Dec. 6, 1955 L. S. CRAIG ET AL 2,726,305

ELECTRIC HYGROSCOPE

Filed May 8, 1953

Fig. 1.

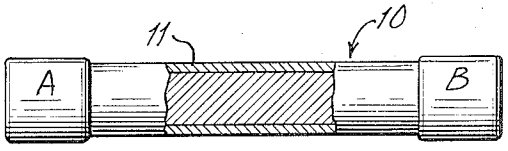
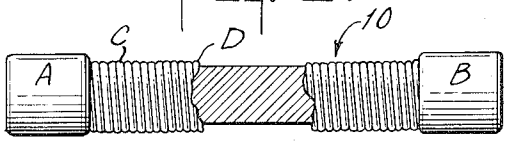


Fig. 2.



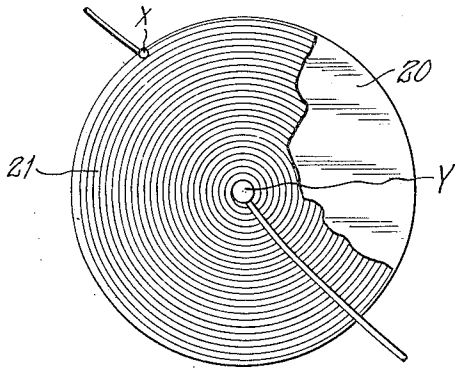


Fig. 3.

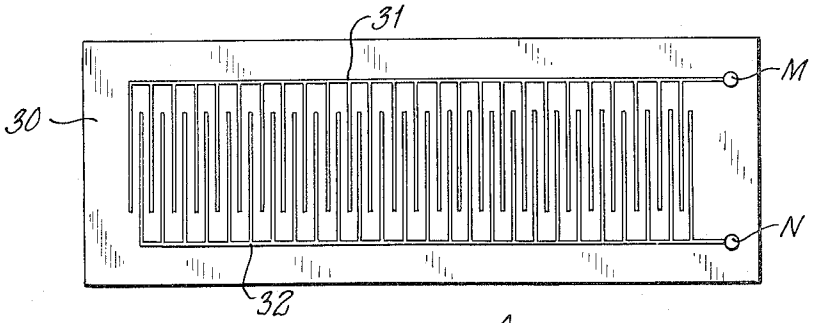


Fig. 4.

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United States Patent Office

2,726,305

Patented Dec. 6, 1955

2,726,305

ELECTRIC HYGROSCOPE

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Application May 8, 1953, Serial No. 353,877

4 Claims. (Cl. 201—63)

This invention is related to our issued Patent 2,714,149, issued July 26,1955.

This invention relates to hygroscopes such as an element whose electrical resistance changes with humidity and in which the resistance of the element may be calibrated to determine the approximate humidity of the air surrounding the element and more particularly to bi-filar wound or formed electrodes.

In the past hygroscopes have been developed to detect humidity and they have taken various forms, for instance, by applying a human hair to an instrument, a pointer was moved over a calibrated scale to indicate approximate humidity. Another type of visual instrument is to indicate the proximity of dew point in atmosphere or gases. A further development was to indicate change in barometric pressure within an air tight container as a measure of the moisture content. The latest in hygroscopes has been with a carbon type humidity element in which the electrical resistance of moisture bearing material (such as carbon) varies directly as the moisture content thereof. The carbon type coating developed and utilized consists of a dilute water solution of: carbon, hydroxy-ethyl cellulose, poly-oxyethylene, sorbitol and alkyl aryl polyether alcohol sprayed on a flat plastic surface with metallic conducting edges or electrodes until the proper resistance is obtained. This sprayed film is in effect a hygroscope in that its resistance changes directly to the moisture absorption of the element. This film may be similarly imposed by dipping or painting the carbon element. But, in all instances, it is necessary to impose a fairly heavy film between electrodes to produce the desired resistance. In these carbon elements, the physical dimensions become excessively large, especially the length of electrodes. The long electrodes are necessary to obtain a sufficiently large number of parallel paths of current between electrodes, to obtain the desired resistance. It is apparent that in the prior art the bi-filar winding or multiple length electrodes have been used to obtain a useable low resistance. In all instances the use of the bi-filar winding with a wood or ceramic element has produced a hygrometer having a negative humidity co-efficient of resistivity. Thus their resistance is lowest when the humidity is highest. It is apparent that all the prior attempts have not been concerned with the effect of ionic impurities and thus we find heavy thick coatings applied to the bi-filar windings (the thick coating provides ample room for the ions to move around). Where these elements are used as an electrolytic resistance hygrometer, the low resistance provided is primarily to increase the response of the element.

In this invention the primary object in introducing a bi-filar conductor or electrode either wound or formed is to produce longer electrodes within the same space limitations provided for a similar type carbon element and thus increase the number of parallel paths available to conduct current. Likewise with the closer spacing between electrodes, the film thickness sprayed or deposited thereon is greatly decreased. This thin film in turn will

produce a very good and quick response. Thus this construction will produce a lower resistance and due to the longer electrodes the efficiency is greatly increased. Further carbon type elements are supposed to have an extremely high positive humidity co-efficient of resistivity and are in fact the only type humidity resistance hygrometers which do have a positive humidity co-efficient; all others have negative humidity co-efficients. It is therefore apparent that only the carbon type elements must be concerned with ionic impurities. For example, a carbon element when coated with any salt solution and exposed to high humidity, the coating must provide room for the ions to move around and in turn the inherent resistance of the element will be low.

It is an object of this invention to provide bi-filar wound electrodes on a carbon element that are coated with a humidity responsive solution to produce an electrical resistance indicating hygroscope.

A further object of this invention is to provide a carbon type hygroscope with a high positive humidity co-efficient of resistivity and an extremely low electrical resistance.

A further object of this invention is to provide a carbon type hygroscope with a one megohm resistance with 90% relative humidity.

A still further object of this invention is to provide a bi-filar wound electrode carbon hygroscope in which the thickness of the film of humidity responsive solution applied to the bi-filar winding is so thin that the effect of ionic impurities is completely eliminated and the inherent resistance of the element will remain low at a high humidity response.

A still further object of this invention is to provide a maximum length of each electrode in a bi-filar wound electrode carbon element hygroscope to increase the number of parallel paths available to conduct current between electrodes and at the same time decrease the distance and resistance between electrodes.

A further object of this invention is to provide bi-filar wound electrodes on a carbon element coated with a minimum thickness of film of humidity responsive solution to reduce the effect of ionic impurities in said film.

A still further object of this invention is to provide a carbon type hygroscope that is coated with a humidity responsive solution in which the magnitude of the film thickness is reduced to a minimum to in turn reduce the ionic impurities that effect the stability of the coating at maximum relative humidity.

Other objects of this invention shall be apparent by reference to the accompanying detailed description and the drawings in which

Fig. 1 illustrates a common carbon type resistance element used as a hygroscope,

Fig. 2 illustrates a carbon type element provided with bi-filar wound electrodes to be utilized as a hygroscope,

Fig. 3 illustrates a carbon type disc hygroscope provided with a bi-filar helix mounted on one face of said disc, and

Fig. 4 illustrates a carbon type hygroscope provided with bi-filar formed electrodes.

Referring to the drawings and especially Figs. 1 and 2 there is illustrated a cylindrical carbon element 10 with metal electrodes A and B positioned at either end of the carbon element. This is similar to other devices illustrated in the prior art. The carbon element 10 must be coated with a humidity responsive solution 11 such as a dilute water solution of: carbon (carbon black and amorphous carbon) hydroxy-ethyl cellulose, poly-oxyethylene, sorbitol and alkyl-aryl-polyether-alcohol sprayed on. Thus the coated element 10, when the electrodes A and B are connected to a calibrated meter, will provide a responsive reading varying with the humidity in the

surrounding atmosphere. Referring to Fig. 2 there is provided a similar carbon type hygroscope with a carbon element **10** and electrodes A and B at either end thereof. However the electrode A is connected to a conductive winding C wound over the complete length of element **10** while electrode B is connected to a conductive winding D which is slightly spaced (1/16") from winding C throughout the entire length of element **10**. Thus the windings C and D become the electrodes and the spacing between electrodes is reduced to the distance between the parallel windings. For example, if the windings C and D are considered as wire electrodes and are spaced 1/16" apart, the cylindrical element is considered 1" in circumference. Thus the length of each electrode will be 16". If the distance between electrodes A and B is 1" as illustrated in Fig. 1 then the distance between electrodes is decreased to 1/16" as illustrated in Fig. 2. Thus the efficiency of the element will be increased by a factor of 16 x 16 or 256 to 1. Referring to Fig. 1 it is apparent that the humidity responsive coating **11** (as in the prior art) must be provided of ample thickness due to the spacing of the electrodes A and B to insure ample parallel paths available to conduct a relatively high shunting current between electrodes. Whereas referring to Fig. 2 the coating or film thickness may be reduced to a minimum due to the close proximity of each electrode (winding C to winding D) to produce relatively low parallel resistance. In fact the film thickness may be decreased 1/256 of the original thickness provided in Fig. 1. This will in effect increase the response of the film while keeping the resistance (between windings or between the wire electrodes) of the same order of magnitude, as originally designed between poles or electrodes A and B. This reduction in film thickness will at the same time decrease the ionic impurities to a minimum as it reduces mobility of the ionic impurities and permits an accurate calibration even at a high relative humidity.

Referring to Fig. 3 there is illustrated a still further embodiment of this invention in which a circular carbon disc **20** is provided and in which a bi-filar helix **21** is affixed or mounted into one face of said disc. The bi-filar helix **21** is provided with two electrodes X and Y. The disc **20** and bi-filar electrodes **21** are similarly coated with a dilute water sloution similar to the solution applied in Figs. 1 and 2. This solution is utilized to produce the humidity response between electrodes. It is apparent that the distance between electrodes will be the distance between the bi-filar windings and the length of the electrodes will be the length of the helix from the periphery of the disc to the center of the disc as illustrated in Fig. 3. Thus a similar result may be obtained with this embodiment to that illustrated in Fig. 2 although the element takes a different form.

Referring to Fig. 4 there is illustrated a still further embodiment of this invention in which a carbon sheet **30** is provided and to which a pair of electrodes M and N are affixed. A pair of formed or stamped electrodes **31** and **32** are positioned in adjacent overlapping relationship as illustrated in Fig. 4. The electrodes **31** and **32** are in turn connected to the electrodes M and N respectively. This unit is coated with a similar dilute water solution as provided in Figs. 1, 2 and 3 and it is apparent that the same improved response and efficiency may be obtained with a hygroscope of this type due to the length of the electrodes **31** and **32** and due to the minimum spacing of the electrodes from each other and thus the provision of a minimum thickness of film coating on the unit.

Although there is disclosed and illustrated a carbon type bi-filar wound or formed hygroscope, the particular configuration of the element or the manner of applying or positioning the electrodes with relation to each other may be varied without departing from the spirit of this invention and this invention shall be limited only by the appended claims.

What is claimed is:

1. A carbon type hygroscope with a high positive humidity co-efficient of resistivity and an extremely low electrical resistance, which includes a carbon core, a pair of electrodes wound in bi-filar form on said core, and a humidity responsive solution coated over said electrodes and core.

2. In a device according to claim 1 in which the humidity responsive solution may be a dilute water solution of: carbon, hydroxy-ethyl cellulose, poly-oxyethylene, sorbitol and alkyl aryl polyether alcohol.

3. In a device according to claim 1 in which the thickness of the film of humidity responsive solution is reduced to a minimum to increase the response of the element while keeping the resistance of the element extremely low.

4. In a device according to claim 1 in which the bi-filar wound electrodes are of maximum length while the distance between electrodes is reduced to a minimum and the magnitude of the coating thickness is reduced to a minimum without affecting the stability of the coating at maximum relative humidity.

No references cited.