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WIDE RANGE ELECTRICAL HUMIDITY-SENSING UNIT

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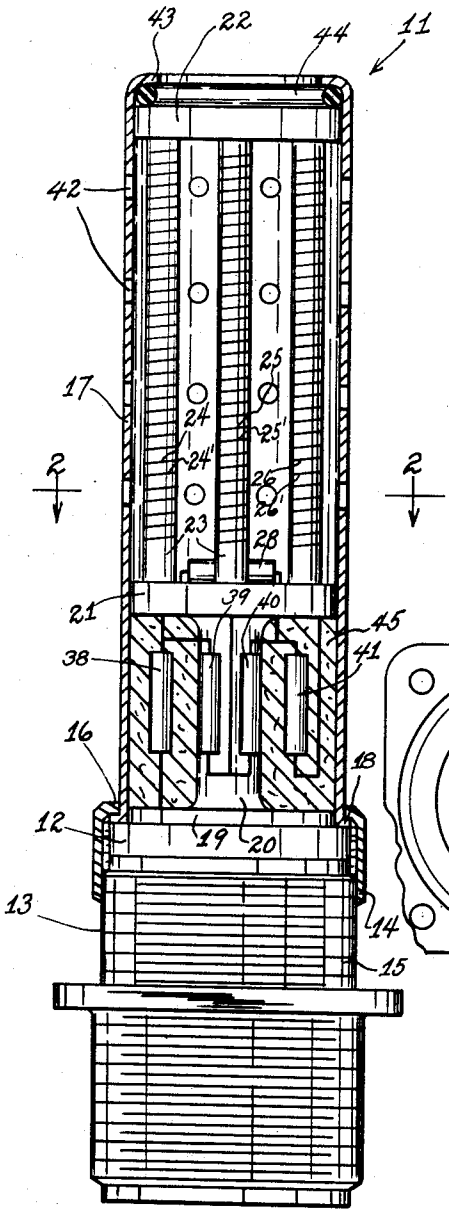


FIG. 1

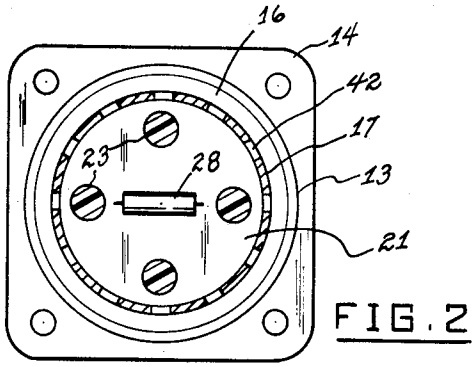


FIG. 2

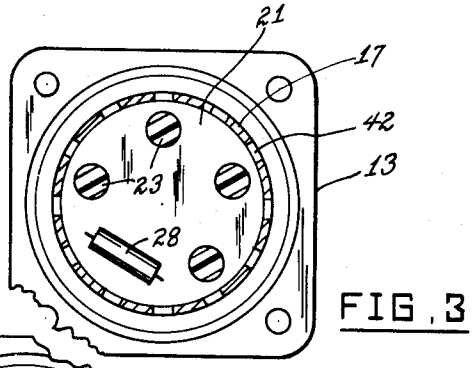


FIG. 3

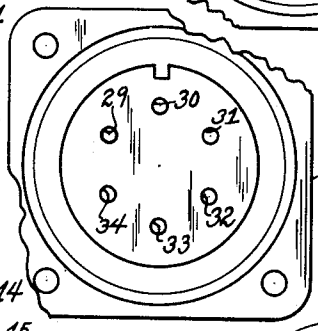


FIG. 4

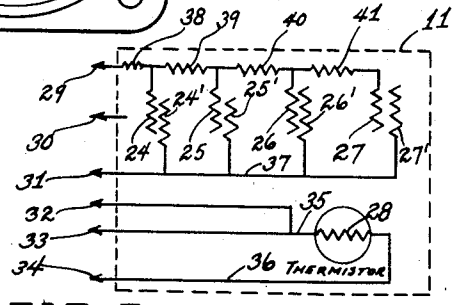


FIG. 5

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WIDE RANGE ELECTRICAL HUMIDITY-SENSING UNIT

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9 Claims. (Cl. 201—63)

This invention relates to humidity sensing apparatus, and more particularly to an electrical humidity-sensing unit of the multiple-element type.

A main object of the invention is to provide a novel and improved humidity sensing unit which is simple in construction, compact in size, and which is arranged to operate over a wide range of relative humidities.

A further object of the invention is to provide an improved electrical humidity-sensing unit of the multiple-element type to cover a wide range of relative humidities, said unit including an electrical compensating network as a unitary part thereof, said unit being inexpensive to manufacture, being rugged in construction, and being stable in performance.

A still further object of the invention is to provide an improved wide-range electrical humidity-sensing unit which provides accurate electrical response over a wide range of humidity conditions, which is highly resistant to shock and vibration, and which is easy to connect into its associated indicating circuit.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a vertical cross-sectional view taken longitudinally through a wide-range electrical humidity-sensing unit constructed in accordance with the present invention.

Figure 2 is a horizontal cross-sectional view taken on the line 2—2 of Figure 1.

Figure 3 is a fragmentary horizontal cross-sectional view similar to Figure 2 but illustrating a modified electrical humidity-sensing unit according to the present invention.

Figure 4 is a fragmentary bottom view of the humidity-sensing unit of Figure 1.

Figure 5 is a schematic wiring diagram showing the electrical connections of the humidity-sensing units of Figures 1 to 4.

Referring to the drawings, and more particularly to Figures 1, 2 and 4, one form of multiple-element humidity-sensing unit according to this invention is designated generally at 11. The humidity-sensing unit 11 comprises a circular base 12 of insulating material which is clamped to a conventional female connector 13 of the pressure-sealed type, by means of a clamping ring 14 which is threadedly engaged on the externally threaded upper portion 15 of the connector 13 and which is formed with an inturned annular clamping flange 16. A cylindrical shield member 17 of suitable rigid material, such as aluminum alloy, is formed at its lower end with an annular outwardly projecting flange 18 which engages the peripheral portion of base 12 and is clamped thereto by the flange 16 of ring 14.

Base 12 is formed with a reduced top portion 19 which fits within the lower portion of shield 17.

Base 12 is integrally formed with an upstanding axial post member 20 which rises from the center of reduced top portion 19. Integrally formed on the top end of

post member 20 is a circular support 21 which is substantially the same in diameter as portion 19 and thus fits closely inside the rigid shield 17. As shown, support 21 is parallel to top portion 19. Designated at 22 is a second circular support of the same diameter as support 21. Support 22 is rigidly connected to support 21 in coaxial spaced parallel relation thereto by a plurality of rod members 23 of insulating material, such as polystyrene, or similar plastic material, said rod members being spaced around the axis of the unit at common radial distances therefrom.

In the form of the invention herein specifically illustrated, four rod members 23 are employed, which may be spaced apart by 90 degree angles, as shown in Figures 1 and 2, or which may be spaced apart by different angles, for example, by angles of approximately 72 degrees, as shown in Figure 3.

Wound on the respective rod members 23 are respective pairs of bifilar conductors 24, 24', 25, 25', 26, 26', and 27, 27', and respective coatings of hygroscopic, humidity-sensitive resistance material, such as lithium chloride, or the like, are provided on said rod members in contact with the bifilar conductors, said bifilar conductors and coatings being formed and arranged so that the conductors and coatings on the different rod members define humidity-responsive resistors having different characteristics. This may be accomplished in any suitable manner, as, for example, by varying the spacing between the bifilar conductors, or by varying the physical characteristics of the coating, such as by varying its thickness.

Thus, the humidity-sensitive element defined by the coating contacting the bifilar conductors 24, 24' may be designed to have its major useful response in a range of relative humidities (at a temperature of 80° F.) of between 41 and 60%, the element defined by the coating on the conductors 25, 25' may be designed to have its major useful response between 26 and 42% relative humidity, the element defined by the coating on the conductors 26, 26' may be designed to have its major useful response between 18 and 33% relative humidity, and the element defined by the coating on the conductors 27, 27' may be designed to have its major useful response between 11 and 23% relative humidity, all at a temperature of 80° F.

In the form of the invention shown in Figures 1 and 2, a temperature sensing resistor 28 is mounted centrally on support 21 within the space defined inwardly of the rod members 23.

Alternatively, as shown in Figure 3, the temperature sensing resistor 28 may be mounted on the outer portion of support 21 so that it is substantially at the same radial distance from the axis of the unit as the rod members 23.

The temperature sensing resistor 28 may be a thermistor of a suitable type, for example, Type L 1215, made by Keystone Carbon Co., Saint Marys, Pennsylvania, having a resistance at 100° F. of about 7,500 ohms and varying in resistance substantially linearly from about 47,000 ohms to about 4,740 ohms over a temperature range from 32° F. to 120° F.

The connector 13 is provided with suitable terminals, for example, the female terminals 29, 30, 31, 32, 33 and 34. Terminals 32 and 33 are connected together and are connected by a suitable conductor 35 passing through base 12 and support 21 to one terminal of the thermistor 28. Terminal 34 is connected by a similar conductor 36 to the remaining terminal of the thermistor.

The respective conductors 24', 25', 26' and 27' of the bifilar pairs are connected to a common wire 37 which extends through base 12 and is connected to the connector terminal 31.

Designated at 38, 39, 40 and 41 are respective compensating resistors which are mounted in the space between base 12 and support 21. Resistor 41 is electrically connected between conductor 27 and conductor 26. Resistor 40 is electrically connected between conductor 26 and conductor 25. Resistor 39 is electrically connected between conductor 25 and conductor 24. Resistor 38 is electrically connected between conductor 24 and connector terminal 29, as shown in Figure 5. The resistors 38, 39, 40 and 41 have suitable values and are interconnected with the humidity-sensitive elements in a manner whereby the resistance between terminals 29 and 31 varies in a definite and easily measurable manner over a wide range of relative humidities which includes and is much greater than the useful range available for each of the humidity-sensitive elements taken alone. Thus, in the typical embodiment of the invention described herein, the unit has a useful range of at least between 11% and 60% relative humidity, at a temperature of 80° F., covering the range between the lower useful limit of the element comprising the bifilar conductors 27, 27' and the upper useful limit of the element comprising the bifilar conductors 24, 24'.

In a typical practical embodiment of the invention, the following values were used for resistors 38, 39, 40 and 41:

Resistor:		Value
38	ohms	910,000
39	do	225,000
40	do	572,000
41	megohms	1.55

The rigid cylindrical shield 17 is formed between supports 21 and 22 with a large number of uniformly distributed apertures 42 to freely expose the humidity-sensing elements and the thermistor to the atmosphere. At its top end the shield 17 is formed with the inturned flange 43, and clamped between said flange 43 and the peripheral portion of the top surface of circular support 22 is a ring member 44 of resilient deformable material, such as rubber or the like. Ring member 44 is under substantial compression and acts as a dimensional filler between flange 43 and support 22. Said ring member also acts as a shock-absorbing means to dampen the transmission of shock or vibration forces from shield 17 to the humidity-sensitive elements. Further damping of such forces is provided by a filling 45 of insulating material, such as wax, or the like, in the space between support 21 and base 12. The insulating material 45 is preferably of a high dielectric character and serves to prevent the formation of resistance leakage paths across the network resistors 38, 39, 40 and 41, which are embedded in the material. Said material also protects the resistors against mechanical damage, dampens the effects of vibrations on the resistors, provides thermal insulation for said resistors, and acts to seal the joint between the internal threads of the clamping ring 14 and the external threads on the upper portion 15 of connector 13.

In use, the unit 11 is conected to a suitable indicator by a multiple-conductor cable having a male connector mating with the female connector 13. The indicator is provided with suitable means to calibrate same in accordance with the temperature, as detected by the thermistor 28, so that the relative humidity will be read directly therefrom, in accordance with the resistance of the humidity-sensitive network, as exhibited between the terminals 29 and 31 of the unit 11.

While certain specific embodiments of an improved wide-range electrical humidity-sensing unit have been disclosed in the foregoing description it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. An electrical humidity-sensing unit comprising a base having a pair of terminals, a pair of parallel spaced supports mounted on said base, a plurality of rod members of insulating material rigidly secured in spaced parallel relation between said supports, respective pairs of bifilar conductors wound on said rod members, hygroscopic coatings of humidity-sensitive resistance material on said rod members in contact with the bifilar conductors, said bifilar conductors and coatings being formed and arranged so that the conductors and coatings on the different rod members define humidity-responsive resistors having different characteristics, means interconnecting said bifilar conductors and terminals, an apertured housing secured to said base and surrounding said supports, and resilient means engaged between said housing and said supports.

2. An electrical humidity-sensing unit comprising a base having a pair of terminals, a first support, a central rigid post member rigidly connecting said first support to said base in spaced parallel relation thereto, a second support, a plurality of parallel rod members of insulating material spaced around said supports, said rod members being rigidly secured between said supports and connecting said supports in spaced parallel relation, respective pairs of bifilar conductors wound on said rod members, hygroscopic coatings of humidity-sensitive resistance material on said rod members in contact with said conductors, said bifilar conductors and coatings being formed and arranged so that the conductors and coatings on the different rod members define humidity-responsive resistors having different characteristics, and means electrically connecting said conductors to said terminals.

3. In combination with the structure of claim 2, a perforated rigid shield secured to said base and surrounding said supports, said shield being provided with an inturned rim at the portion thereof adjacent said second support, and a shock-absorbing resilient ring member disposed between said second support and said inturned rim.

4. In a wide-range humidity-sensing unit, a pair of parallel, rigid, spaced supports, a plurality of rigid rod members of insulating material secured in spaced parallel relation between said supports, respective pairs of bifilar-wound conductors on said rod members, and respective hygroscopic coatings of humidity-sensitive resistance material on said rod members in contact with said conductors.

5. In a wide-range humidity-sensing unit, a pair of spaced parallel disc members, a plurality of rod members of rigid insulating material secured in spaced parallel relation between the marginal portions of said disc members, respective pairs of bifilar-wound conductors on said rod members, and respective coatings of humidity-responsive resistance material on said rod members in contact with said conductors.

6. In a holder for a wide-range, resistance-compensated humidity-sensing unit of the multiple-element type, a base member, a post member rigidly secured to said base member, a first support plate secured to the end of said post member in spaced parallel relation to said base member, defining a space therebetween to receive compensating resistors, a second support plate parallel to said first support plate, and a plurality of rod members of rigid insulating material secured in spaced parallel relation between said support plates and being adapted to receive respective pairs of bifilar-wound conductors thereon and to receive respective hygroscopic coatings of humidity-sensitive resistance material in contact with said conductors.

7. In a holder for a wide-range, resistance compensated humidity-sensing unit of the multiple-element type, a circular base member, a post member rigidly secured to said base member and extending axially thereof, a first support disc axially secured to the end of said post member in parallel spaced relation to said base member, defining an annular space therebetween adapted to receive compensating resistors, a second support disc parallel to

said first disc, and a plurality of rod members of rigid insulating material secured between the marginal portions of said discs and being adapted to receive respective pairs of bifilar-wound conductors thereon and to receive hygroscopic coatings of humidity-sensitive resistance material in contact with said conductors.

8. The structure of claim 7, and a perforated cylindrical cover engaged around said discs and base member, means clamping one end portion of said cover to said base member, and an annular cushioning member of resilient deformable material clampingly secured between the other end portion of the cover and the peripheral portion of said second disc.

9. The structure of cliam 7, and a perforated cylindrical cover engaged around said discs and base member, means clamping one end portion of said cover to said base member, an inturned peripheral flange on the other end portion of said cover, and an annular cushioning member of resilient deformable material clampingly secured between said inturned peripheral flange and the peripheral portion of said second disc.

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