

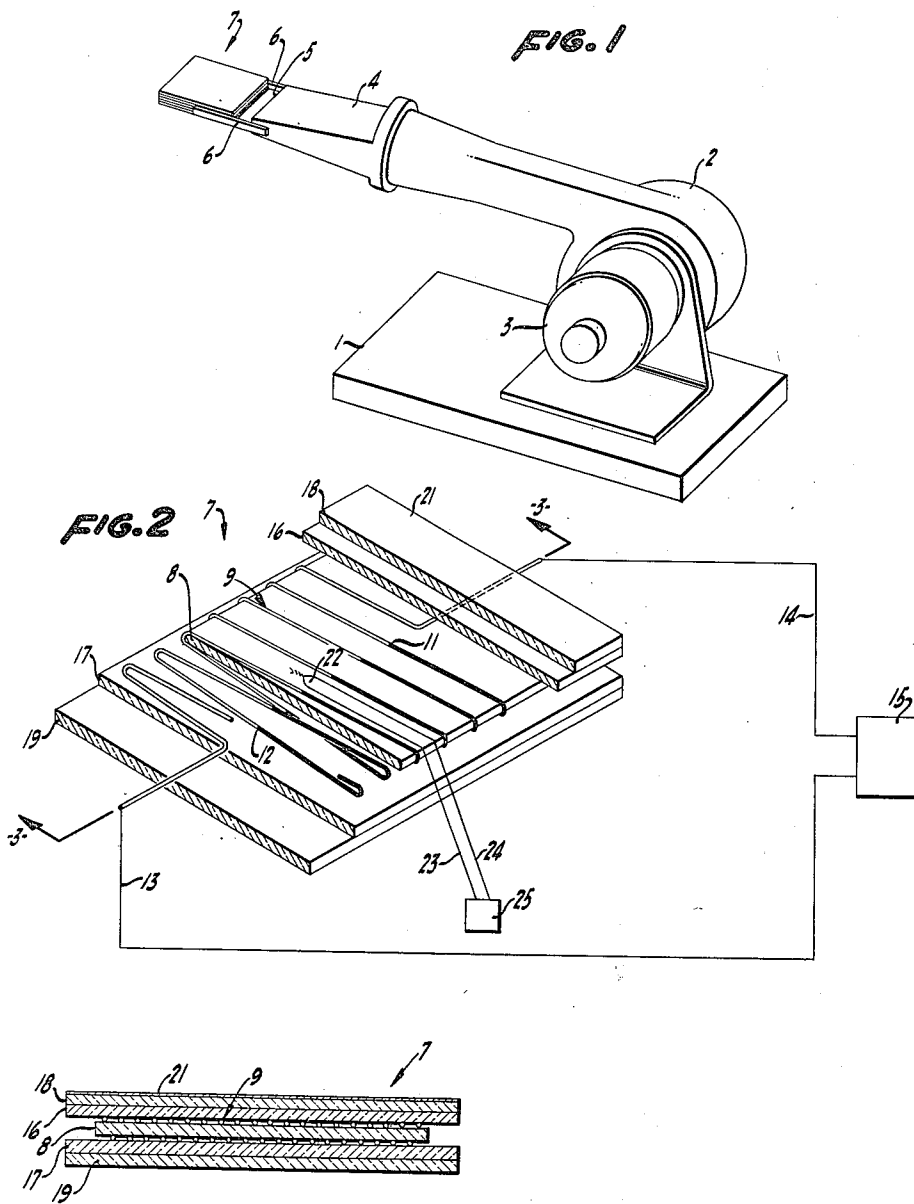
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HEMISPHERICAL RADIOMETER SENSING UNIT

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HEMISPHERICAL RADIOMETER SENSING UNIT

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This invention relates to and in general has for its object the provision of a sensing unit for sensing the total heat radiated from a hemisphere of space (half space) at any given time.

More specifically, the object of this invention is the provision of a sensing unit including a flat thermal resistance plate provided on opposite sides thereof respectively with the hot and cold junctions of a thermopile, the radiation receiving side of said radiometer being blackened and its opposite side being highly polished and where-in means is provided for subjecting both sides of the meter to a uniform and constant current of air.

The invention possesses other advantageous features, some of which, with the foregoing, will be set forth at length in the following description where that form of the invention which has been selected for illustration in the drawings accompanying and forming a part of the present specification is outlined in full. In said drawings, one form of the invention is shown, but it is to be understood that it is not limited to such form, since the invention as set forth in the claims may be embodied in a plurality of forms.

Referring to the drawings:

Fig. 1 is a perspective view of a radiometer sensing unit embodying the objects of our invention.

Fig. 2 is an enlarged perspective view of the sensing unit with portions thereof broken away to show its thermopile and the thermocouples thereof.

Fig. 3 is a section taken on the line 3-3 of Fig. 2.

The device as shown in the figures includes a base 1 and an air blower 2 mounted thereon and driven by an electric motor 3. Secured to the discharge end of the blower is a nozzle 4 having a generally rectangular mouth 5, and supported from the nozzle by arms 6 is a sensing unit generally designated by the reference numeral 7.

As shown in Figs. 2 and 3, the sensing unit 7 is of laminated construction and is formed about a relatively thin central rectangular plate 8 made from a thermal resistant material such as a phenol condensation product. Supported on the plate 8 is a thermopile generally designated by the reference numeral 9 having its hot junctions or thermocouples 11 disposed on the upper face

of the plate 8 and its cold junctions 12 disposed on the lower face thereof. Conveniently, the thermopile can be made of alternate sections of copper and constantan wire, the adjacent ends of these sections being soldered to form the opposed thermocouples 11 and 12. Connected in series with the thermopile through leads 13 and 14 is a potentiometer 15.

Bonded to the central plate 8 over the hot junctions 11 is an upper thermal resistant plate 16. Similarly bonded to the lower face of the plate 8 is a thermal resistant plate 17. Bonded to the outer faces of each of the plates 16 and 17 respectively are aluminum plates 18 and 19. The upper face of the plate 18 is blackened by applying thereto a layer of non-reflecting black paint 21. The lower or exposed face of the lower aluminum plate 19 should be highly polished so as effectively to reflect all radiation to which it may be subjected. In addition to this, the plate can be shielded if desired.

Mounted within a shallow recess formed in the central plate 8 is a thermocouple 22 connected through leads 23 and 24 with a thermometer 25, serving as means for determining the absolute temperature of the sensing unit 7.

From an inspection of Fig. 1, it will be noted that the radiometer unit 7 is in direct alignment with the end of the nozzle 4, and is so positioned that air from the blower will sweep over both faces thereof.

The upper face of the sensing unit 7 is unobstructed and consequently it is in a position to receive radiation from half space or the hemisphere lying above it. It is for this reason that the device in combination with the potentiometer 15 has been designated a "hemispherical radiometer." Furthermore, since in this instrument, the use of windows (glass or otherwise) is unnecessary, it is under the influence of the total thermal radiation from one half space rather than only a selected portion thereof, as would be the case if such radiation had to pass through a physical window of some sort.

The blower produces uniform and constant convection effects upon both the upper and lower surfaces of the sensing unit and as a result approximately one half of the net radiation absorbed by the black upper surface of the meter flows through the meter, thereby producing a

temperature drop across the central thermal resistance plate 8. This temperature difference produces an electromotive force in the thermopile 9 proportionate to the irradiation falling on the upper blackened surface of the sensing unit and indicated by the potentiometer 15.

The equation for the total hemispherical irradiation, G , falling upon a unit area of the meter per unit of time, is:

$G = Kv + \sigma Tm^4$, wherein

K = the calibration constant of the meter,

v = the E. M. F. of the thermopile

σ = Stefan-Boltzmann constant, and

Tm = the absolute temperature of the radiometer

By blackening the lower face of plate 19 to correspond with the blackened upper face of the plate 18, the radiometer will then serve to measure the net exchange by radiation across the plane of the meter, this being proportional to the electromotive force developed by the thermopile.

From the above description it will be noted that we have provided a simple but effective hemispherical radiometer sensing unit which, by a suitable choice of the blackening material, can be made to respond equally to all wavelengths of radiation in the thermal radiation band. Since the receiving surface of the instrument is a plane, it "sees" a whole hemisphere, and a single reading gives directly the summation of the energy falling on the plane of the meter surface from all directions. The absorptivity of the meter is independent of the angle of incidence for the cosine law is obeyed. Due to the low thermal resistance and capacity of the meter, the response time is small. As previously indicated, the blower serves to maintain uniform convection losses from both surfaces of the radiometer unit independent of the air currents and wind prevailing at the location of the meter, and also tends to decrease the response time by maintaining a high rate of heat transfer from the meter. This in turn helps to maintain uniform, reproducible readings and to prevent the temperature of meter from rising substantially above the ambient air temperature.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. A radiometer sensing unit comprising: a thermal resistance element; a thermopile mounted on said thermal resistance element with its hot and cold junctions disposed on opposite sides thereof; a black body disposed over said

hot junctions and a body having an outer polished surface disposed over said cold junctions; and means for passing a gaseous current over said black body and said polished surface, the upper face of said sensing unit being unobstructed so as to enable it to see the total hemisphere.

2. A radiometer sensing unit comprising: a base; a blower mounted on said base and including an elongated nozzle; a relatively flat thermal resistance element mounted in alignment with said nozzle; a thermopile mounted on said thermal resistance element with its hot and cold junctions disposed on opposite sides thereof; a black body disposed over said hot junctions; and a body having an outer polished surface disposed over said cold junctions; said blower serving to force a gaseous current over said black body and over said polished surface, the upper face of said sensing unit being unobstructed so as to enable it to see the total hemisphere.

3. A radiometer sensing unit comprising: a base; a blower mounted on said base and including a nozzle; a relatively flat thermal resistance element mounted symmetrically in front of said nozzle; a thermopile mounted on said thermal resistance element with its hot and cold junctions disposed on opposite sides thereof; a black body disposed over said hot junctions and a body having an outer polished surface disposed over said cold junctions; and means disposed within said radiometer for determining its temperature, said blower serving to force a gaseous current over said black body and over said polished surface, the upper face of said sensing unit being unobstructed so as to enable it to see the total hemisphere.

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