7. In a thermocouple structure co-operating with a flame to generate electrical energy, a pair of thermoelectrically similar conductors, said conductors extending longitudinally in general parallel relation, the width of one conductor in a direction transverse to the other conductor being greater than the width of said other conductor, said one conductor overlying the other so that the edges of said one conductor extend transversely beyond the other conductor, the end of said wider conductor extending beyond the end of the other conductor, and a third conductor joining said ends, and being thermoelectrically dissimilar to each of said pair of conductors to form a pair of exposed thermoelectric junctions.

8. In a thermocouple structure co-operating with a flame to generate electrical energy, a pair of thermoelectrically similar conductors, said conductors extending longitudinally in general parallel relation, one of said conductors having a substantially circular cross section, the other of said conductors having a flat cross section, the width of said other conductor being substantially greater than the diameter of said circular conductor, said flat conductor overlying the circular conductor so that the edges of the flat conductor extend transversely beyond the circular conductor, and a third conductor joining said pair, and being thermoelectrically dissimilar to each of said pair of conductors to form a pair of exposed thermoelectric junctions.

9. In a thermocouple structure co-operating with a flame to generate electrical energy, a pair of thermoelectrically similar conductors, said conductors extending longitudinally in general parallel relation, one of said conductors having a substantially circular cross section, the other of said conductors having a flat cross section, the width of said other conductor being substantially greater than the diameter of said circular conductor, said flat conductor overlying the circular conductor so that the edges of the flat conductor extend transversely beyond the circular conductor, the end of said flat conductor extending beyond the end of the circular conductor, and a third conductor joining said ends and being thermoelectrically dissimilar to each of said pair of conductors to form a pair of thermoelectric junctions.

WILLIAM A. RAY.