

Jan. 17, 1950

C. A. MABEY
WET BULB THERMOMETER
Filed Feb. 17, 1945

2,494,769

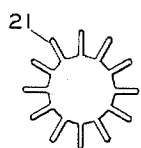
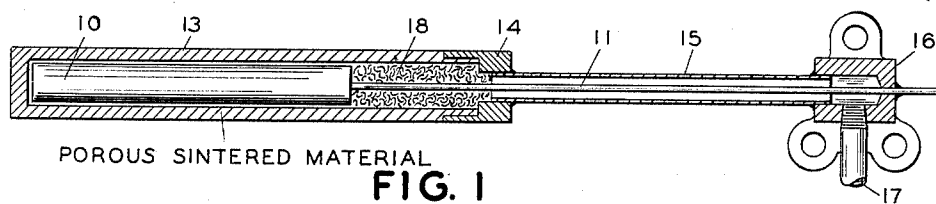


FIG. 2

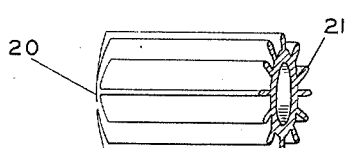


FIG. 3

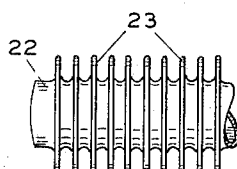


FIG. 4

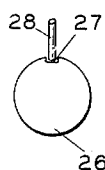
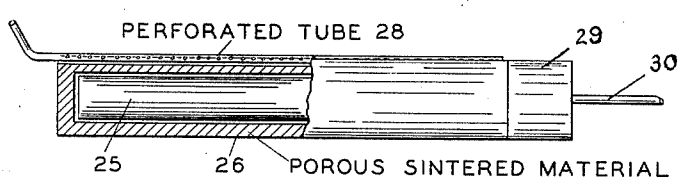


FIG. 5



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UNITED STATES PATENT OFFICE

2,494,769

WET BULB THERMOMETER

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Application February 17, 1945, Serial No. 578,489

4 Claims. (Cl. 297-2)

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This invention relates to psychrometric or hygrometric apparatus, of the so-called "wet-and-dry-bulb" class, and more especially to means for maintaining the wet bulb in a uniformly and consistently moist condition. The underlying theory, basic limitations, and problems attending the use of the wet bulb in hygrometry are discussed in detail in my co-pending application Serial No. 534,541, filed May 8, 1944, now Patent No. 2,435,632, dated February 10, 1948, and relating to certain improvements in that field. The use of cloth wicks for the purpose of moistening a temperature-sensitive bulb is open to many objections, including their tendency to foster corrosion, due apparently to aeration of the water, and the difficulty of maintaining the fabric in a satisfactorily clean condition. Moreover, at high temperatures, cloth wicks and capillary feeding become increasingly impracticable. Ceramic tubes, on the other hand, are fragile, are relatively thick-walled, poorly conductive to heat, and, because of unfavorable manufacturing tolerances, cannot be fitted closely to thermometer walls, thereby requiring for satisfactory operation the interposition of some material of high thermal conductivity, as set forth in said copending application Serial No. 534,541.

It is an object of the present invention to provide, for the purpose of hygrometry, a "wet bulb" which shall be characterized by a more rapid rate than heretofore available of transmission of surface temperature to the sensitive element.

It is a further object to provide a wet bulb which shall have great mechanical strength.

It is a further object to provide a wet bulb formed of a material which may be manufactured on a quantity basis with a high degree of precision in mechanical dimensions and a corresponding degree of uniformity in thermal transmission characteristics.

It is a further object to provide a wet bulb which may have its fitting surfaces readily machined to any desired form and dimensions.

It is a further object to provide a wet bulb the condition of whose surface may be predetermined, and, once established, shall be permanent.

It is a further object to provide improved means for maintaining the surface of a bulb of the class described in a permanently moist condition.

In carrying out the purposes of the invention, it is proposed to encase a temperature-sensitive bulb or element which may be of more or less conventional type, in a sleeve formed of porous metallic material characterized by high thermal

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conductivity, relatively great mechanical strength, and permanence of surface characteristics. It is further proposed, in those instances where it may be found undesirable to force the moistening water through the whole thickness of the sleeve, to provide means for moistening the exterior surface of the sleeve whereby to reap the full advantage of the capillarity of the porous material without transmitting said water any appreciable distance through the mass of the same.

In the drawings:

Fig. 1 is a sectional view of a porous metal sleeve embodying the principle of the invention, and utilized in combination with a temperature-sensitive bulb of a conventional type.

Figs. 2 and 3 are end and side elevations, respectively, of an alternative form of sleeve suited to the purposes of the invention.

Fig. 4 is a side elevation of a further alternative form of sleeve.

Figs. 5 and 6 are end and side elevations respectively (the latter partly in section) of a further alternative form of bulb embodying the principle of the invention.

Referring now to the drawings:

The numeral 10 designates an extended hollow cylindrical metallic bulb containing a temperature-sensitive medium, which may be a volatile or expansible fluid, and adapted for connection by means of a capillary tube 11 to a pressure-responsive device of conventional type (not shown in the drawings) whereby to provide a measure of the pressure within said bulb, and hence of the temperature of the walls and contents thereof.

In keeping with the spirit of the invention, the bulb may alternatively contain means to produce an electrical effect representative of temperature variations, said means being either in the nature of a winding formed of a material having predetermined resistance/temperature relations, or of a thermoelectric junction developing a measurable electrical potential in correspondence with temperature conditions. It will be understood that should said electrical means be utilized, the tube 11 will be replaced by, or will contain, suitable conductors, and that similarly suitable electrical instrumentalities will be provided for determination of temperature as producing said electrical effect.

Enclosing the bulb 10 is a sleeve or envelope 13 formed of porous metal, preferably of somewhat greater length than said bulb, closed at one extremity and internally dimensioned to provide a clearance fit, whereby there will exist between the inner wall of said sleeve and the outer wall

of said bulb an annular space sufficient to permit the passage of water by seepage or capillarity. The technique of manufacturing suitable shapes of porous metal articles is well known, one such method being fully set forth in U. S. Letters Patent No. 2,310,061, granted to O. R. Bowen, February 2, 1943. The process disclosed in said Bowen patent involves the mixing of metallic powders in suitable proportions, together with certain substances to act as die lubricants, forming the mixture into an article of the desired shape by briquetting and then sintering the formed article under suitable temperature and atmospheric conditions, for which process no invention is herein claimed.

The open end of the sleeve 13 is terminated by a metallic collar 14, sealed thereto, as by soldering, and also having connected thereto and surrounding the capillary tube 11 an extended tubular portion 15 formed preferably of material having a relatively low thermal conductivity, such, for example, as stainless steel. The extended portion 15, in turn, is carried by a hollow structure 16, through the wall of which passes in sealed relationship the capillary tube 11, and having an attachment opening 17 adapted for connection to a constant-level water box, not shown in the drawing, or to other suitable source, whereby may be maintained a constant head of water within the sleeve 13.

In assembling the apparatus, the bulb 10, being preferably shorter than the sleeve 13, is pushed as far as possible into said sleeve, and the space between the end of the bulb and the collar 14 may be filled with a porous non-conducting medium 18, such as glass wool. In operation, the exterior surface of the sleeve 13 is exposed to the atmosphere whose moisture content is to be determined, and the interior thereof, including such annular space as may exist between the inner walls of the sleeve 13 and the outer surface of the bulb 10, as well as the space occupied by the non-conducting material 18, and the space within the tubular extension 15, is filled with water supplied thereto through the attachment 17. The water permeates material of the sleeve 13, causing the surface to become moist, and to remain so, whereby the temperature of the assembly, including the bulb 10 will be the "wet bulb" temperature required for the purpose of humidity determination. The remoteness of the bulb 10 from the mounting 16, and the general non-conducting nature of the interconnection, including the influence of the material 18 within the sleeve 13 in inhibiting convection currents in the contained water, combine to prevent the transfer of appreciable heat between said bulb and said mounting, whereby errors due to undesired heat transfer are reduced to a minimum.

Experiment has shown that the normal surface of sintered metal objects is not readily wetted by water, but that this characteristic is eliminated by natural tarnish. The tendency of a porous sintered metal sleeve in service is therefore to acquire a surface of the desired hydrophilic nature; and it has been found that such a surface, once formed, will be retained, and will remain effective over extended periods of time.

In Figs. 2 and 3 is shown a sleeve 20 formed of porous sintered metal and provided with axially disposed fins 21, whereby the exposed surface is greatly increased, and the time of response to temperature variations correspondingly reduced. In Fig. 4 is shown an alternative form of sleeve, in which a body part 22 is provided with

radially disposed fins 23. The molding processes by which porous metal products are formed readily lend themselves to the manufacture of sleeves having surface conformations such as shown in Figs. 2, 3 and 4; and the relatively great strength of the material permits the use of much thinner sections than would be practicable with a ceramic product.

In Figs. 5 and 6 is shown an alternative form of porous metal sleeve embodying the principle of the invention, and differing from that shown in Fig. 1 primarily in the manner in which the surface is maintained in a moist condition. A temperature-sensitive bulb 25, identical in all respects to the bulb 10 shown in Fig. 1, is similarly enclosed in a sleeve or envelope 26 formed of porous sintered metal. On the upper surface of the sleeve 26 is formed a groove 27, constituting a shallow trough from which water may be distributed over the whole surface of the sleeve. Positioned within the groove 27 is a small tube 28 having minute lateral perforations, whereby, when said tube is connected to a source of water supply at a suitable constant pressure, said water will exude from said perforations at a rate sufficient to compensate for evaporation, and maintain the surface of the sleeve in a uniformly moist condition. The open end of the sleeve 26 is terminated by a metallic collar 29 sealed thereto and corresponding to collar 14, except that said collar 29 is sealed directly to the capillary tube 30 which extends from bulb 26. It will, of course, be understood that heat-insulating material may be included within sleeve 26, between the bulb 25 and collar 29.

In the construction shown in Figs. 5 and 6, it is not necessary that the water be transmitted through the whole thickness of the porous sleeve 26, which minimizes the possibility of malfunctioning due to the pores in the material becoming clogged with solid matter after long periods of operation. Furthermore, the external application of water eliminates undesirable effect due to possible filling of the pores of the internal surface of the sleeve when reaming the same to its final dimensions, and does away with the need for the extreme care which might otherwise be demanded in this mechanical operation.

The terms and expressions which I have employed are used as terms of description and not of limitation, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

I claim:

1. A wet bulb thermometer comprising a thermometer bulb, a porous metal sleeve covering said bulb at one end and extending beyond the other end of said bulb, and fluid-circulation-inhibiting fibrous material within the portion of said sleeve which extends beyond said other end of said bulb.

2. A wet bulb thermometer comprising a thermometer bulb, a porous metal sleeve covering said bulb at one end and extending beyond the other end of said bulb, fluid-circulation-inhibiting fibrous material within the portion of said sleeve which extends beyond said other end of said bulb, and means for supplying water to the space occupied by said insulating material.

3. A wet bulb thermometer comprising a thermometer bulb, a porous metal sleeve covering said bulb at one end and extending beyond the other end of said bulb, fluid-circulation-inhibiting

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fibrous material within the portion of said sleeve which extends beyond said other end of said bulb, and means for supplying water to said sleeve.

4. A wet bulb thermometer comprising a thermometer bulb having means extending therefrom for connecting said bulb to a temperature-measuring apparatus, a porous metal sleeve surrounding said bulb, said sleeve being of substantially greater length than said bulb and having an open end, fluid-circulation-inhibiting fibrous material in said sleeve between an end of the latter and said bulb, and a fitting secured to said open end and having an opening for passage of said connecting means.

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