Aug. 21, 1934. W. C. GOSS 1,970,745

HUMIDITY SENSITIVE INSTRUMENT

Filed Oct. 19, 1931 2 Sheets-Sheet 1

Fig. 1

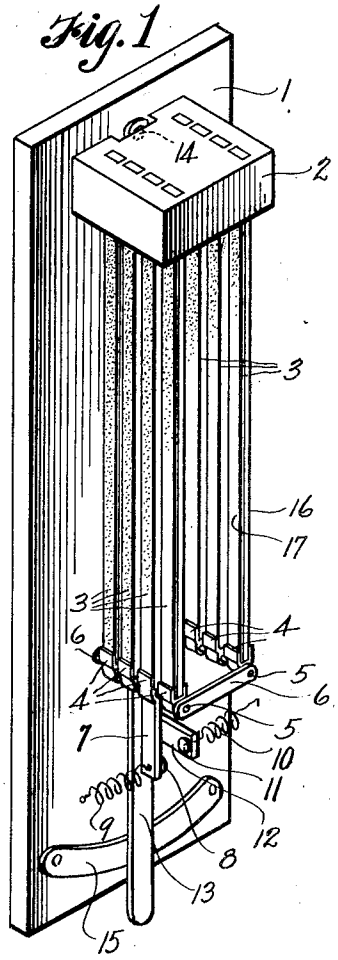


Fig. 3

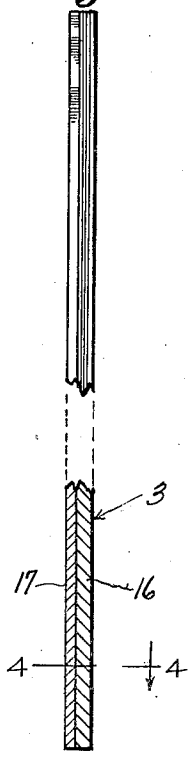


Fig. 2

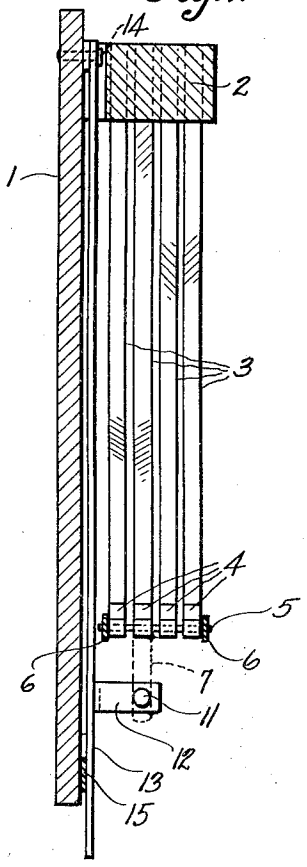


Fig. 4

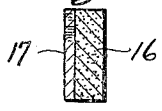


Fig. 5

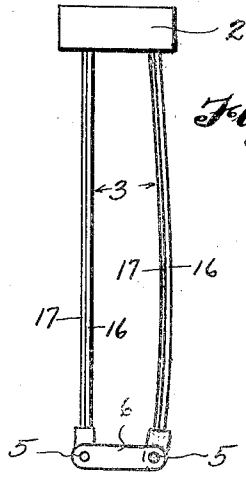


Fig. 6

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HUMIDITY SENSITIVE INSTRUMENT

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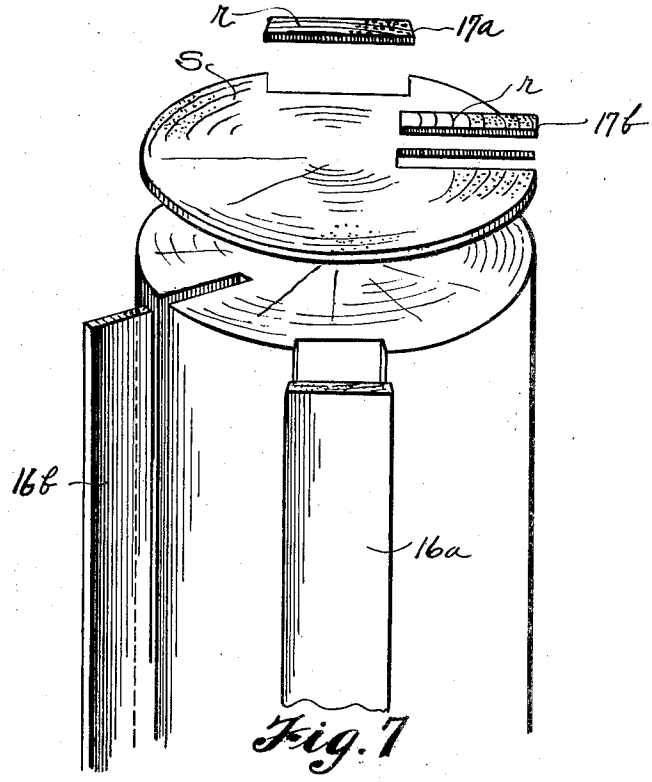


Fig. 7

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UNITED STATES PATENT OFFICE

1,970,745

HUMIDITY SENSITIVE INSTRUMENT

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Application October 19, 1931, Serial No. 569,830

5 Claims. (Cl. 297—1)

This invention relates to humidity sensitive instruments and has reference in particular to an instrument designed to be functionally actuated in accordance with changes of relative humidity of the surrounding air for the purpose of operating a switch, valve, lever or other device, to cause adjustment or operation of a control mechanism with which the element may be associated.

It is the principal object of this invention to provide an instrument of the above character especially useful for humidity control and which will operate with accuracy under all conditions of humidity, which will be extremely sensitive to changes of relative humidity, and which will operate quickly, and will maintain its accuracy and efficiency indefinitely.

It is also an object of the invention to provide a device of the above stated character that is adapted to various uses, that is simple in construction and mode of operation, and which can be manufactured and sold at a small cost.

The objects of the invention reside primarily in the novel arrangement of wooden strips composing the element, especially with reference to their thickness, direction of grain, direction of annual rings and assembled relationship whereby their degree of expansion and contraction is maintained within certain definite limits to avoid any damaging strains or stresses which might operate to render the instrument inaccurate.

In accomplishing these and other objects I have provided the improved details of construction, the preferred forms of which are illustrated in the accompanying drawings, wherein—

Figure 1 is a perspective view of a humidity control device constructed in accordance with the present invention.

Figure 2 is a central, vertical section of the same.

Figure 3 is an enlarged sectional detail lengthwise of the element, particularly illustrating the end grained hygroscopic element and the longitudinal grained backing strip.

Figure 4 is an enlarged cross section taken on the line 4—4 in Figure 3.

Figure 5 illustrates the use of two strips to compensate for inaccuracies.

Figure 6 is a perspective view illustrating the manner of cutting the hygroscopic strips from a wooden board to provide a definite percentage of expansion or contraction incident to humidity changes, and illustrating the position of the board within the log before it is removed therefrom.

Figure 7 is a perspective view explanatory to the methods of cutting the strips.

Explanatory to the invention it will here be stated that in devices of this general character the element or elements are made up of two flat wooden strips, one a hygroscopic facing strip that has an appreciable amount of expansion or contraction incident to changes of relative humidity, and the other a backing strip that is relatively non-expandable or non-contractible for changes of humidity; these two strips being carefully prepared and glued or otherwise suitably fastened together. This element is fixedly mounted at one end with its other end freely movable for actuating an instrument for controlling or indicating purposes. Changes in relative humidity of the surrounding air will cause contraction or expansion of the hygroscopic strip in accordance with the degree of change and this by reason of its connection with the backing strip causes a lateral bending of the element in one direction or the other and this movement of the element is employed to actuate a control device.

Referring more in detail to the drawings—

In Figure 1 of the drawings I have shown the present device as employed for the purpose of opening and closing an electric circuit. The control element proper is mounted on a base plate 1 of electrically non-conductive material. An anchor block 2 is fixed rigidly to the upper end of this base plate and has secured therein the upper ends of the bi-strip elements 3 arranged in tandem series of four elements each. All of these elements are alike in construction and size, and each is fitted at its lower end with a clip 4. Pivot rods 5—5 are extended through the alined clips of elements of each series and links 6—6 pivotally connect the ends of one of the rods 5 with the ends of the other so that the two series of elements are thereby operatively connected and will move together.

It will be here stated that the above described method of mounting and of connecting the elements is only one of a number of different ways of construction and it is not intended that it be confined only to the method described.

Extending downwardly from one of the clips 4 is a flexible or springlike extension leg 7 and this mounts a contact point 8 with which a circuit wire 9, from one side of an electric circuit, connects. A wire 10 from the other side of the circuit connects with a similar contact point 11 that is mounted on an arm 12 carried by an adjustable lever 13. This lever is supported by a pivot 14

fixed in the upper end of the base plate, and the lower end portion of the lever may be moved laterally in opposite directions to adjust the contact point 11 toward or from the contact point 8. An arcuate plate 15 with graduations thereon is attached to the lower end of the base plate beneath the swinging end of the lever, as a gauge for making adjustment of the latter.

With the device so constructed, a circuit may be closed between the circuit wires by bringing the contact points 8 and 11 together and it will be opened when the points are separated. Thus, movement of the element by reason of changes in relative humidity, as presently described in detail, will cause a corresponding movement of the extension leg 7, and this may be made to open or close the circuit at any desired condition of humidity by proper setting of the lever 13.

It will be stated here that various kinds of control devices may be employed in connection with this type of element for opening a switch, for closing a valve, or for doing other work, and the present illustration is merely explanatory to the mode of operation and the various uses to which the device may be put.

In the construction of the various elements of the present device, I employ a backing strip 16 of longitudinal grained wood, preferably Alaska cedar or other suitable wood of similar or like properties. As a facing for the backing, I employ a very thin wooden strip 17 preferably of end grained yew wood, or other suitable wood of similar or like properties.

As a matter of explanation, it will here be stated that by "longitudinally grained wood" I mean a strip of wood in which the fiber forming the grain of the wood extends lengthwise of the strip. By "end grained wood" I mean that the direction of the grain is directly through the strip from face to face as distinguished from lengthwise of the strip, or even crosswise thereof. This would mean that a strip as used for facing would have the pores opening to the flat inner and outer faces of the strip. In a strip as used for the backing, the pores would extend lengthwise and would not be open to atmosphere except at the ends of the strip.

Figure 7 is explanatory to the method of cutting the strips to provide the "longitudinal grained" and "end grained" pieces. In this figure, L designates a wooden log and at 16*a* and 16*b* I have defined strips suitable for use as backing strips. These strips extend lengthwise of the log and therefore the grain of the wood in the strips is lengthwise thereof. Therefore, these are termed "longitudinally grained" strips. The flat inner and outer surfaces of the strip 16*a* are in planes substantially tangential of the annual rings of the log and thus this strip is identified as a "longitudinally grained tangential cut". The flat inner and outer surfaces of the strip 16*b* are radially of the log and therefore this strip is identified as a "longitudinally grained radial cut".

At one end of the log I have shown a slab *s* cut therefrom by cutting through the log in spaced planes perpendicular to its axis and directly through the grain. This slab is identified as an "end grained slab". Cut from this slab are end grained strips 17*a* and 17*b*. The longitudinal direction of the strip 17*a* is substantially tangential to the annual rings *r* of the slab and this strip therefore is identified as a "tangential end grained cut". The longitudinal direction of the strip 17*b* is radial of the slab and the annual rings *r* are substantially directly across the strip, therefore this strip is identified as a "radial end grained cut". Both strips should be carefully selected, to be free of any imperfections. Preferably, the yew wood is treated, such as by boiling in water or other liquid, or otherwise, to remove all material from its cells so that they will be open for easy penetration and intimate contact of air with the cell structure. Also, it has been found that this treatment straightens out the fibers of wood that are bent over on the surfaces of the strip in the cutting and thus permits easier penetration of air into the cell structure and pores of the strip. The strips after proper preparation are secured together by means of a water free glue.

In order to avoid detrimental case hardening taking place in the element after it has been put into use by reason of stretching or compressing the strips beyond their elastic limits, a very careful selection of materials must be made and due consideration must be given to a certain required relationship between the stiffness of the backing strip and the strength and hygroscopic expansion of the facing strip. The backing strip must be sufficiently thin that it may be bent in either direction an extent required to accommodate the full range of humidity changes without causing undue compression to develop within the hygroscopic facing strip when the relative humidity rises to its maximum. Also, the backing strip must have sufficient rigidity or stiffness and resiliency to give it the strength and stability necessary for an efficient instrument, and it must not develop case hardening internally by reason of being bent in either direction.

Alaska cedar has been found to possess to a greater extent than any other wood of which I now have knowledge, those requirements necessary for an efficient and durable instrument, and yew wood most satisfactorily serves for the facing strips by reason of the fact that it may be cut very thin, may be treated to open its pores without detrimental effect, and is a wood that may be bent back and forth many thousands of times and yet always return to its original position.

Very satisfactory results have been obtained with a backing strip approximately .044 of an inch in thickness and a facing strip approximately .024 of an inch thick. This relationship of thickness has been found by experiment to provide an instrument that is sensitive, accurate and which will accommodate the full range of humidity change without change in calibration, that is, the backing strip has the required thickness to give it the strength necessary to provide durability and a high power of restitution, and has the necessary thinness to avoid case hardening within itself or the facing. Also, the facing strip is sufficiently thick to effectually bend the backing strip either under compression or tension, yet is of such thinness that it substantially instantly responds to the slightest change in humidity.

In the construction of elements of this character, it is desirable to have as much movement as possible without subjecting either the facing or backing strip to strain beyond its elastic limit. Thus it is required that careful attention should be given to the preparation, especially of the hygroscopic facing strip. The extent of contraction and expansion to a definite degree is governed by the direction of grain of the piece, and one of the important features of this invention is the method of cutting the strips to provide for a definite percentage of expansion. This method is best understood by reference to Figure 6 of the drawing wherein 20 designates a

board of wood from which a strip 21 is to be cut. As here shown the board has a certain percentage of expansion in the crosswise direction of the grain of the wood and no appreciable expansion in the lengthwise direction, therefore, by cutting the strip in a properly calculated diagonal line, as at 21, a definite percentage of expansion and contraction due to changes of humidity may be provided for; it being understood that this will vary from approximately zero to the maximum possible for this strip of wood, in accordance with the angularity of the diagonal cut.

Heretofore, in the construction of instruments of this character, strips of wood of considerable width have been used, but his results in inaccuracy by reason of transverse cupping of the elements, due to unequal expansion or contraction of the joined strips incident to any quick change in relative humidity. For instance, if the element is perfectly flat at one certain condition of humidity, and the air should suddenly become very dry, the thin facing strip will shrink rapidly in a direction transversely of the strip, while the backing strip, being relatively non-expansible and non-contractible, will respond slowly. Therefore the unequal stresses set up in the two pieces, which are firmly glued together, cause transverse cupping, and this increases the effective thickness of the element and as a natural consequence renders the strip more rigid and thereby retards it in its movement. This naturally makes an error in the reading which will be given or otherwise interferes with action of the instrument.

In the present instance, this above difficulty has been satisfactorily overcome by making up an element from wide strips of material, then splitting it through both strips into a plurality of relatively narrow strips. In the present instance these narrow strips are made about one-eighth of an inch wide, and they are used in multiples of two as presently described, to compensate for possible warping. With the strips cut very narrow, transverse cupping will not occur to any extent that would cause any noticeable variation from a correct reading.

Devices of this character, as heretofore made, also become inaccurate by reason of longitudinal twisting. This will be the result when facing strips are used in which the direction of the annual rings of the wood, as seen on the surfaces of the facing strips, are not directly across the strips. The use of a facing strip in which the direction of the annual rings is angularly across the strip causes the strip to expand or contract unevenly thus to twist in a spiral manner lengthwise and the extent of warping is usually in accordance with the degree to which the direction of the annual ring marks of the material varies from a line directly across the strip. In other words, the greater the angle relative to a direct transverse line, the greater will be the degree of warping of the strip. In the present instance I have overcome this warping tendency by arranging the strips in such manner that the angular inclination of the ring marks of one strip is opposite to and equal to the inclination of those of the strip paired therewith. Thus when the original wide strip is split into thin pieces to avoid cupping, every other piece may be turned end for end so that they constitute pairs of strips in which the direction of the rings in one will be opposed to that of the other. That is, the arrangement is such that the tendency of any one of the individual strips to warp in one direction by reason of the diagonal direction of the ring will be overcome by the use of a complimentary piece, which is arranged to give an equal warping tendency in the opposite direction, and the net result is that the strains balance each other. This arrangement of the pieces is indicated best in Figure 2, where the direction of the annual rings is designated by the shade lines placed thereon. For best results, all facing strips should either be tangential or radial cut but exact radial cuts are preferred.

Another feature of the present invention is the method of compensation which results in an instrument of permanent calibration. This is accomplished by use of the two series of strips in tandem, as shown in Figure 1. The strips of one series would be made up in a dry room. The strips of the other series would be made up in a room where the air is very moist. The water free cement would be applied only to the backing strips and allowed to dry somewhat before the end grained strips are applied thereto. This precaution in the gluing results in a minimum penetration of the glue into the end grained pieces. Then at approximately 30 per cent humidity the strips made up in the dry room should be straight, and at approximately 85 per cent humidity the strips made up in the moist room should be straight. At 60 per cent humidity the two sets of strips when arranged as in Figure 1 will be bent practically equal amounts, but in opposite directions. Should the instrument be subjected to eighty per cent humidity, there will be a tendency toward case hardening in the strip made up at the low moisture content. Then if the humidity is changed to 50 per cent, this strip will tend to underrun its mark, and the other strip will not come quite down to the mark, due to a tendency for internal lag. Therefore, these two tendencies will approximately balance when the two sets of strips are tied together, as illustrated, by use of the links 6, thus resulting in a substantially perfect reading.

Having thus described my invention, what I claim as new therein and desire to secure by Letters Patent is—

1. In an instrument of the character described, a plurality of co-acting humidity sensitive elements each including as a part thereof a hygroscopic wooden strip sensitive to humidity changes; the strips of the various elements being opposedly arranged with respect to their fiber structure, thereby to balance in the instrument effects of warping tendencies in the individual elements.

2. In an instrument of the character described, a plurality of humidity sensitive, co-acting elements in paired relation, each comprising a resilient backing strip and a hygroscopic wooden facing strip secured thereon; the facing strips of paired elements being alike with respect to fiber structure but reversed in position on the backing strips, thereby to effect in the instrument a balance of warping tendencies.

3. In an instrument of the character described, a plurality of humidity sensitive, co-acting elements in paired relation, each comprising a resilient backing strip and a hygroscopic wooden facing strip secured thereon; the facing strips of paired elements being end grain cuts arranged on their respective backing strips with the direction of inclination of annual rings reversed to cause counter action of warping tendencies.

4. An instrument of the character described comprising humidity sensitive elements arranged

in tandem, each element comprising a flexible, resilient backing strip with a hygroscopic facing strip secured thereon, a mounting to which each of said elements is rigidly secured at one end, means operatively connecting the free ends of the elements to permit them to function conjointly, the strips comprising one of said elements being assembled in an atmosphere of relatively low humidity and those of the other being assembled in an atmosphere of relatively high humidity.

5. In an instrument of the character described, a fixed support, a plurality of coextensive humidity sensitive elements similarly arranged and in parallel relation with ends fixed in said support, means joining together the other ends of said elements for unitary movement; each of said elements comprising a resilient backing strip and a hygroscopic wooden facing strip secured thereon; the facing strips of alternate elements being end grain cuts arranged on their respective backing strips with the direction of inclination of the annual rings reversed to effect a balance in warping tendencies.

WORTH C. GOSS.