E. W. COMFORT.

THERMO ELECTRIC HUMIDITY INSTRUMENT.

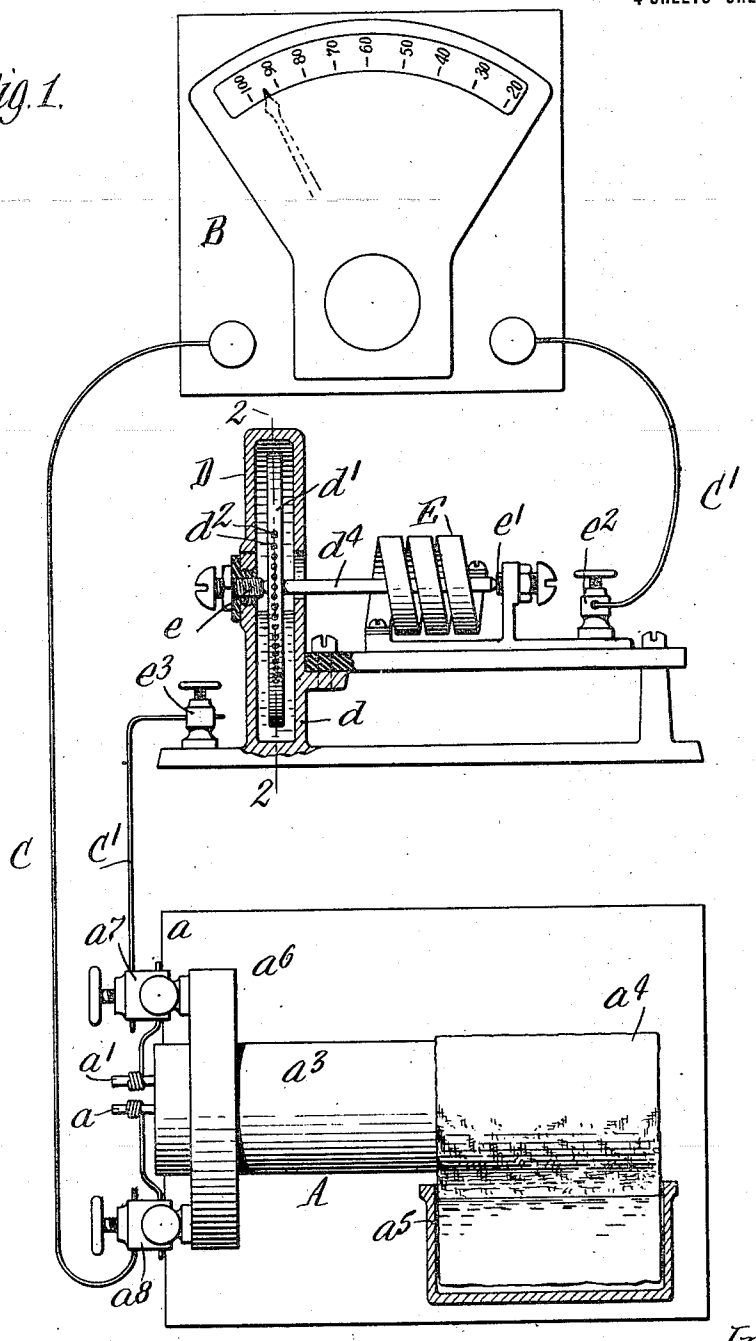
APPLICATION FILED FEB. 1, 1909.

1,169,617.

Patented Jan. 25, 1916.

4 SHEETS—SHEET 1.

Fig. 1.

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4 SHEETS—SHEET 2.

Fig. 2.

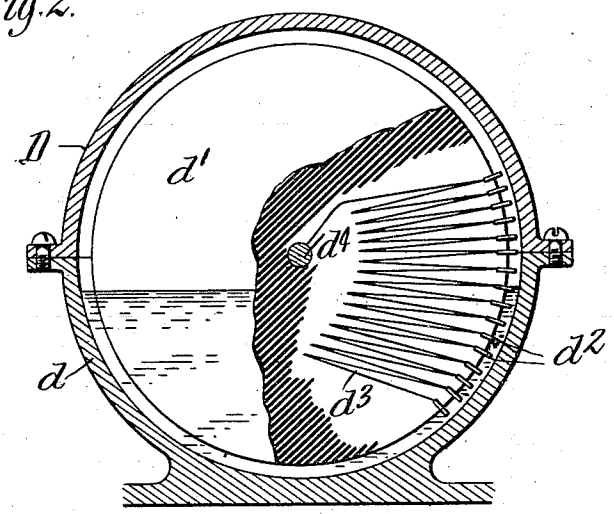



Fig. 3.

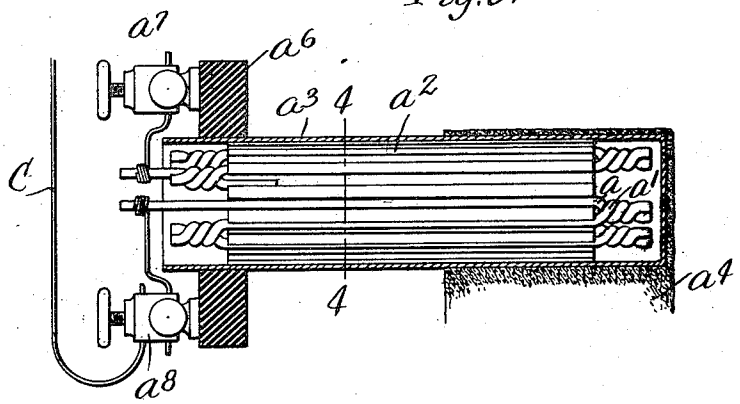
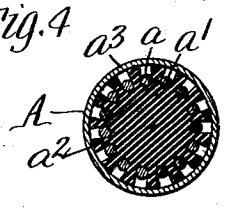



Fig. 4

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4 SHEETS—SHEET 3.

Fig. 5

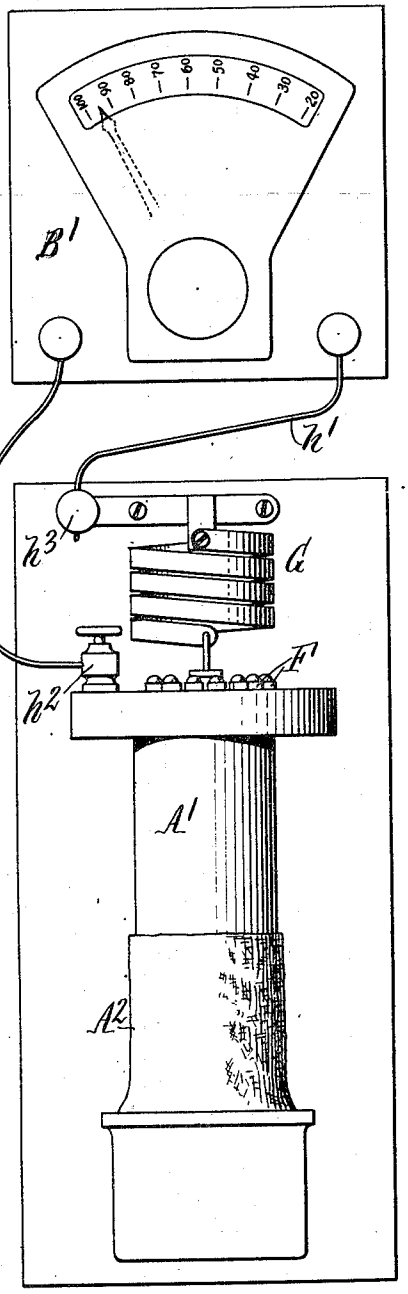



Fig. 6.

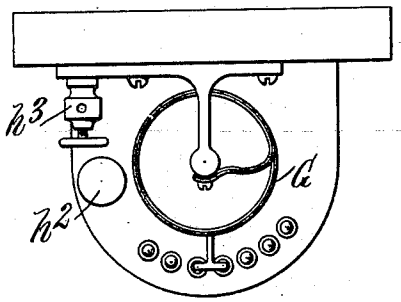
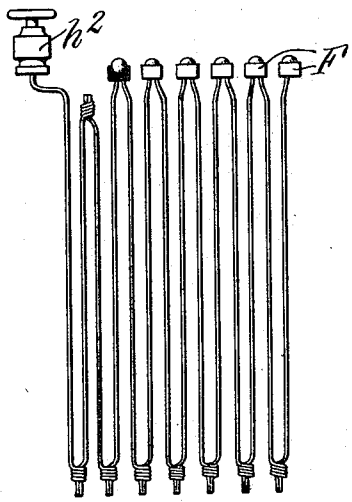



Fig. 7.

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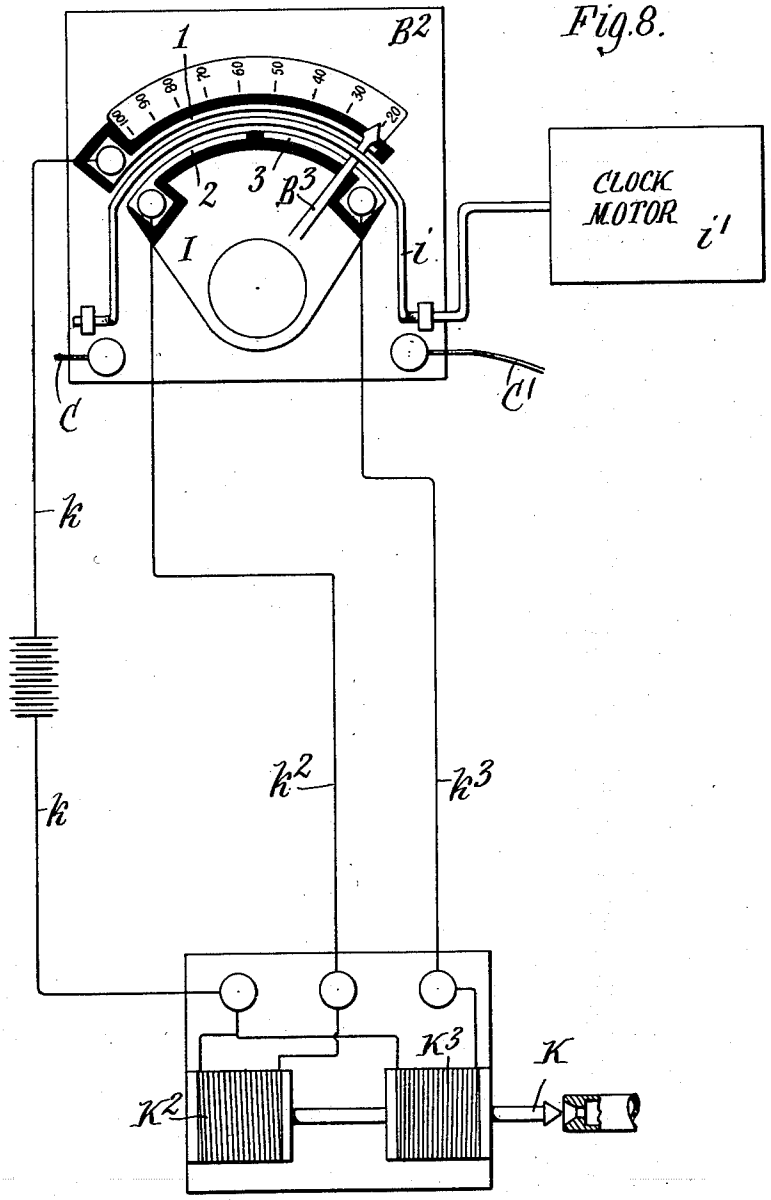
4 SHEETS—SHEET 4.

Fig. 8.

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# UNITED STATES PATENT OFFICE.

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## THERMO-ELECTRIC HUMIDITY INSTRUMENT.

1,169,617. Specification of Letters Patent. Patented Jan. 25, 1916.

Application filed February 1, 1909. Serial No. 475,539.

*To all whom it may concern:*

Be it known that I, EDWARD W. COMFORT, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Thermo-Electric Humidity Instruments, of which the following is a specification.

The dry and wet bulb temperatures of the atmosphere are equal when the air is saturated, or has a humidity of one hundred per cent., but for all percentages of humidity below saturation there is a difference between the wet and dry bulb temperatures, this difference, or wet bulb depression, at any given dry bulb temperature increasing as the percentage of humidity decreases. As the electric current produced by a thermoelectric battery is proportional to the difference in temperatures affecting its opposite junctions, it follows that if the opposite junctions of a thermoelectric couple or pile be subjected respectively to the dry and wet bulb temperatures of the air a current will be produced except when the air has a humidity of one hundred per cent., which current will be proportional to the wet bulb depression, so that changes in the humidity of the air can be indicated by a device for measuring this current. If the dry bulb temperature of the air remained constant it would only be necessary to connect a delicate milliammeter properly calibrated to the thermoelectric pile to accurately indicate percentages of humidity. As, however, the wet bulb depressions for the same percentage of humidity change with fluctuations in the actual, or dry bulb, temperature of the air it is necessary, in order to indicate the percentages of humidity under ordinary atmospheric conditions, to make provision for varying the electric current in response to changes in the actual temperature of the air. The hygrometric charts show that for any given percentage of humidity above, say twenty per cent., the wet bulb depressions vary by a practically constant difference for equal changes in the dry bulb temperature, and consequently means are provided for increasing or decreasing the current in proportion as the dry bulb temperature lowers or rises. This can be done in different ways, for example, by automatically increasing or decreasing the resistance in the electrical circuit in proportion as the temperature rises or falls by means controlled by a thermostat, or by automatically varying the number of couples in the thermoelectric pile by a thermostatic device to decrease or increase the voltage of the electric current in proportion to increments or decrements in the temperature.

The object of the invention is to produce an efficient instrument of simple construction in which a thermoelectric battery is utilized to operate a device by which the hygrometric condition of the air can be either indicated, recorded or regulated.

In the accompanying drawings, consisting of three sheets: Figure 1 is an elevation, partly in section, of a humidity gage or indicator embodying the invention. Fig. 2 is a sectional elevation, on an enlarged scale, in line 2—2, Fig. 1, of the rheostat. Fig. 3 is a longitudinal sectional elevation of the thermoelectric battery. Fig. 4 is a transverse section of the thermoelectric battery in line 4—4, Fig. 3. Fig. 5 is an elevation of a humidity indicator of modified construction. Fig. 6 is a plan view thereof omitting the indicating device. Fig. 7 is an elevation of the thermoelectric pile employed in the instrument shown in Fig. 5. Fig. 8 illustrates diagrammatically a humidity regulator adapted to be actuated by thermoelectrical means.

Like letters of reference refer to like parts in the several figures.

Referring first to the instrument shown in Figs. 1–4, A represents a thermoelectric battery and B an electric current measuring device connected in circuit with the battery A. The battery shown consists of conductors $a$ $a'$ of dissimilar metal connected in couples which are arranged around a cylinder $a^2$ of insulating material, the conductors lying in longitudinal grooves in the cylinder whereby they are retained in position and insulated from each other. $a^3$ is a shell or casing inclosing the conductors. This shell is open at one end and the junctions of the couples at this end of the battery are exposed to the actual or dry bulb temperature of the air. $a^4$ represents a wick or piece of absorbent material which incloses the other end of the battery and is kept wet by dipping into water in a receptacle $a^5$ whereby the junctions at this end of the battery

are influenced by the lower wet bulb temperature of the air. The battery is supported on a suitable insulating base $a^6$ provided with binding posts $a^7$ $a^8$ which connect the terminals of the battery and of the external circuit C C'.

The current measuring device B can be a delicate milliammeter or galvanometer of ordinary construction except that the scale is suitably calibrated to indicate percentages of humidity preferably ranging from twenty per cent. to one hundred per cent.

D represents a rheostat which, in the construction shown, comprises a cast iron receptacle $d$ party filled with mercury, and a disk $d'$ of suitable insulating material which is adapted to revolve in said receptacle and has a series of peripheral contact points $d^2$, Fig. 2, connected by a resistance wire $d^3$, the coils or loops of which are embedded in the disk. The disk $d'$ is secured to a shaft $d^4$ journaled at opposite ends in adjustable bearings $e$ $e'$. One end of the resistance $d^3$ is connected to the shaft $d^4$ of the disk, see Fig. 2. The shaft bearings are both insulated from the mercury receptacle, but one of the bearings, $e$, and the mercury receptacle are electrically connected with binding posts $e^2$ $e^3$, respectively, by which the rheostat is connected in the battery circuit C C' so that the circuit is completed through the resistance $d^3$.

A thermic motor E of well known form, consisting of a coiled bar composed of two strips of metal having different coefficients of expansion, is attached at opposite ends to the rheostat shaft $d^4$ and to a fixed part of the rheostat frame. This bar is subjected to the dry bulb temperature of the air and a rise in the temperature will cause it to change form and rotate the rheostat shaft and disk in a direction to lift the contact points $d^2$ successively out of the mercury, while a fall in the temperature will cause the disk to rotate in the opposite direction and successively immerse the contact points in the mercury, thus increasing or decreasing the resistance in the battery circuit and consequently modifying the current in proportion to changes of temperature. Variations in the humidity and also the temperature of the air therefore mutually influence the operation of the current measuring instrument B in such manner that it accurately indicates the percentage of humidity of the air.

The described operation of the instrument is, of course, not dependent upon the described construction of either the thermoelectric battery, the means for causing its opposite junctions to be influenced respectively by the dry and wet bulb temperatures of the air, the rheostat, the thermic motor for operating the rheostat, or the current measuring device, and either of these devices may be of any suitable construction capable of coöperating to indicate humidities when combined as described.

Figs. 5–7 illustrate a modification of the apparatus, in which, in place of a rheostat for increasing and reducing the circuit resistance to compensate for changes in temperature, thermoelectric couples are subtracted from or added to the battery for decreasing or increasing the electric current in proportion to changes of temperature. In this apparatus, A' represents the thermoelectric battery and B' a high resistance galvanometer. The battery consists of thermoelectric couples arranged substantially as before described, but a larger number of couples is required than is shown in the drawings to make the instrument operative for a wide range of temperatures. As the operation of the apparatus is only dependent on changes of voltage the couples can be made of fine wire and a large number can be used. The battery is preferably arranged vertically with its lower junctions inclosed by the wetted wick $A^2$, and contact devices F are provided at its upper junctions preferably consisting of cast iron cups containing mercury and floating contact points. G represents a thermic motor which consists of a coiled compound bar, such as before described, fixed at one end and having a contact shoe at its free end adapted to move from one to the other of the contact devices F which are arranged below the path of movement of the shoe. The circuit conductors $h$ $h'$ for the galvanometer are connected by binding posts $h^2$ and $h^3$ respectively to the first thermoelectric couple of the battery and to the fixed end of the thermic motor G. If the actual temperature of the air affecting the motor G lowers, the contact shoe will be moved in a direction to add couples to the battery and increase its voltage in proportion to the fall in temperature, while if the temperature rises, the shoe will be moved in the opposite direction to cut out couples from the battery and decrease its voltage in proportion to the rise in temperature. The operation of the galvanometer B' in this construction, like that in the first apparatus described, is therefore responsive to both changes in the humidity and temperature of the air and will accurately indicate the percentage of humidity.

The constructions above described both illustrate the application of the invention to a humidity indicating device. It will be manifest that a recording instrument could be substituted for the indicator if it be required to make a record of the humidity conditions.

Fig. 8 shows the application of the invention to a humidity regulating apparatus. An indicating instrument $B^2$ similar to the

ammeter or galvanometer before used is shown, but a stationary contact bar 1 and two adjustable contact bars 2 and 3 are provided over which the index $B^3$ of the instrument swings, the index being normally out of contact with these bars. The bars 2 and 3 are separated by a gap and are mounted on a plate I which is adjustable to change the position of said gap relative to the humidity scale. $i$ is a pivoted bail which is oscillated by a clock work or other motor $i'$ to intermittently press the index $B^3$ against the contact bar 1 and one or the other of the contact bars 2 and 3, depending upon the adjustment of said bars and the position of the index. K represents the controlling valve or device of an apparatus for increasing or decreasing the humidity, and $K^2$ and $K^3$ two solenoids or electrical devices for moving said valve in opposite directions. The solenoids are both connected by the conductor $k$ of an electrical circuit to the contact bar 1 and are connected by circuit conductors $k^2$ and $k^3$ respectively to the contact bars 2 and 3.

If it is desired to maintain a humidity of fifty-five per cent., for example, the contacts 2 and 3 are set as shown, with the gap between them opposite the fifty-five per cent. mark on the scale. So long as the humidity remains at fifty-five per cent., the index being over the gap, the circuit cannot be closed through either of the solenoids and the regulating device will remain inactive. A decrease in the humidity will cause the index to swing over the contact bar 3 so that the circuit will be intermittently closed through the solenoid $k^3$, which will move the regulating device K to increase the humidity again, whereas if the humidity rises above fifty-five per cent. it will cause the index to swing over the contact bar 2 so that the circuit will be intermittently closed through the other solenoid $k^2$, which will move the regulating device K to decrease the humidity. Any desired percentage of humidity can be maintained by adjusting the plate I to set the gap between the contact bars 2 and 3 opposite to the mark on the scale indicating such humidity. Other suitable regulating means could be used in place of those described.

I claim as my invention:

1. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means for subjecting another junction portion thereof to the wet bulb temperature of the air, a device operated by the current generated by said battery, and a device for altering said current in response to changes in the dry bulb temperature of the air, substantially as set forth.

2. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means for subjecting another junction portion thereof to the wet bulb temperature of the air, a humidity indicating device operated by the current generated by said battery, and means for altering said current in proportion to changes in the dry bulb temperature of the air, substantially as set forth.

3. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means for subjecting another junction portion thereof to the wet bulb temperature of the air, a device connected in circuit with said battery and operated by the current generated by the battery, and a device for automatically varying the resistance in said circuit in proportion to changes in the dry bulb temperature of the air, substantially as set forth.

4. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means for subjecting another junction portion thereof to the wet bulb temperature of the air, a humidity indicating device connected in circuit with said battery and operated by the current generated by the battery, a rheostat for varying the resistance in said circuit, and a thermic motor for operating said rheostat, substantially as set forth.

5. The combination of a battery composed of a group of thermoelectric couples arranged with opposite junctions at opposite ends of the battery, a wick surrounding one end of said battery, means for wetting said wick, a device operated by the current generated by said battery, and a device for automatically altering said current in proportion to changes in the dry bulb temperature of the air, substantially as set forth.

6. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means for subjecting another junction portion thereof to the wet bulb temperature of the air, a humidity indicating device connected in circuit with said battery and operated by the current generated by the battery, a rheostat interposed in said circuit comprising a receptacle containing mercury, and a revolving body partly immersed in said mercury and having exposed contacts connected by resistance, and a thermic motor for revolving said body to immerse more or less of said contacts, substantially as set forth.

7. The combination of a thermoelectric battery composed of a group of thermoelectric couples, means whereby the opposite ends of said couples are influenced respectively by the dry and wet bulb temperatures of the air, and a humidity indicating

device operated by the electrical current generated by said battery, substantially as set forth.

8. The combination of a thermoelectric battery, one junction portion of which is influenced by the dry bulb temperature of the air, means whereby another junction portion of said battery is influenced by the wet bulb temperature of the air, indicating means which are moved by the current generated by said battery, a graduated scale cooperating with said indicating means to indicate the hygrometric condition of the air, and a device for altering said electric current in response to changes in the dry bulb temperature of the air, substantially as set forth.

Witness my hand, this 21st day of January, 1909.

EDWARD W. COMFORT.

Witnesses:
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WM. L. FOX.