S. W. CRAMER AND W. B. HODGE.

APPARATUS FOR REGULATING HUMIDITY.

APPLICATION FILED SEPT. 14, 1911.

1,382,956. **Patented June 28, 1921.**

2 SHEETS—SHEET 2.

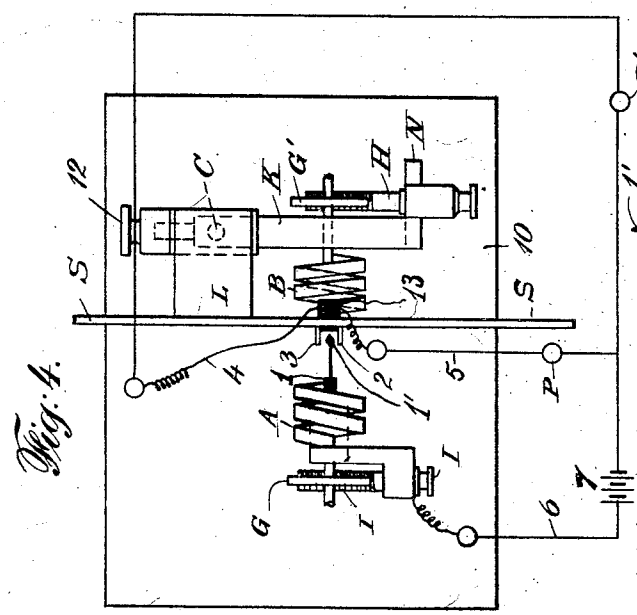


Fig. 4.

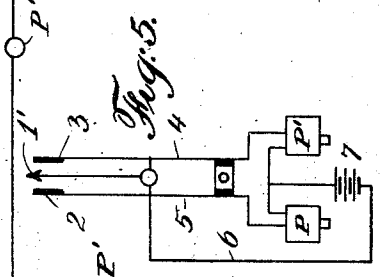


Fig. 5.

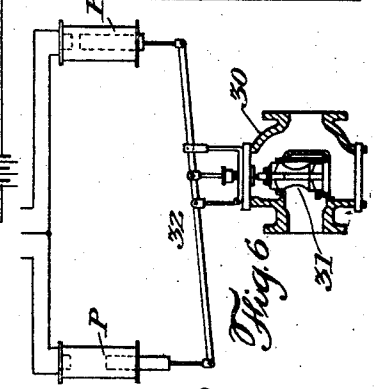


Fig. 6.

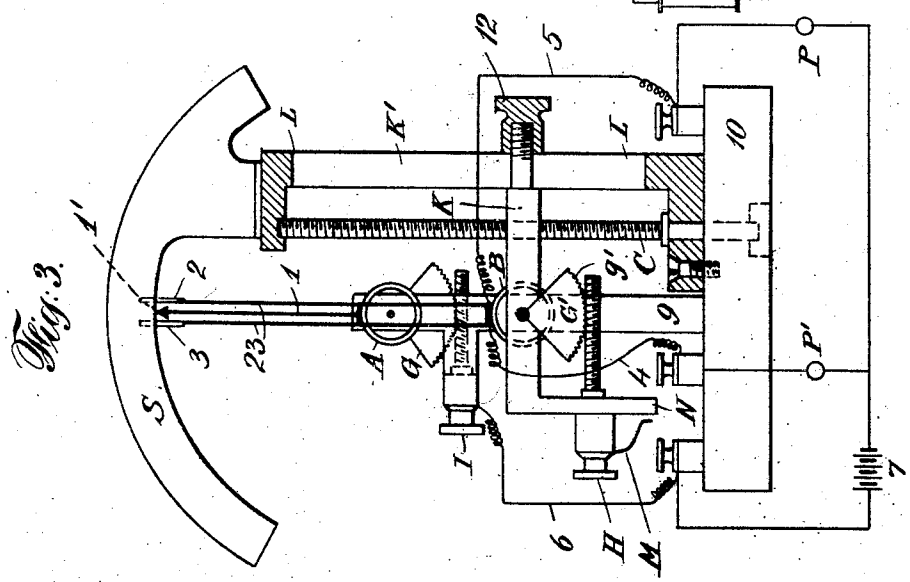


Fig. 3.

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APPARATUS FOR REGULATING HUMIDITY.

1,382,956. Specification of Letters Patent. Patented June 28, 1921.

Original application filed December 26, 1907, Serial No. 408,049. Divided and this application filed September 14, 1911. Serial No. 649,224.

To all whom it may concern:

Be it known that we, STUART W. CRAMER and WILLIAM B. HODGE, citizens of the United States, residing at Charlotte, county of Mecklenburg, and State of North Carolina, have invented the new and useful Improvements in Apparatus for Regulating Humidity, described in the following specification.

Our invention relates to apparatus for automatically regulating the degree of moisture in factories or other buildings and in separate compartments thereof. It consists in certain improvements in the structure and in the mode of operation and adjustment of such apparatus, hereinafter fully described, the present case being a division of our pending application Serial Number 408,049, filed December 26th, 1907.

In the accompanying drawings,

Figure 1 is a side elevation of apparatus embodying the invention, partly in section and partly in diagram;

Fig. 2 is a front elevation of the same, partly in diagram;

Fig. 3 a rear elevation;

Fig. 4 is a top plan;

Fig. 5 a diagram of a part of the mechanism by which the moisture in the room is caused to increase or decrease according to the control effected, and Fig. 6 is a detail in diagram of the moisture varying mechanism.

The apparatus comprises wet and dry bulb thermometric elements, each consisting of a receptacle filled to a greater or less extent with thermo-expansive fluid, such as alcohol, ether or some other liquid or gas adapted to produce changes of internal vapor pressure on changes of the temperature to which the receptacles are subjected, and a flexible walled part or member upon which the changes of such expansion are made effective and which will therefore operate as a motor member adapted to contribute its motive effect to the operation of the apparatus. In the present case, such motor member is a so-called Bourdon diaphragm, being a hollow tube bent into spiral form and adapted to flex or expand upon increase of its internal pressure and contract upon decrease thereof. The dry bulb element, marked A′, is subjected in an ordinary dry state to the temperature of the air in the room to be controlled, and is connected with its motor member A by a tube in which an elastic joint 8 is provided to allow movement of the member with respect to the receptacle. The spiral motor tube is rotatably supported by one of its ends in a post or upright 9 on the support 10, and carries a segment rack G engaged by a tangent screw I also mounted on the post, so that the operation of the set screw in one direction or the other will cause the spiral motor member to turn on its central axis.

The wet bulb element comprises a receptacle B′ similar to the dry bulb receptacle and independently subjected to the wet bulb temperature of the air by being covered with a saturated wicking after the manner of ordinary hygrometers, or otherwise kept at the wet bulb temperature of the air in the room, so that the volume of its contained fluid will vary therewith. This receptacle is connected by a tube and elastic joint 11 with a flexible walled motor member B which may be of the same type as the dry bulb motor member, being rotatably mounted in the same way upon a bracket K and provided with a similar segment rack G′ and tangent set screw H on the bracket by which this motor member also may be angularly adjusted on its spiral axis. The bracket K is adjustably carried by an upright standard L and on an adjustment screw C which is journaled therein and accessible from the under side of the base 10 as shown in Fig. 1, so that by the operation of the said screw the bracket K and the parts carried thereon can be raised or lowered on the standard as desired. The standard L is provided with a slot K′ engaging an extension of the bracket, to which a set nut 12 is applied, for securing the bracket in its adjusted position.

The moisture varying apparatus, by which the degree of moisture put into the room or compartment is controlled or by which the water supply is varied, comprises a suitable valve mechanism, parts of which are diagrammatically indicated by P and P′ in the drawings, for controlling the water pipe line, not shown, an external source of power for operating such valve mechanism, which in the present case is an electrical source

7 with a suitable circuit, and a controlling device consisting of two mutually coöperating members adapted to operate by engagement, one with the other, these members being in the present case the contact terminals of the said circuit. One of the members of the said controlling device is formed by the contact portion 1′ of a pointer or lever arm 1 which is mechanically secured to the free end of the dry bulb motor member A so as to be turned about the axis thereof as the vapor pressure generated in the receptacle A′ changes under changing temperatures. The set-screw I above referred to, is for the purpose of setting this pointer member with reference to a temperature scale S mounted on the top of the standard L, as shown in Fig. 1, so that aside from and in addition to its humidity controlling functions later explained, this pointer member may also serve to indicate the temperature of the room to the attendant in charge, who will thus be enabled to control the room-heating apparatus accordingly.

It may be remarked at this point that the temperature indication is a desirable adjunct to the apparatus, inasmuch as the relative humidity of the room air is a function of the room temperature and the latter is desirably kept as nearly constant as possible. The higher such temperature is, the lower the humidity will be.

The other member of the controlling device consists of contact portions 2 and 3 of a similar pointer or lever arm (diagrammatically indicated in the drawing and marked 23), which arm is mechanically fastened at 13 (Fig. 1) to the free end of the wet bulb member B so as to rotate about the axis thereof according to the pressure changes in the wet bulb receptacle B′, the two motors being mounted in opposition to each other so that their respective arms 1 and 23 will move in substantially parallel and proximate planes and in the same direction with increasing temperature or vice versa.

In the present case, employing an external operating source which is electrical, the dry bulb lever arm 1 is connected to the common return line 6 of the source 7, and its contact portion 1′ is bent over at a right angle to the arm as indicated, so as to be capable of engaging the wet bulb lever arm 23 which is connected to the other end of the circuit with its two contact portions 2 and 3 disposed on opposite sides of the contact 1′. The contact portions 2 and 3 respectively, form the terminals of the branch circuits 4 and 5 (see diagram, Fig. 5) containing the parts P and P′ of the valve mechanism, so that one or the other of these parts becomes actuated according as whether contact is made with one or the other of the contact portions 2 or 3, it being understood that the said parts P and P′, as above stated, are the means whereby the external source of power can be made effective, perhaps at some distance from the thermometric elements, to control the supply of moisture to the room. The construction and operation of such devices is well known in this art and will not require further description, further than to point out that in Fig. 6 a section of the moisture supply pipe is shown at 30, and the moisture valve at 31, with suitable connections 32 with the magnets P and P′, whereby the said valve is operated in one direction or the other. The arms of the controlling device are indicated in the drawings in diagram, but it will, of course, be understood that they are intended to be formed of any suitable material having sufficient cross-sectional dimension to adapt them to perform the functions ascribed to them with reliability and uniformity, and that their engagement, one with the other, brings about the desired change in the amount or rate of moisture supplied. The said members of the controlling device are arranged, as stated, to move in the same direction under like changes in temperature of the two thermometric elements and at rates of movement corresponding to the different rates of change of the wet and dry bulb temperatures, so that the above mentioned coöperative engagement of the two members will take place only from the differential expansive effects of the wet and dry bulb motor members, and the valve mechanism of the moisture varying apparatus will thus also be controlled by such differential action, as will be readily understood. The tangent screw H which controls the angular position of the wet bulb motor member B, as above described, is adapted to set the arm bearing the contacts 2, 3 with respect to the position of the contact 1′ and in accordance with the difference in temperature between the wet and dry bulb elements or technically, the "wet bulb depression" that is desired to be established between the two, and for this purpose it is provided with a pointer M and a depression scale N, the latter being a part of the adjustable bracket K above referred to.

When it is desired to maintain a degree of humidity corresponding to a given constant wet bulb depression, this tangent screw H is turned until the pointer M indicates this depression on the scale N. When the temperature of receptacle B′ becomes lowered sufficiently by evaporation to correspond with the depression which the pointer attached to tangent screw H indicates, contact will thereby be made between 1 and 2, and the moisture varying mechanism will then be put in operation to increase the moisture in the room. When the difference in temperatures thereafter becomes

less than indicated on the scale, contact will then be made between contact members 1 and 3, and the operation of the moisture varying mechanism will then be discontinued, and so on, it being observed that the action just described is the result of the difference in the movements of the two arms whereby one overtakes and makes contact with the other and that such action is independent of the variation range of the room-temperature, that is to say, of the joint position of the two arms with reference to the temperature scale S. The adjustment afforded by the screw C provides for a predetermined variation of the wet bulb depression as set by the depression scale N, this being mainly for the purpose of maintaining a constant relative humidity of any desired percentage, a condition which requires an increasing wet bulb depression for a rising temperature and a decreasing depression for a falling temperature, the increase or decrease being of different rates for different percentages of humidity. By adjusting the screw C the axis of the arm 23 may be brought into, or above or below alinement with the axis of the arm 1. When in alinement, the instrument will be set to maintain a degree of humidity corresponding to a fixed wet bulb depression, which, however, will not be a constant relative humidity. When it is desired to maintain a constant relative humidity, the axis of the arm 23 will be set above alinement with the axis of arm 1 a sufficient distance to give the necessary rate of change in the wet bulb depression as determined by reference to tables prepared for the purpose. If it is desired that the wet bulb depression decrease as the temperature rises, the axis of arm 23 is lowered below that of the arm 1. In either case it will be observed that the rate at which the depression varies, under changing temperature, depends upon the ratio of the effective lengths of the two arms or members of the controlling device, that is to say, the respective distances between the contact portions and the pivotal axes thereof. The operation of the screw C in the present case tends to shorten or lengthen the effective length of the wet bulb arm, and thus controls the ratio of one length to the other, but it will be observed that the change is effected by the relative movement between the two arms and hence that either or both can be subject to adjustment as desired.

By utilizing liquid-containing thermal elements wherein the motor wall or diaphragm is actuated by changes in vapor pressure, we have achieved a great improvement in this art and desire to claim the same as such. Contrary to assumptions heretofore made by others, we have ascertained and commercially demonstrated that changes in barometric conditions do not adversely affect the accuracy of such thermal elements when differentially combined, because the barometric effect on one element is substantially off-set by a corresponding effect on the other and also that certain other irregularities in the individual motion-temperature curve of such instruments are likewise also sufficiently compensated, when differentially combined, to be neutralized in their differential effect and thereby we have secured the advantage of the wide range of motion per degree of temperature change that is afforded by such elements without any drawback arising from their inherent and well-known irregularities. The wide range of movement just referred to affords a considerable extent of differential action or motion which is relatively large enough, as we have found, to offset and render negligible those errors which in other instruments are attributable to the thermal expansions and contractions of the base or the structure which supports the elements in position and of their operating connections. In consequence of these facts the two combined elements may be variously located within or outside the regulating instrument and as far apart as may be necessary to remove one from the influence of the other and the possibility of error due to the change in length or shape of any structural part of the instrument may be disregarded because relatively so slight as compared to the differential movement. These several advantages all make for a greater refinement of the adjustment of the instrument for operating on different specific depressions or on different rates of variable depressions, since as compared with instruments of the bar type a given change in the depression is accomplished by a relatively greater movement of the adjusting screw, thereby enabling a slight adjustment of said screw to produce extremely minute and very accurate setting of the instrument.

We claim:

1. Apparatus for automatically regulating humidity comprising in combination, two thermal elements containing liquid adapted to produce change of internal vapor pressure therein according to temperature change and including flexible walls constituting motor members actuated by such changes, said elements being independently subjected to the wet and dry bulb temperatures of the air, a humidity controlling device moved by said elements and arranged to be operated only by the difference of the action of said motor members, valve mechanism directly controlling the proportion of moisture in the air and a source of power for operating said mechanism controlled by said device.

2. An instrument for regulating humidity comprising in combination, two thermal elements each containing liquid or gas adapted to produce change of internal pressure there-

in according to temperature change and including flexible motor wall members actuated by such changes, said elements being independently influenced by the wet and dry bulb temperatures of the air, valve mechanism for varying the proportion of moisture in the air, controlling means between said motor members and mechanism whereby the latter is operated only by the difference of the action of said motor members and means for altering the character of the differential operation of said controlling means to cause the instrument to regulate humidity according to different variable wet bulb depressions

3. An instrument for regulating humidity comprising in combination, two thermal elements each containing liquid or gas adapted to produce change of internal pressure therein according to temperature change and including flexible motor wall members actuated by such changes, said elements being independently subjected to the wet and dry bulb temperatures of the air, valve mechanism for varying the proportion of moisture in the air, controlling means between said motor members and mechanism whereby the latter is operated only by the difference of the actions of said motor members and means for adjusting the value of the wet bulb depression of the instrument.

4. In apparatus of the kind described, two thermal elements containing liquid adapted to produce changes in the internal vapor pressure according to temperature change and a two-part humidity controlling device differentially operated by said members and comprising one part connected to and operated by one of said thermal elements and the other part connected to and operated by the other element.

5. Apparatus for regulating humidity, comprising two flexible hollow spirals internally subjected to the action of vapor or gaseous pressure confined thereby and each provided with an arm at its free end, moisture-varying apparatus controlled by the differential action of said spirals on said arms and means for shifting the axis on one of said arms relatively to the other to vary the differential action of said means.

6. Apparatus for regulating humidity comprising wet and dry bulb thermal elements, each containing a source of fluid pressure varying according to temperature change and each provided with an arm moved by change in the internal pressure and moisture varying apparatus controlled by the differential action of said arms.

7. Apparatus for regulating humidity, comprising wet and dry bulb thermal elements, each containing liquid and each provided with a rotary contact member movable into contact with each other by the differential effect of the pressure in said element, a power source controlled by the contact of said members, and moisture-varying apparatus actuated by said power source.

8. Apparatus for regulating humidity, comprising two flexible hollow spirals subjected to the action of thermal expansive fluid respectively contained therein under wet and dry bulb temperatures respectively, a moisture-varying apparatus controlled by the differential rotary effects of said spirals under changing pressures, and means for setting the relative angular position of said spirals.

In testimony whereof, we have signed this specification in the presence of two witnesses.

STUART W. CRAMER.
WILLIAM B. HODGE.

Witnesses to S. W. Cramer:
H. G. KIMBALL,
LOUIS SCHOEMMELL.
Witnesses to Wm. B. Hodge:
ROBT. I. DALTON,
JOHN C. WATSON.