

Feb. 18, 1964

A. C. JASON ETAL

3,121,853

HYGROMETRIC ELEMENTS

Filed March 29, 1961

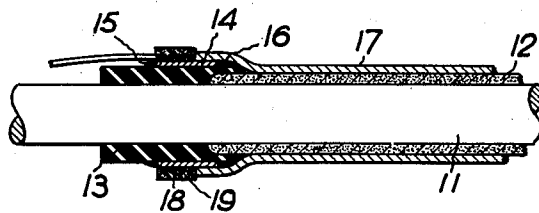


Fig. 1.

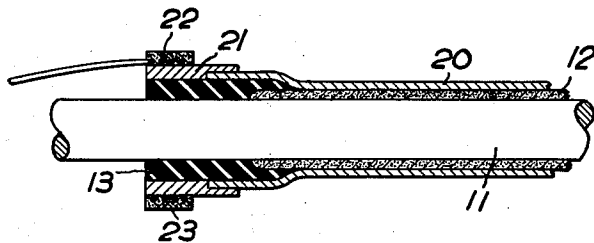


Fig. 2.

INVENTORS:
ALFRED CHARLES JASON
ALEXANDER LERS

By
Stevens, Davis, Muller & Mosher
Attorneys

1

3,121,853

HYGROMETRIC ELEMENTS

Alfred Charles Jason and Alexander Lees, both % Torry Research Station, Aberdeen, Scotland
Filed Mar. 29, 1961, Ser. No. 99,308
14 Claims. (Cl. 338—35)

This invention relates to hygrometric elements of which the humidity responsive element is a layer of porous metallic oxide, the electrical properties of which layer (notably the effective capacitance and resistance) vary with variations in humidity, the layer being included between electrodes one of which is porous. Thus it has been proposed to provide a base of conducting material (e.g. a plate of aluminium) with a thin film of metallic oxide (e.g. aluminium oxide produced electrolytically) and a thin metallic foil such as gold leaf or a layer of gold, silver or other metal deposited by evaporation or cathode sputtering, the foil being thin enough to permit absorption and dissipation of moisture through it by the oxide layer. British patent specification No. 732,969 discloses the use in a similar element, of a coherent conductive vapour-permeable deposit of graphite instead of a thin film of metal. That specification also discloses an element of rod form, the base electrode being an aluminium wire and it further discloses details of electrolytic processes for forming a layer of alumina on an aluminium base which yield elements of high electrical breakdown strength and a low proportion of failures.

Elements of rod form produced as described in the said specification No. 732,969 have been found extremely sensitive but have also been found to change their electrical properties markedly with age when subjected to cycles of high and low humidity e.g. 90 to 30 percent, the change always being in the direction of lower sensitivity.

An object of the present invention is to mitigate if not arrest this ageing phenomenon. The alumina layer produced as described in the former specification contains numerous fine pores extending nearly down to the base and the change in electrical properties with humidity is due to a variation in the amount of water adsorbed on the pore sides. This adsorption is believed to be governed by the presence on the pore sides of ions derived from the acid in which the electrolytic oxidation has been performed. Specification No. 732,969 describes the use of chromic or oxalic acid and British patent specification No. 805,051 the use of sulphuric acid. The loss of sensitivity is believed to be due to the migration of relatively light anions resulting from the electrolytic process, away from the pore sides and into the mass of alumina.

The present invention proposes to reinforce or replace the light anions by a different, heavier ion of much smaller mobility that is anions having a molecular weight of more than 200 or a diameter in excess of 10^{-7} cms. The elements produced by the methods described in the above-mentioned specification 805,051 or similar methods using sulphuric acid are stored for 3 to 6 months at normal humidity (about 60 percent) and temperature. They are then dipped, for a period not less than one second in a saturated solution of a salt containing large or heavy anions. Such a salt is an alkali metal tungstate, specifically sodium tungstate. The period should not exceed one minute, otherwise tungstate crystals subsequently form which lead to electrical breakdown of the element. If the elements are then cycled between high and low humidity it is found that they age rapidly and their physical characteristics become adequately stabilised at a useful high sensitivity. It is found that the relation between humidity and electrical properties is more nearly linear than was the case with the undipped elements.

2

In addition to the above described treatment, improvements have been made to the mechanical construction of the element.

It will be convenient to describe these with reference to the accompanying drawings illustrating two examples both in longitudinal section.

In both cases there is a central stem 11 of aluminium on which an aluminium oxide layer indicated generally at 12 is produced and treated as above described. Over a portion of the stem beyond the end of the oxide layer 12 a thin sleeve 13 of insulating material, preferably an epoxy resin is applied to the unoxidised metal so that it overlaps the oxide 12 for a distance which in the case of a stem of wire of perhaps $\frac{1}{16}$ inch diameter overlaps the oxide for a distance for about 1 mm.

In the case of FIGURE 1 on to the insulating sleeve 13 and close to the portion which overlaps the oxide layer 12 is applied a short thin sleeve 14 of metal such as aluminium. This sleeve 14 is secured at both ends by two thin bands 15, 16 of insulating material applied in the form of a solution, care being taken to make the surface as continuous as possible at the oxide end. The porous film of conductive metal such as aluminium 17 is then evaporated on to the oxide layer 12 and over the insulating sleeve 13 at this end and is continued sufficiently far to make electric contact with the conductive metal sleeve 14. A thin connecting wire 18 is wound round the exposed part of the sleeve 14 and is protected and secured with a coating 19 of cement, preferably an epoxy resin.

The construction shown in FIGURE 2 is preferred however as it is simpler. In this case the outer film of porous metal indicated at 20 is first evaporated on to the oxide layer 12 and over the sleeve 13 up to a point about 2 mm. short of the end remote from the oxide, thus leaving the insulation clear for a band of this width. On to this band and on to and in connection with the film coating 20 is applied a thin short sleeve 21 of metal such as aluminium. A thin connecting wire 22 is wound round this metal sleeve to make connection with it and is protected and secured with a coating 25 of cement, preferably of an epoxy resin.

In both cases the metal sleeve 14 and 21 respectively may be produced by evaporation and might be of gold instead of aluminium.

The completed element is treated by the method above described to reinforce or replace the light ions by a different heavier ion of much smaller mobility.

We claim:

1. A method of improving the ageing properties of hygrometric element comprising a base electrode of aluminium, a layer thereon of aluminium oxide produced by electrolytic oxidation using sulphuric acid, and an outer porous electrode, in which the element is stored for three to six months at normal room humidity and temperature, and then dipped for a period not less than a second and not more than a minute in a saturated solution of a salt containing large or heavy anions.

2. A method according to claim 1 in which the salt is an alkali metal tungstate.

3. A method according to claim 1 in which the salt is sodium tungstate.

4. A method according to claim 1 in which the element is thereafter cycled between high (e.g. 90 percent) and low (e.g. 30 percent) humidity until it has aged and its physical characteristics have been adequately stabilised.

5. A hygrometric element comprising a base-electrode of aluminium, a layer thereon of aluminium oxide produced by electrolytic oxidation using sulphuric acid, and an outer porous electrode, the light ions normally present in the sides of the pores in the aluminium oxide being replaced by a different ion of much smaller mobility.

6. A hygrometric element according to claim 5 in which the outer porous electrode is of evaporated metal.

7. A hygrometric element according to claim 6 in which the evaporated metal is aluminium.

8. A hygrometric element comprising a base electrode of aluminium wire, a layer thereon of aluminium oxide, and an outer porous electrode of metal evaporated on in which to make connection with the other electrode, a thin insulating sleeve is applied to the unoxidised metal of the core electrode so that it slightly overlaps the oxide layer and the outer porous electrode is applied to overlap the insulating sleeve and make contact with a thin metal conducting sleeve upon which a connecting wire is wound, the wire then being protected and secured by insulating cement.

9. A hygrometric element according to claim 8 in which the outer porous electrode overlaps the metal conducting sleeve but leaves uncovered the portion on which the wire is wound.

10. A hygrometric element according to claim 8 in which the conducting sleeve overlaps the outer porous electrode sufficiently to make a good connection to it.

11. A hygrometric element according to claim 10 in

which the insulating sleeve and the protecting and securing coating are both of epoxy resin.

12. A hygrometric element according to claim 8 in which the conducting sleeve is of evaporated aluminium.

13. A hygrometric element comprising a base electrode of aluminium, a layer thereon of aluminium oxide produced by electrolytic oxidation using sulphuric acid, and an outer porous electrode produced by electrolytic oxidation using sulphuric acid, said element being stored for 3 to 6 months at normal room humidity and temperature, then dipped in a saturated solution of an alkali metal tungstate for a period between one second and one minute, and then cycled between high and low humidity until its physical characteristics are adequately stabilised.

14. A hygrometric element according to claim 13 in which the base electrode is an aluminium wire.

References Cited in the file of this patent

UNITED STATES PATENTS

2,754,378	Ohlheiser	July 10, 1956
2,757,104	Howes	July 31, 1956
2,820,727	Grattidge	Jan. 21, 1958
2,859,318	Ohlheiser	Nov. 4, 1959