

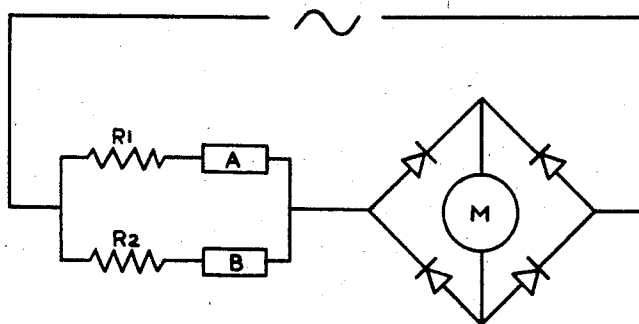
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DEVICES FOR MEASURING RELATIVE HUMIDITY

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1

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DEVICES FOR MEASURING RELATIVE HUMIDITY

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1 Claim. (Cl. 201—63)

This invention relates to devices for measuring relative humidity, and more particularly to devices which are generally known as humidity sensitive elements and which are adapted to exhibit a variable electrical resistance according to the moisture absorbed or adsorbed from the air or gas in which they are placed. Such electrical resistance elements are of relatively low conductivity and are highly porous and capable of adsorbing water vapour from the atmosphere in direct relation to the relative humidity. By "highly porous" is meant having a great number of relatively small pores extending throughout the whole mass and accessible to the air.

Porous ceramic elements have previously been used for this purpose, but elements of this kind heretofore known suffer from the disadvantage that they generally possess a very high dry resistance and a very great variation of resistance with humidity, and these characteristics are considerable impediments to the construction of a simple and robust instrument for measuring the resistance of the elements.

The present invention accordingly has for its main object to overcome these disadvantages, and the invention accordingly consists in a humidity sensitive element comprising a ceramic material possessing a semi-conducting characteristic when in the dry state.

According to the preferred form of the invention, the element comprises an oxide of titanium, and preferably comprises a reduced form of titanium dioxide.

In carrying the invention into effect in one convenient manner, the improved humidity sensitive element is formed from powdered titanium dioxide which is mixed with distilled water, made into slabs or other suitably shaped pieces and dried slowly. Alternatively, the slabs may be formed by dry pressing. The slabs are then fired at 900° C. to 1100° C. in an oxidising or inert atmosphere in order to sinter the material and form a body of suitable strength, after which the slabs are heated in a hydrogen or other reducing atmosphere at about 400° C. to 900° C. for several hours, in order to reduce the titania, the length of time required varying according to the temperature used. The resistivity of the material is found to decrease as the temperature and duration of the heating in hydrogen are increased, but the material is found to possess optimum characteristics if the reduction process is arrested when the material turns a medium blue colour which usually occurs when the composition of the material is between TiO_2 and $TiO_{1.97}$. An alternative method of preparation is to fire the slabs in a reducing atmosphere at 900° C. to 1100° C., and then to partially oxidise them at a lower temperature until the medium blue stage is again reached.

Another method is to fire the material in an inert or oxidising atmosphere at 900° C. to 1100° C., and then in a reducing atmosphere for ½ to 3 minutes at the same temperature.

A still further method is to mix finely divided carbon or other combustible material with unfired titania, sinter in

2

a non-oxidising atmosphere, and burn away the carbon in an oxidising atmosphere. Further modifications of the porous structure may be made by grinding a slab of reduced titania to a fine powder, reforming into a slab, and then firing again.

After cooling, the slabs, formed by any of the above methods, are cut into pieces roughly of the required size and ground to the required shape, the result being a slab of semi-conducting ceramic material which is a semiconductor when in the dry state, but whose resistance decreases substantially continuously according to the amount of moisture which it adsorbs, and the element may thus be readily employed in an instrument for measuring the resistance of the element and thereby the humidity of the air or gas in which it is placed.

Before the relationship between relative humidity and the electrical resistance of each element or batch of elements is established by calibration, the elements are preferably exposed to the normal changes of atmospheric humidity for a period of about six months in order to improve the subsequent stability of calibration. This ageing process may be artificially accelerated, for example by immersing the elements in steam or water for several days.

An element formed of reduced titanium dioxide also has the advantage that it is relatively inert chemically, and the material is readily obtainable in the form of fine particles, which means that the sintered bodies possess the very fine pores which are necessary for adequate sensitivity; a further advantage is that sintered titanium dioxide can be readily reduced until it possesses the desired semi-conducting characteristics.

A further advantage of reduced titanium dioxide is that owing to its comparatively small range of resistance variation, it can be readily incorporated in a measuring instrument. Such an instrument could be made by connecting a humidity sensitive element formed of reduced titanium dioxide in series with a source of alternating voltage and an alternating current microammeter, so that the microammeter may be used to measure the current through the element and consequently the humidity of the atmosphere. The relative humidity scale of such an instrument, however, will be considerably compressed at the dry end and open at the wet end, the scale mark corresponding to 50% relative humidity being quite near to zero. By the addition of a series resistor of the correct value, however, it is possible to put the 50% RH scale mark at the middle of the range, so that the scale is then open in the middle and compressed at each end. The extent of this closing up at the extremes of range, however, depends upon the intrinsic response curve of the element, and by using an element of reduced titanium dioxide, an instrument can be constructed having a much more satisfactory scale spacing than would be possible with an element having a higher range of variation of resistivity.

A simple form of instrument having a substantially uniform scale spacing could be obtained by the arrangement shown diagrammatically in the accompanying drawing in which two elements A and B of reduced titanium dioxide, and two resistors R_1 and R_2 are arranged in a series-parallel combination the resistances of the elements and of the resistors being adjusted so that a nearly linear calibration results.

Conveniently, one resistance and one element of each respective pair are connected in series to form the two arms of a parallel network connected in circuit with an A.C. source and an A.C. microammeter M.

If desired, the elements may be provided with metallic contacts. These may conveniently be formed by applying to the elements a liquid or paste which, after firing at a

suitable temperature, provides an adherent metallic conducting film on which electric leads can be soldered.

I claim:

An electrical resistance element formed of a highly porous non-hygroscopic ceramic having high resistivity which is fixed by the relative humidity of air in contact therewith and varies with the relative humidity of such air, in which the ceramic employed consists essentially of a non-stoichiometric oxide compound of titanium, TiO_x , where x have a value lying between 1.97 and 2.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,886,682

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Stanley Martin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 2 and 3, and line 12, and in the heading to the printed specification, lines 3 and 4, name of assignee, for "British Scientific Instrument Research Corporation", each occurrence, read
-- British Scientific Instrument Research Association --.

Signed and sealed this 1st day of December 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

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