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SELF-VENTILATING THERMOCOUPLE WELL

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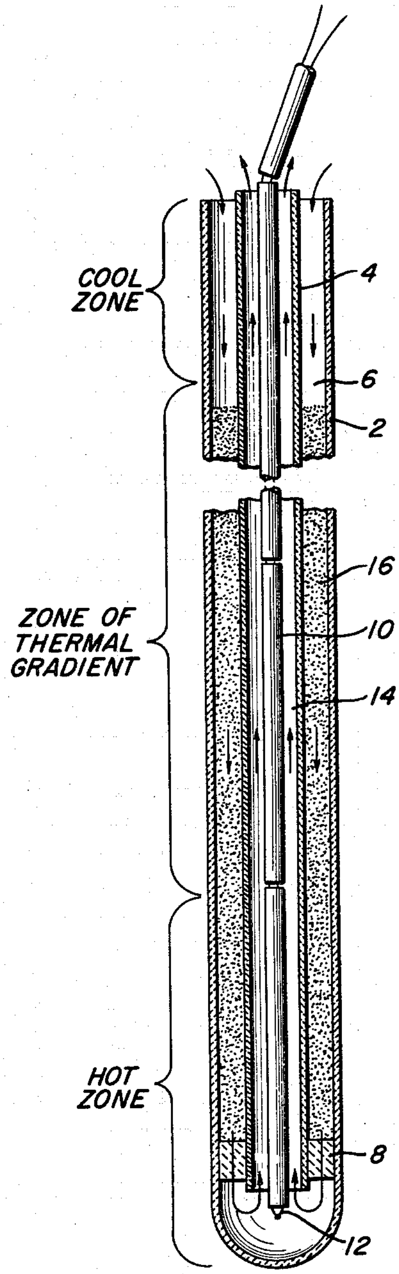

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SELF-VENTILATING THERMOCOUPLE WELL

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1 Claim. (Cl. 136—4)

The present invention relates generally to thermocouples and more particularly to an improved protective tube or well for thermocouples especially suitable for protecting thermocouples from contaminating gases.

One of the most common causes of failure of noble-metal thermocouples is contamination of the noble-metal wires and the hot thermal junction brought about by the action of reducing gases in the atmosphere where the thermocouple is being used.

Although thermocouples in normal use are ordinarily encased in a protective tube made of refractory material such as porcelain or the like, they are susceptible to the detrimental effects of the action of reducing gases if such gases are present in the surrounding atmosphere. I have found that these gases permeate to some degree the walls of conventional protective tubes no matter what the composition of the tubes may be.

The problem of inaccurate noble-metal thermocouple performance is particularly acute in the iron and steel industry where a substantial amount of reducing gas is produced. For example, blast furnace gas, which contains a high percentage of CO, is used to heat blast furnace stoves. While the heating gas passing through a stove in any given period contains a predominance of CO_2, it is well known that there are isolated areas in the stove where the gas is predominately CO. If one of the stove thermocouples is located in one of these areas its accuracy will be detrimentally affected. The CO permeates the wall of the protective tube or well of the thermocouple and reacts with other elements inside the tube so as to form contaminants which deposit upon the noble-metal wires of the thermocouple. For example, the CO may react with iron oxide which may be present in the atmosphere within the tube in the form of flue dust, or it may react with silicon from the tube itself. In the former case, disassociated FeO is formed, and in the latter volatilized SiO is formed. Under reducing conditions both of these lead to alloying of the noble-metal of the thermocouple as contaminants to an extent sufficient to seriously alter the thermoelectric properties thereof.

My objects are to prevent such reducing action within the thermocouple well or tube; to provide means for this purpose in the form of a self-ventilated thermocouple tube or well having airflow-inducing means incorporated therein; and other objects as will be manifest from the following description and drawing.

These and other objects will become more apparent after referring to the following specification and attached drawing, in which a device embodying my invention is illustrated in longitudinal section by way of example.

The illustrative embodiment shown in the drawing is a thermocouple well including an open top outer refractory tube 2 which may be made of porcelain or other suitable material as preferred. An inner tube 4, which may be similar in composition to tube 2, having open ends is concentrically disposed within the tube 2.

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The diameter of tube 2 is greater than the diameter of tube 4 to the extent that an annular space 6 is provided between the outer wall of tube 4 and inner wall of tube 2.

The bottom of tube 4 is spaced from the closed bottom of tube 2 and is surrounded by a solid ring 8 of porous refractory. The ring 8 may be rigidly affixed to tube 4 or any other suitable means as desired. The outer periphery of ring 8 engages the inner wall of tube 2 and wedges the tube 4 in centralized position relative to tube 2.

An insulated noble-metal thermocouple 10 of conventional design having a hot junction 12 at one end and a cold junction (not shown) at its other end is suspended in the tube 4 with an annular space 14 between the exterior of the thermocouple and the interior of the tube 4. The "Cool," "Thermal Gradient," and "Hot" zones of the thermocouple well, that exist when the device is in normal use, have been indicated and labeled in the figure of the drawing.

Dry porous refractory 16, in powder form, fills the annular space 6 from the refractory ring 8 substantially up to the bottom of the "Cool" zone.

When the device of the invention is in normal use it is vented, in a manner to be more fully described, by the circulation of air passing into the annular space 6 from the open end of tube 2 inwardly through the refractory powder filling 16 and ring 8 and then outwardly through annular space 14 surrounding thermocouple 10, as indicated by the arrows in the figure. The motive force for inducing and maintaining the circulation of air as just described is based on the well known physical phenomenon of thermal transpiration. The refractory filling 16 provides a multiple series of orifices in the "Thermal Gradient" zone portion of annular space 6 which acts as a thermal pump and forces the air from the cool end of the "Thermal Gradient" zone toward its warm or hot end. Since it is inherent in the metallurgical or other use of a thermocouple that there be a thermal gradient between the hot and cold junctions, this requirement for thermal transpiration is necessarily present. Therefore, all that remains to effect thermal transpiration is to provide a multiple-orifice forming medium in the thermal gradient. The latter is provided by the refractory filling 16. Thus, a means is provided of slow passage of air or other protective atmosphere through the thermocouple well to counteract any reducing gas permeating the well wall. The rate of flow induced by this means is great enough to maintain the atmosphere inside the thermocouple well sufficiently oxidizing as to avoid serious contamination of the thermocouple and at the same time is sufficiently small that the temperature within the well is substantially unaltered thereby. Too rapid passage of air or other protective atmosphere through the thermocouple well, as could easily result from forced air passage, would seriously alter the temperature inside the well and consequently detrimentally affect the efficiency of the thermocouple. Moreover, usual equipment for forced passage or circulation is apt to be cumbersome, awkward or otherwise impractical in the desired location for the thermocouple.

I have obtained optimum results by using dried magnesium oxide (MgO) powder of approximately .05 micron particle size as the refractory filling 16. Satisfactory results were also obtained by using dried rouge (Fe_2O_3) or levigated alumina (Al_2O_3) of .05 to .5 micron particle size. The refractories in each case were dried by baking for 1 hour at 1000° to 1200° C. before being packed into the tube. After the refractory has thus been dried and placed in the annular space 6 it may be tamped lightly by hand or rammed under slightly higher pressure by suitable mechanical means without affecting subsequent thermal transpiration.

Although I have mentioned specifically only MgO, Fe_2O_3 and Al_2O_3, it will be noted that other refractory materials having sintering temperatures above the range of temperatures to be checked may be used as refractory filler **16**.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claim.

I claim:

A self ventilating well for a noble-metal thermocouple which comprises an outer tube having a closed bottom and open top, an inner tube having an open top and an open bottom concentrically disposed within said outer tube with its outer wall spaced from the inner wall of said outer tube and its bottom spaced from the bottom of said outer tube, said inner tube being adapted to receive said thermocouple therein in concentric spaced relation, and refractory powder in the space between the outer wall of said inner tube and the inner wall of said outer tube, said refractory having a sintering temperature above the range of temperatures to be measured by said thermocouple and being of approximately .05 to .5 micron particle size.

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