Oct. 14, 1941.

P. L. CAFFIER

2,259,061

THERMORESPONSIVE DEVICE

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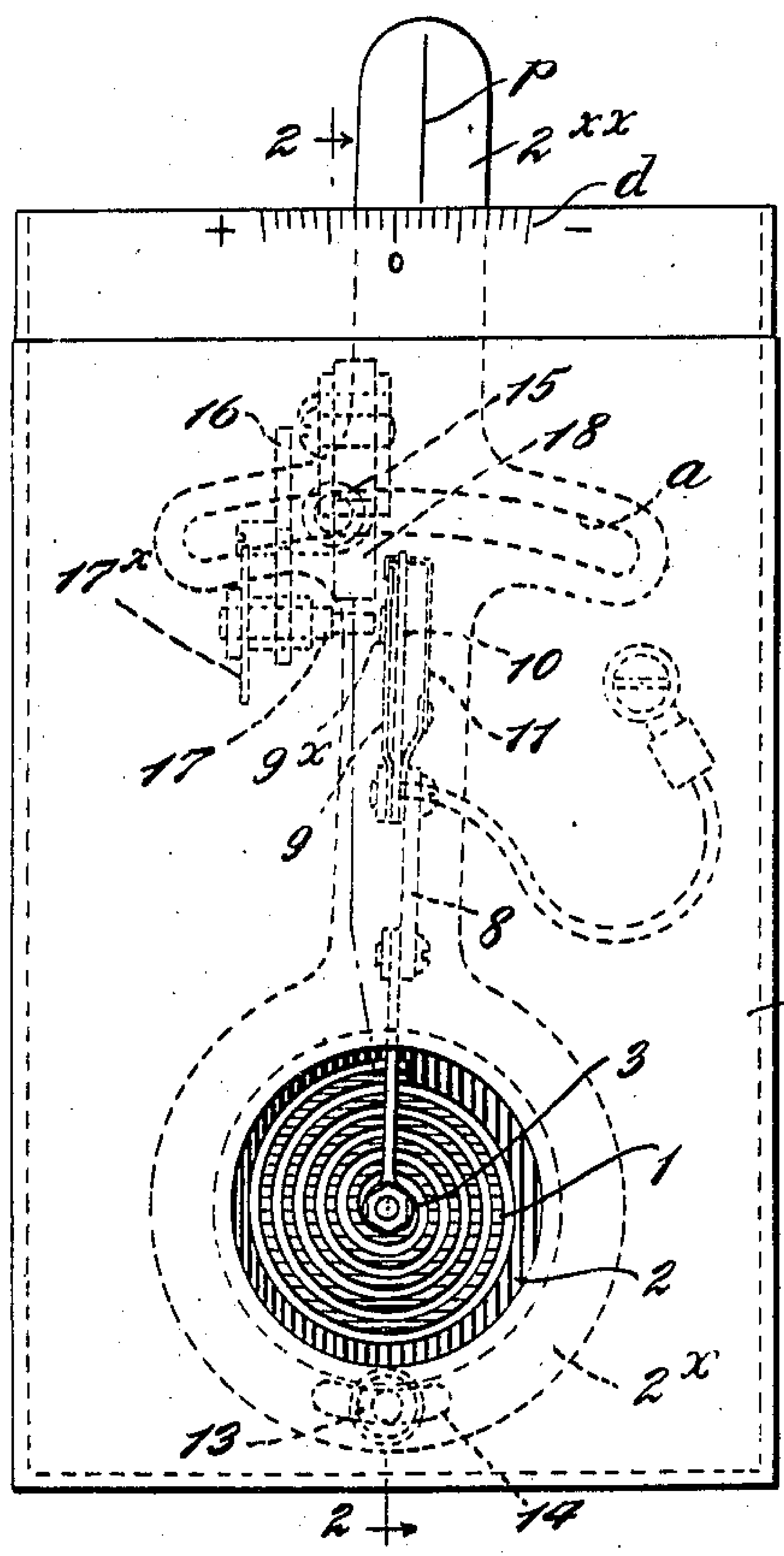

Fig. 1.

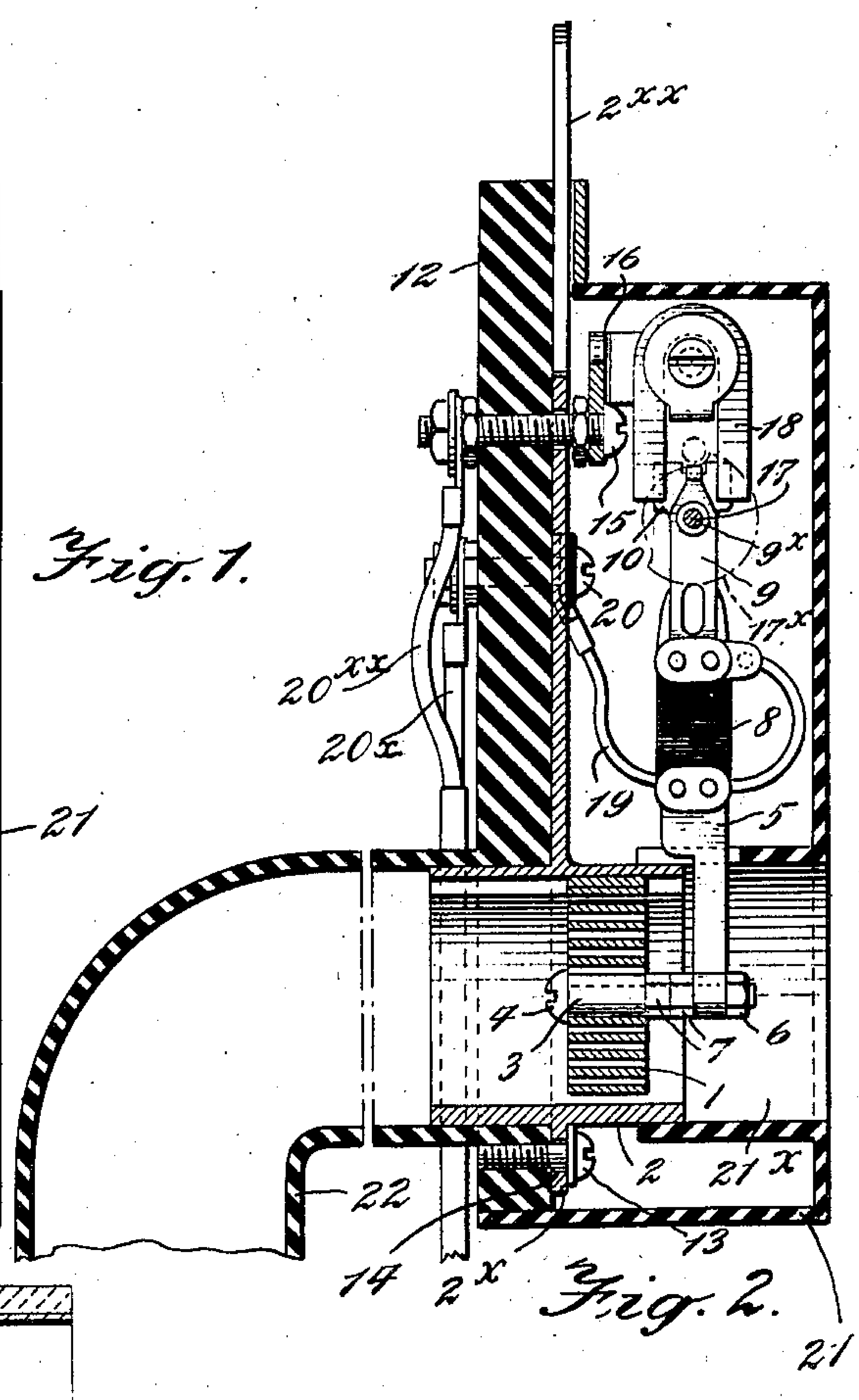

Fig. 2.

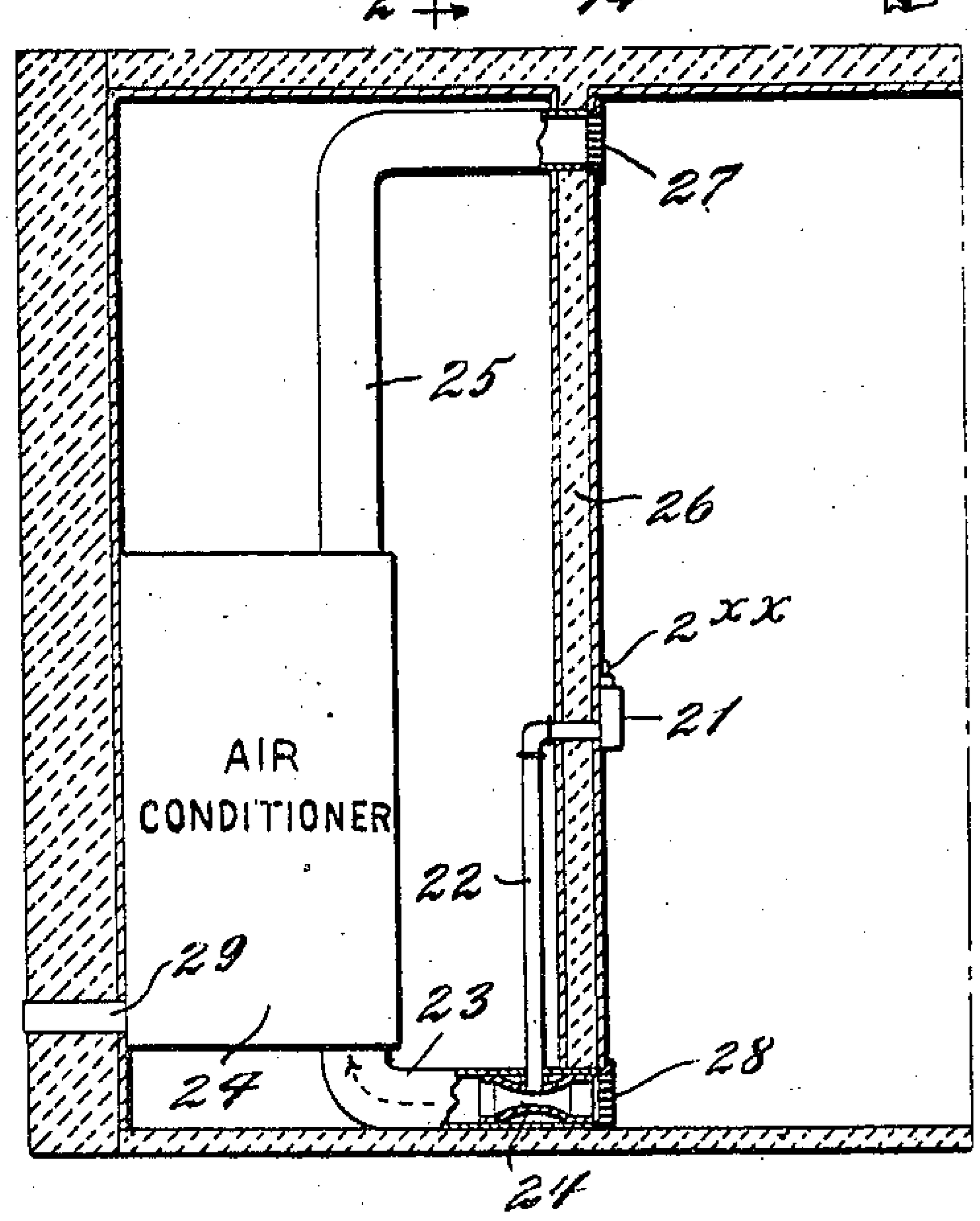

Fig. 3.

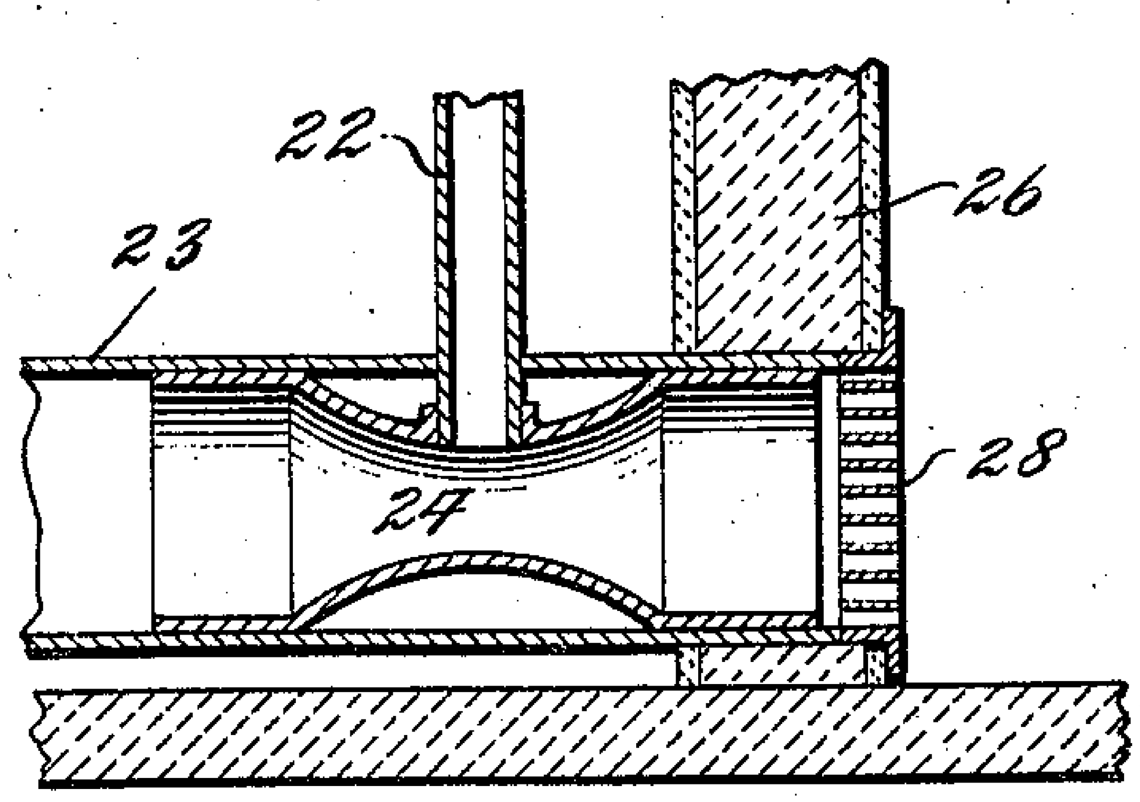

Fig. 4.

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THERMORESPONSIVE DEVICE

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2 Claims. (Cl. 297—16)

This invention relates to a simple method, and efficient means, to cause a thermo-responsive-element to conform instantly and accurately to air temperature variations.

The invention will be described with reference to the accompanying drawing in which

Figure 1 is a view in front elevation of an embodiment of the invention showing certain elements in transverse section and other elements partly in dotted lines.

Figure 2 is a sectional elevation on the line 2—2, Figure 1.

Figure 3 is a diagrammatic view, partly in section, showing the application of the device to an air conditioner for rooms.

Figure 4 is an enlarged vertical section taken longitudinally through the inlet end of the air inlet pipe for the air conditioner showing a Venturi connection between the temperature-responsive device and said pipe.

The sluggishness of thermo-responsive elements in reacting to changes in temperature of fluids such as air, as is well known to those skilled in the art of temperature control, is due to a slow process of heat transfer between the thermo-responsive element and the air in which it is disposed, this condition getting more objectionable as the temperature difference between the air and the thermo-element becomes smaller and resulting in poor and inaccurate control of all automatic air heating or cooling systems.

This phenomenon, often referred to as "thermal inertia," is in reality caused by the existence of a film of air molecules adhering very strongly to the radiating surface of all thermo-responsive elements by surface adhesion. This surface film, due to the low heat conducting properties of quiescent air, impedes very strongly the heat transfer from the thermo-responsive element to the surrounding air or vice versa. Most metals being generally good heat conductors, it then becomes obvious that the removal of this film will make a bimetal thermo-responsive element highly sensitive to air temperature variations even though the mass of said thermo-element may still be rather large, and the temperature difference between the element and the air may be very small.

By my invention this film is positively removed by the rapid motion of air forced over and close to the radiating surface of the thermo-responsive element, with the result of instant response to air temperature variations. This cannot be accomplished by ordinary convection as created, for example, by heat-induced rising air currents, which are entirely too feeble and not properly directed to remove this "surface film."

In the drawing, I have shown a thermo-responsive element 1 in the form of a relatively heavy spiral spring. The temperature-responsive element may be of any form adapted to transmit a moving force to a registering or control element such as a switch arm, for example. The element may be a bimetal spring and due to the invention, the bimetal spring or other form of temperature-responsive element may be made relatively heavy to transmit adequate power, to close or open a switch for example, and, at the same time, be highly responsive to air temperature variations. The outer end of the spiral spring 1 is held in fixed position to a casing wall in the form of a tube 2 which, in the present embodiment, completely encircles the spring. The inner end of the spring is fixed to a sleeve 3 through which passes a headed stud 4 threaded at one end. Tightly fitted on stud 4 is the lower end of a switch arm 5, a nut 6 threaded on stud 4 serving to clamp the end of the switch arm against washers 7.

To the upper end of arm 5 is secured an insulating block 8 which, in turn, carries a conventional type of magnet switch which comprises the spring-contact-carrying-element 9, the contact being indicated at $9x$, and a rigid back plate 10. At the rear of the back plate is a phosphor bronze cushioning arm 11 to reduce sparking, which is well known in this art.

A supporting panel 12 is apertured to receive tube 2 and the tube or a member connected thereto may be formed with a depending area, or, as shown in the drawing, a flange $2x$ which may be apertured to receive a retaining stud 13 threaded in panel 12. The aperture for the stud in flange $2x$ is elongated as shown more particularly in Figure 1 at 14.

Carried by the tube 2 adjacent one face of panel 12 is an adjusting arm $2xx$. The arm will be held against the panel by means of the stud 13. Additional means comprises screw 15 which passes through an arcuate aperture at a in an intermediate wing area of arm $2xx$, the screw being utilized to hold in position the contact assembly which coacts with contact $9x$. The said contact assembly comprises a bracket 16 through which screw 15 passes, the bracket carrying the adjustable contact pin 17 (Figure 1) and also a conventional magnet 18.

Contact-carrying arm 9 has connected thereto a pigtail wire 19, one end of the wire engaging a screw **20** passing through the panel and receiving wire **20**x. When contact **9**x engages contact pin **17** an electrical circuit is closed through wire **20**x, the switch elements including pin **17**, bracket **16**, screw **15** and wire **20**xx secured to the latter screw. Wires **20**x, **20**xx will lead to the element to be energized and the source of power in a series circuit giving direct line voltage operation.

At the front of the panel a cover **21** may be provided and the cover may be formed with an internally projected tube **21**x to shield all of the elements carried by the panel with the exception of the thermo-responsive spring **1**. Rearwardly of the panel, tube **2** will communicate with a conduit such as **22** which will lead to means for forcibly drawing air through tube **2** from the room or chamber in which the thermo-responsive device is located.

In the present embodiment the means for forcibly causing a current of air to pass over the surfaces of the thermo-responsive element comprises the intake pipe **23** or an air conditioner **24**. To aid in the suctional force created through pipe **23** by fan or other suction means of the air conditioner, a venturi **24** may be placed in pipe **23** and pipe **22** led into the venturi as shown more particularly in Figure 4. The outflow duct leading from the air conditioner is indicated at **25** and it passes through a wall **26** near the top thereof, a conventional form of screen being indicated at **27**. Pipe **23** being the return duct of the air conditioner, likewise passes through wall **26** and a conventional form of screen **28** is shown applied thereto. A fresh air duct for the air conditioner is shown at **29** leading to the outside air.

In the operation of the device, the operating differential is adjusted by rotating adjustable threaded pin **17** by means of thumb head **17**x (Figure 1), thereby changing its position in the field of the magnet.

The temperature adjustment for the room is effected by moving arm **2**xx to the left or the right, and the arm may carry or be marked with a pointer as indicated at p, the degree of adjustment being indicated on the plate by the marking at d.

As air is withdrawn from the room or chamber in which the device is located, through the action of the air conditioner, the suction through pipe **22** will force air through tube **2** and the air will be drawn uniformly over the entire surface of the spiral spring **1**. To aid in this uniform action of the air relatively to the spring the inner wall of tube **2** has been modified from a true circle by increasing the internal diameter to conform with the outer shape of the spring. The air under forced draft drawn over the surfaces of the thermo-element at the temperature within the room or chamber will effectively remove the insulating film adhering to said surfaces, and heat transfer between the element and the air in either direction will be unimpeded and hence the thermo-responsive element will conform itself to the temperature of the air with practically no time lag.

It will be understood that the means for causing a forced draft of air across the surface of the thermo-responsive element may be widely varied from that illustrated in the drawing. This method of film removing must not be confused with the mere ventilation practiced in conjunction with the installation of thermostats for example, where a draft of air may be flowing within the cover and past the thermo-responsive element, in an effort to prevent stagnation and thus generally increase the speed of response of the instrument because unless the film of air is positively and at all times removed by a forceful method from the radiating surfaces and invisible small crevices existing upon the element, it will not respond with the precise manner as realized in my invention.

It will also be noted that the rotary motion furnished by the thermo-responsive spiral spring may actuate or throw into action any form of electrical switch such as a mercury capsule, etc., the drawing being illustrative of one embodiment only. A spiral was chosen as being the most convenient shape to obtain motion and still retain a fairly equal space between convolutions so the fairly constant stream or air of high velocity be continuously maintained in intimate contact with the surface of the element. Any other form of element so shaped that a thin stream of air at high velocity can be made to remove the surface film can be substituted.

Having described my invention, what I claim and desire to secure by Letters Patent is as follows:

1. A surface film-free thermo-responsive element reacting to variations in temperature of air at atmospheric pressure, comprising a spiral bi-metallic spring having closely wound convolutions, a device operatively connected to and adapted to be thrown into action by said element, a tubular wall surrounding the spring and spaced therefrom approximately the same distance as the spacing between the convolutions, and means for causing a continuous air stream of high velocity to pass in direct and intimate contact with all the surfaces of the spring transversely thereof.

2. A thermo-responsive element reacting to temperature variations of air at atmospheric pressure comprising a bi-metallic spiral spring having closely wound convolutions, a device operatively connected to and adapted to be thrown into action by said element, and means for causing a stream of said air at high velocity to continuously brush the surfaces of the spring from edge to edge of its tape convolutions, thereby preventing said air from forming an insulating film upon the surfaces of said spring.

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