



# UNITED STATES PATENT OFFICE.

GOVERNOR D. WARREN, OF DENVER, COLORADO.

## AIROMETER.

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*To all whom it may concern:*

Be it known that I, GOVERNOR D. WARREN, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Airometers; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

My invention relates to improvements in airometers or devices for measuring the quantity of air used in the performance of certain classes of work or wherever compressed air is used to operate machinery.

My object is to provide an apparatus of this class of such perfect, delicate, and sensitive construction that it shall accurately measure the quantity of air used in the operation of machines—as air-drills, for instance.

In my improved construction I employ a casing divided by suitable partitions into a number of transverse chambers in which are located rotary fans connected with a shaft, the said fan-chambers communicating with each other by orifices inclined to the axis of the shaft, whereby the air is adapted to strike the wings or blades of the fans at right angles or approximately at right angles. As soon as the air strikes one fan it passes to the orifice of an adjacent partition and travels through the last-named orifice in a direction parallel with its travel through the first orifice, and thus strikes the blades of the fan in the next chamber at right angles to their adjacent surfaces. By virtue of this arrangement the air is advantageously applied to the blades of the fans and is applied equally advantageously to all of the fans within the said casing, thus making a much more sensitive and accurate air-measuring instrument than would be the case if a fan-wheel having continuous spiral blades extending from one end of the shaft to the other were employed. The fans are preferably made of aluminium or some material of low specific gravity, and consequently having little momentum when set in motion,

whereby they become more sensitive to variations in the volume of air passing through the instrument. A suitable register is mounted to be acted on by the rotary shaft through the instrumentality of worm-gearing.

Having briefly outlined my improved construction, as well as the function it is intended to perform, I will proceed to describe the same in detail, reference being made to the accompanying drawings, in which is illustrated an embodiment thereof.

In the drawings, Figure 1 is a perspective view of an airometer equipped with my improvements. Fig. 2 is a vertical longitudinal section taken through the same, the parts being shown on a larger scale. Figs. 3, 4, and 5 are sections taken on the lines 3-3, 4-4, and 5-5, respectively, viewed in the direction of the arrows. Fig. 6 is a fragmentary detail view of the device with the fan-chamber-separating partitions shown partly in section to disclose the inclined orifices.

The same reference characters indicate the same parts in all the views.

Let A designate a suitable casing considered in its entirety. Within this casing is located a number of disks A', separated by spacing-rings A<sup>2</sup>, forming fan-chambers A<sup>3</sup>, in which are located fans A<sup>4</sup>, mounted on and made fast to a revoluble shaft A<sup>5</sup>. The hubs of these fans are secured to the shaft by means of fastening-pins A<sup>6</sup>. There is a disk A<sup>7</sup> in the right-hand end of the chamber, (see Fig. 2 of the drawings,) with which is formed integral a part A<sup>8x</sup>, surrounding the adjacent fan-chamber. This disk A<sup>7</sup> is also provided with a hollow sleeve A<sup>8</sup>, which terminates near the end of the casing A and is closed by a plug A<sup>9</sup>, in which bears a conical extremity A<sup>10</sup> of a reduced part A<sup>12</sup> of the shaft. The opposite extremity of the shaft is provided with a journal A<sup>13</sup>, which engages an opening formed in the disk A', located in the left-hand extremity of the chamber. The disk A<sup>7</sup> bears against a shoulder A<sup>14</sup>, formed in the casing. A screw-plug A<sup>15</sup> is threaded in the left-hand extremity of the casing and bears against the adjacent end disk A', whereby the disks and spacing-rings are locked within the casing and held in suitable relation with the other parts

when the elements of the device are assembled. Into the head  $A^{15}$  is threaded an inlet-pipe B, while with the opposite extremity is connected an outlet-pipe C. The pipe C is threaded into a sleeve D, inserted in the extremity of the casing remote from the head  $A^{15}$ . The reduced part  $A^8$  of the shaft  $A^5$  passes through a split bushing E, located in the opening of the disk  $A^7$  and provided with a circumferential groove  $E'$ , from which orifices  $E^2$  lead to the reduced part of the shaft. Oil is fed to the groove  $E'$  through an orifice  $E^4$  (indicated by dotted lines in Fig. 3) and exteriorly closed by a screw-plug  $E^3$ . This screw  $E^3$  also serves to hold the disk  $A^7$  and its sleeve  $A^8$  in the proper relative position to enable the worm F of the reduced part of the shaft to engage a worm-wheel G, mounted on a spindle  $G'$ , extending at right angles to the fan-shaft and having a pinion  $G^2$  communicating with a gear  $G^3$ , mounted on a spindle  $G^4$ , carrying a gear  $G^5$ , which operates the multiplying-gears of the register  $G^6$ . The extremities of the spindle  $G'$  are journaled in the casing, while the spindle intermediate its extremities passes through a screw-plug  $G^7$ , closing an opening between the register-chamber and the air-chamber of the casing. As the register mechanism is of ordinary construction, it will not be further described in detail. In one side of the sleeve  $A^8$  is formed an opening  $A^{17}$ , into which the gear G protrudes to enable it to engage the worm F. It will thus be seen that it is necessary that the disk  $A^7$  and its sleeve be maintained in the proper relative position. Hence the necessity for the screw  $E^3$ , which performs the double function of locking the sleeve-disk in place and at the same time closes the orifice through which the oil or lubricating material is passed to the circumferential groove  $E'$  of the divided bushing E.

All of the partitions  $A'$  are provided with orifices H, which are inclined to the axis of the operating-shaft and are so arranged with reference to the inclination of the blades  $A^{10}$  of the fans that the air as it passes through the orifices strikes the fans at right angles or approximately at right angles. This feature is best illustrated in Fig. 6.

From the fan-chamber  $A^3$  farthest to the right (see Fig. 2) lead orifices  $A^{18}$  to the extremity  $A^{10}$  of the chamber. These orifices  $A^{18}$  extend parallel with the axis of the shaft, there being no necessity for their inclination, since the air after passing through them does not act on the fans of the device.

From the foregoing description it is believed that the use and operation of my instrument will be readily understood. The device may be connected with a mechanism to be operated in any suitable manner. The air enters the main chamber of the casing from the air-compressor (not shown) through the inlet B, connected with one end of the casing,

and escapes therefrom through the outlet C, connected with the other end of the casing. After entering the casing-chamber through the inlet B the air passes through the inclined orifices H of the disk  $A'$  farthest to the left (see Fig. 2) and strikes the inclined blades of the fan located in the adjacent fan-chamber. The air after acting on this first fan passes through the inclined orifices H of the next disk or partition separating the fan-chambers and acts on the next fan, and so on until the air has engaged successively all the fans on the shaft  $A^5$ , after which it passes through the orifices  $A^{18}$  into the chamber extremity  $A^{10}$  and passes thence through the outlet C. The action of the air on the fans rotates the shaft  $A^5$ , and the rotary movement is communicated to the spindle  $G'$  through the instrumentality of the worm F and the gear G, and this motion is communicated from the spindle  $G'$  to the register through the instrumentality of the pinion  $G^2$  and the gears  $G^3$  and  $G^5$ . The air used is indicated on the dials I, around which travel the pointers or indicators  $I'$ , operated by the multiplying-gears of the register mechanism in a manner that will be readily understood.

Another advantage of my improved construction is that when the flow of air to the machine to be operated is interrupted—by the cut-off valve, for instance—the air within the fan-chambers resists the movement of the fans instead of acting to propel them, and this resistance acts to retard the travel of the fans and correspondingly retards the operation of the registering mechanism, thereby causing the instrument to accurately and properly register the air used. My improved instrument is therefore adapted to accurately register the amount of air passing there-through even when the air acts in pulsations, as well as when the passage is continuous or the flow of air uniform. This is a very important feature, since usually the air does not flow uniformly and steadily to the instrument or machine to be actuated thereby, but varies for the reasons stated.

Having thus described my invention, what I claim is—

1. In an airometer, the combination with a suitable casing, of a shaft located therein and suitably journaled, a number of separated chambers, fans located in the respective chambers and made fast to the shaft, disks or partitions separating the fan-chambers and provided with orifices inclined to the axis of the shaft, spacing-rings surrounding the fan-chambers and separating the partitions, a stop at one end of the casing, an adjustable plug inserted in the opposite end of the casing whereby the partitions and spacing-rings are held in the assembled relation, the casing being provided with suitable inlet and outlet openings, a register, and a suitable connection between the register and the fan-shaft.

2. In an instrument of the class described, the combination with a casing provided with suitable partitions whereby its chamber is subdivided into a number of compartments, a shaft passing through said partitions and compartments, and fans mounted on the shaft, orifices being formed in the partitions separating the fan-chambers, spacing-rings surrounding the fan-chambers and separating the partitions, a stop at one end of the casing, an adjustable plug inserted in the opposite end of the casing whereby the partitions and spacing-rings are held in the assembled relation, the casing being provided with an inlet and an outlet opening, substantially as described.

3. The combination with a suitable casing, of a number of disks located in said casing, spacing-rings separating the disks to form fan-chambers, a shaft passing through said partitions and fan-chambers, fans located in the said chambers and having inclined blades, the said fans being connected to rotate with the shaft, and inclined orifices formed in the partitions and extending at suitable angles to the inclination of the blades, the casing being provided with a stop located at one extremity, and an adjustable plug located at the opposite extremity whereby the mechanism within the casing is locked in the assembled relation.

4. The combination with a suitable casing, of a number of partitions and spacing-rings located in the casing whereby the casing-chamber is subdivided to form a number of fan-chambers, a stop located at one end of the casing, a screw-plug inserted in the casing at its opposite end whereby the partitions and spacing-rings are held in the assembled relation, a shaft passing through the partitions and fan-chambers, fans located in the said chambers and fast on the shaft, orifices formed in the partitions separating the fan-chambers

and also in the end partitions whereby the air is allowed to enter and leave the casing-chamber, substantially as described. 45

5. The combination of a casing whose chamber is subdivided to form a number of fan-chambers by suitable partitions in which are formed orifices inclined to the axis of the chamber; spacing-rings separating the partitions to form the fan-chambers which are surrounded by the rings, a stop at one end of the casing, and an adjustable plug inserted in the opposite end of the casing whereby the rings and partitions are held in the assembled relation, a shaft passing through the partitions and fan-chambers, fans located in the fan-chambers and connected to rotate with the shaft, one extremity of the shaft being provided with a worm, a worm-wheel engaging said worm, a register, and a suitable connection between the worm-wheel and register for operating the latter, substantially as described. 50 55 60

6. The combination of a casing whose chamber is subdivided to form a number of fan-chambers, by partitions having orifices whereby the fan-chambers communicate with each other, the partition at one end of the casing being provided with a hollow sleeve through which the shaft passes, a worm formed on the shaft and located within this sleeve, the latter having an opening at one side, a spindle journaled in the casing at one side of the sleeve, a worm-wheel fast on the spindle, the sleeve being open on one side to allow the worm-wheel to engage the worm, a register, and a suitable connection between the spindle and the register whereby the rotation of the shaft operates the register. 65 70 75 80

In testimony whereof I affix my signature in presence of two witnesses.

GOVERNOR D. WARREN.

Witnesses:

DENA NELSON,

OTTO E. HODDICK.