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ELECTRIC HYGROSCOPE

Leo S. Craig, Fair Haven, and Allen Kaufman, Elberon, N. J., assignors to Monmouth Electric Company, Neptune, N. J.

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This invention is related to our co-pending application Serial No. 353,877, filed May 8, 1953.

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 a carbon type resistance hygrometer.

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, hydroxyethyl cellulose, poly-oxyethylene, sorbitol and alkyl aryl polyether alcohol sprayed on a flat plastic, glass or ceramic 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 carbon film or paste may be similarly dispersed on a strip of glass or plastic by dipping or painting and metal electrodes provided at either end thereof. The material in the film as described above includes the carbon powder as the conductive material. The remaining ingredients are the dispersing agents and binders and humectant. The action of humidity upon this film or paste is in effect to move the carbon particles further apart or closer together thus changing the resistance of the film. The limitations or deficiencies of this type of carbon element are (1), in order to obtain a sufficiently low resistance for this particular use, a large amount of carbon must be used. With this type of unit it is essential that the unit be fairly or reasonably small. Thus, with a small unit the film thickness becomes so great that in inducing an electrical current through the thick film there is rather a large lag in the reading. To overcome this lag and to obtain a low lag, the unit must be made with a very large surface area, thus, its dimensions are beyond the size permissible for this type unit. (2) At high humidity, that is, above 90% the carbon particles in the coating or paste are moved far apart by the humectant. Thus the inherent film resistance is of the order of megohms. The difficulty with this type of thick carbon paste coating is that if any of the components introduce a parallel resistance which is much less than the basic resistance, this resistance, especially if the impurities are ionic in nature, decreases with increasing humidity. The result is that a maximum resistance is

obtained around 90% R. H. rendering the unit worthless above 90%.

In this invention it is a primary object to provide a carbon type hygrometer in which the carbon paste is mixed with a metal powder and the mixture is applied to a plastic, glass or ceramic strip separating two electrodes and in which the film thickness of this mixture is extremely limited.

A further object of this invention is to provide a carbon type hygrometer in which a carbon paste including a humectant is mixed with powdered silver and the resultant mixture is sprayed or painted or dipped on a plastic, glass or ceramic strip separating two electrodes and in which the carbon and silver coating is extremely thin.

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

A still further object of this invention is to provide a carbon type hygrometer which includes a glass core with an electrode at either end thereof and a thin coating of humidity responsive solution applied to the glass core between the two electrodes in which said humidity responsive solution is comprised of a metal powder, a carbon powder, a dispersing agent, a binder and a moisture absorbing humectant.

A further object of this invention is to provide a carbon type hygrometer in which there is 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 hygrometer that comprises a glass core with a carbon type humidity responsive solution coated on said glass core between a pair of electrodes and in which the magnitude of the film thickness is reduced to a minimum to in turn reduce the ionic impurities that affect the stability of the coating in maximum relative humidity.

Other objects of this invention shall be apparent by reference to the accompanying detailed description.

In using a carbon type hygrometer it is of the utmost importance that the carbon film that will provide a humidity response must be of a minimum thickness. However, the basic deficiency in using carbon is due to its low electrical conductivity. Since the electrical conductivity of metals is decades higher than that of carbon, it is believed that the combination of a metal powder with a carbon paste or powder might enhance the mixture to form a good conductive path between electrodes when the material is coated on a non-conductive core such as plastic, glass or ceramic. It has been found that in such a mixture, the metal particles do not cohere but rather seem to separate and stand off from each other. This would indicate an effective break in an electrical path or chain from one electrode to another. Whereas, the carbon particles tend to cohere and although their electrical conductivity is low, they tend to produce a plurality of conductive paths between electrodes. The mixture of carbon powder and silver thus will produce bridges between the conductive metal particles and in effect the metal particles will assist the conductive path of the carbon particles and raise the electrical conductivity of each path into which the particles become chained. Although there is a material chain reaction of the carbon particles, the metal particles are induced into this chain to shunt out some of the carbon particles and produce the desired increased electrical conductivity between electrodes. Experimenting with various metal powders, silver powder has been found to produce a most desirable result, that is, mixing easily with the carbon powder, having some infinity to bridge or join with the carbon particles and having a high elec-

trical conductivity. Utilizing this new mixture of metal powder with carbon powder and providing the necessary dispersing agents, binders and humectant provides a coating mixture that when applied to a non-conductive core to separate a pair of electrodes will produce a low resistance humidity element with an extremely thin film coating and most important of all this coating produces a tremendously fast response and the element having a low resistance permits the humidity range of the element up close to 100%.

Although there is disclosed in this invention a carbon type hygrometer in which a non-conductive core separates a pair of electrodes and in which a thin film of humidity responsive solution is applied to said core from one electrode to the other and in which this film or core is comprised of carbon powder, powdered metal, a binder, a humectant and a dispersing agent, it is to be understood that the percentages of the ingredients may be varied and the particular metal powder to be utilized may be varied without departing from the spirit of this invention. It is further apparent that other metal powders which do not form superficial oxides in the atmosphere may be similarly used and this invention shall be limited only by the appended claims.

What is claimed is:

1. A carbon type hygrometer which includes a non-conductive core separating a pair of electrodes, a humidity sensitive film coated on said core between said electrodes, said humidity sensitive film including a mixture of carbon powder and conductive metal powders in a 50–50 mixture, said mixture mixed in a dilute water solution with hydroxy-ethyl cellulose, poly-oxyethylene, sorbitol and alkyl aryl polyether alcohol.

2. In a carbon type hygrometer according to claim 1 in which 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.

3. In a carbon type hygrometer according to claim 1 in which the magnitude of the coating thickness is reduced to a minimum without affecting the stability of the coating at maximum relative humidity.

4. In a carbon type hygrometer according to claim 1 in which a percentage of carbon powder to silver powder may be a minimum of 10% silver to a maximum of 90% carbon.

5. In a carbon type hygrometer according to claim 1 in which a percentage of carbon powder to silver powder may be a maximum of 90% silver to a minimum of 10% carbon.

6. In a carbon type hygrometer according to claim 1 in which the conductive metal powder is the precious metals that do not oxidize in air.

References Cited in the file of this patent

UNITED STATES PATENTS

2,256,642 Gaut et al. ---------- Sept. 23, 1941