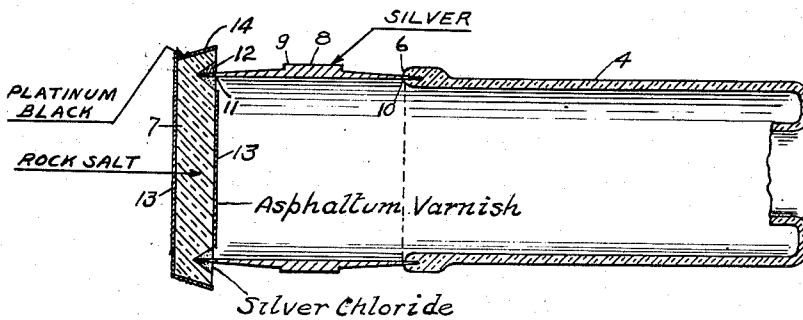
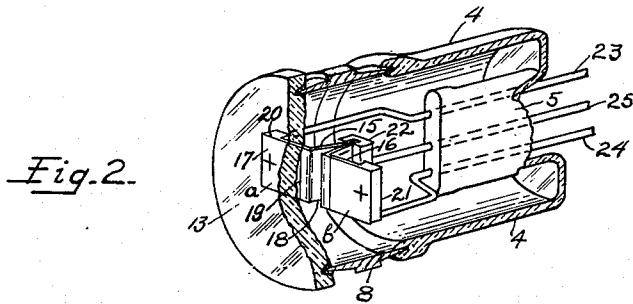
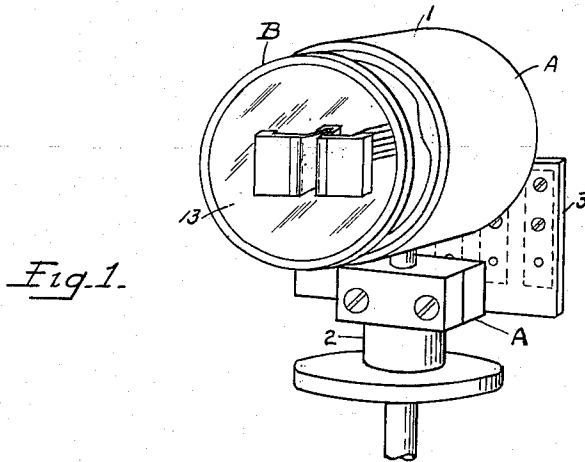


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THERMOCOUPLE TUBE

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THERMOCOUPLE TUBE

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America as represented by the Secretary of War

Application November 29, 1939, Serial No. 306,750

1 Claim. (Cl. 136—4)

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This invention generically relates to thermo-responsive devices adapted to be used with the apparatus described and claimed in the application of Charles F. Green, filed November 29, 1939, Serial No. 306,753, and that of Laurens A. Taylor, filed November 29, 1939, Serial No. 306,755, more especially it is directed to a thermo-couple tube evacuated to a high degree and provided with a window having a high transmission coefficient for low temperature radiation.

One object of this invention is to provide a thermo-couple tube evacuated to a high degree and including a rock salt window and a glass envelope or bulb, the window and bulb being interconnected so that the strains produced by the difference in expansion between the rock salt window and the glass bulb will be absorbed for the purpose of preventing cracking of the window.

Another object of this invention is to provide a highly evacuated thermo-couple tube embodying a glass envelope or bulb and a rock salt window, the rock salt window being connected to the glass bulb so as to prevent cracking of the window during or after the tube has been subjected to the high temperatures incidental to the creation of the vacuum.

Another object of this invention is to provide a highly evacuated thermo-couple tube adapted to contain thermo-electric generating units and embodying an optical rock salt window and a lead glass envelope or bulb, the rock salt window and glass bulb being connected by means of a silver sleeve adapted to absorb the strains produced by the unequal expansion thereof, as a result of the high temperatures incidental to the creation of a high degree of vacuum.

Another object of this invention is to provide a highly evacuated thermo-couple tube embodying an optical rock salt window and a lead glass bulb, the window and bulb being united through the instrumentality of a strain absorbing sleeve, the connection of said sleeve with the rock salt window including a sealing means adapted to maintain a high degree of vacuum over an indefinite period and the treatment of the inner and outer surfaces of the rock salt window being such as to prevent the vapor from the rock salt causing a slow deterioration of the tube.

With these and other objects in view, this invention consists in certain novel details of construction, combination and arrangement of parts to be more fully hereinafter described and claimed.

Referring more particularly to the accompanying drawings, in which corresponding parts are indicated by similar reference characters:

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Fig. 1 is a perspective view of the thermo-couple tube constituting the subject matter of this application and illustrating the mounting for the tube;

Fig. 2 is a sectionized perspective of the thermo-couple tube and illustrating the thermo-electric generating units within the tube and the rods connecting the units and extending to the exterior of the tube;

Fig. 3 is a fragmentary longitudinal section of the thermo-couple tube, illustrating the manner of connecting the rock salt window to the lead glass envelope or bulb.

To solve the problem of a suitable window material for thermo-couple tubes, transmission data was obtained on various types of glasses, mica, quartz, rock salt, fluorite, silver chloride and etc. The glasses in general were highly opaque to low temperature radiation lying in the region of that available from airplanes. Of the glasses, lead glass had the most favorable coefficient and it was found that very thin sections gave relatively good results, but these thicknesses were entirely too thin to be used in practical application to thermo-couple tubes. Quartz in crystal and fused form had low coefficients while sodium chloride (rock salt), potassium chloride, and calcium fluoride (fluorite) had relatively high coefficients in thickness which could be used. Sodium chloride was the best due to its transmission of the infrared radiation through a wider range of the spectrum than the other substances. Certain manufactured silver chloride crystals gave high transmission, but these could not be reproduced later. These investigations resulted in the adoption of optical rock salt for window material. The use of rock salt, however, presented some exceedingly difficult problems, among which might be mentioned connecting the rock salt window material to the glass bulb so that the window material would not crack when the tube was exposed to the high temperatures incidental to evacuation; sealing the rock salt window so as to maintain the high vacuum over an indefinite period; providing a suitable sealing material having a high coefficient for low temperature radiation and preventing vapor from the window material causing slow deterioration of the tube. After many experiments, the tube forming the subject matter of the instant application was finally developed and this tube which is an improvement of that disclosed in my Patent No. 2,125,133, entitled "Evacuated Receptacle," issued July 26, 1938, briefly stated, consists of a lead glass bulb 4, an optical rock salt window 7 connected to the bulb by means of a silver sleeve 8, the latter having

one end fused to the glass bulb and the other end sealed to the rock salt window, the inner and outer surfaces of the window being treated with a suitable asphaltum varnish 13.

In the illustrated embodiment characterizing this invention A is a mounting for the thermocouple tube B. This mounting consists of a cylindrical portion 1 into which the tube B is adapted to be inserted, a pedestal 2 adapted to seat in a suitable support (not shown) and 3 a terminal panel carrying suitable terminal plates for the conductors extending to the exterior of the tube.

Thermocouple tube B which is positioned in cylinder portion 1 of the mounting, as shown in Fig. 1, consists of a lead glass envelope or bulb 4 which is sealed at its outer end by the stem or press 5 and open at its inner end as at 6. An optical rock salt window 7 is connected to the edge of opening 6 by means of a cylindrical metallic sleeve 8 preferably of silver, although other metals having the requisite strain-absorbing powers may be used. Silver sleeve 8 is tapered from its central portion 9 to its opposite ends 10 and 11, as clearly shown in Fig. 3 of the drawings. The edge of bulb 4 surrounding its open end 6 is fused over the end 10 of silver sleeve 8.

In order to seal the free end 11 of sleeve 8 to the rock salt window 7, the inner surface of the latter adjacent its periphery is formed with an annular groove 12, V-shaped in cross-section, as clearly shown in Fig. 3 of the drawings. Annular groove 12 is adapted to be filled with an inorganic salt, in the present instance, silver chloride, the salt at the time of its insertion in the groove being in a plastic state. Silver chloride was selected as a seal because of its high transmission coefficient for low temperature radiation. When groove 12 has been properly filled with the silver chloride, the edge 11 of sleeve 8 is forced through the material and into groove 12 until it reaches the position shown in Fig. 3.

After the silver chloride has hardened the edge 11 of the silver sleeve 8 will be effectively sealed in the groove 12 so as to maintain a high degree of vacuum over an indefinite period.

By connecting the rock salt window 7 to the glass bulb 4 through the instrumentality of sleeve 8, the strains resulting from the difference in expansion of the glass and the rock salt window will be absorbed by the sleeve and thus cracking of the window will be prevented when the tube is exposed to the high temperatures incidental to evacuation. As the evacuation temperatures also cause the rock salt window to give off certain vapors, and to prevent these vapors causing tube deterioration, the inner and outer surfaces of the window are coated as at 13 with a suitable varnish such as asphaltum or the like.

Within the tube B are mounted thermo-electric units a and b which in the present instance are in the form of thermocouple strips 15-16 arranged end to end and connected in bucking relation. Each of the strips 15-16 is composed of electrically dissimilar metals 17 and 18 united along junction line 19, as clearly shown in Fig. 2 of the drawings. The outer elements 17 of the respective strips are connected to vertically dis-

posed bars 20-21, while the inner elements thereof are bent backward and connected to the vertically disposed bar 22, as clearly shown in Fig. 2 of the drawings. Bars 20-21 are connected to and supported by rods 23-24 while bar 22 is connected to and supported by rod 25. These rods extend through the tube and to the terminal plates (not shown) on panel 3 of mounting a, as will be understood without further discussion. Although in the present instance thermocouples a and b are of the type described and claimed in the application of Laurens A. Taylor, filed November 29, 1939, Serial No. 306,755, it is to be understood that if desirable other units may be employed such as those described in the copending applications of Charles F. Green, filed November 29, 1939 and serially numbered 306,753 and 306,754, respectively.

In conclusion, it will be seen this invention provides a thermocouple tube having a rock salt window which will not crack when the tube has been exposed to the high temperatures incidental to the creation of a high vacuum; which will maintain the vacuum over an indefinite period and which because of its high degree of vacuum characteristics will provide an extremely sensitive thermocouple tube.

Having described my invention, what I claim as new and wish to secure by Letters Patent is:

A thermocouple tube comprising a lead glass envelope open at one end and sealed at the other, a rock salt window for the tube, coating means on the inner and outer surfaces of the window to prevent slow tube deterioration, said coating means being substantially coextensive with the inner surface and coextensive with the outer surface on said window, a silver sleeve connecting the rock salt window and the edge surrounding the open edge of said envelope, said edge being fused over the inner end of the sleeve, means for sealing the free end of the sleeve to the rock salt window, said means including an inorganic salt having a high transmission coefficient for low temperature radiation, means in connection with the peripheral edge of said window to effect a reduction in radiation losses, said means including a coating of platinum black applied to said peripheral edge, and thermo-electric generating means within the tube.

AUGUST J. KLING.

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