only by methods which basically are calorimetric, that is, which measure directly the rate of heat loss from an object maintained at the temperature of the body, irrespective of air temperature.

The apparatus for this purpose consists essentially of a hollow sphere, or cylinder, containing a fluid which can be maintained accurately at the accepted mean surface temperature of the human body, with an accurate means of measuring the rate of heat supply required to maintain the temperature at that exact point. The latter measurement can be made with sufficient accuracy by electrical methods. Although a definite BET is desirable, the mean radiant and air temperatures may both vary, provided the heat loss by radiation and convection from a surface at 83 F is maintained at the correct proportion or within reasonable limits.

This instrument, the *eupatheoscope*, can readily be adapted as a thermostat by electrical control to shut off or turn on heat when the critical temperature of 83 F or any other predetermined temperature on the surface of the vessel is increased or decreased. A modification of the instrument is called the *eupatheostat*.

Another instrument for maintaining comfort conditions is at present available only in a model adapted to British practice as it is designed for a temperature of 75 F. It consists of a blackened copper sphere of approximately 6 in. diameter in which is housed a cylindrical sump containing a volatile liquid. In operation, a small electric heating coil drawing about 5 watts creates in the sphere a vapor pressure which is constant as long as the heat losses from the sphere are standard. If the temperature of the air or the MRT becomes too high for comfort, a greater pressure is created, owing to a smaller loss of heat from the sphere. This increase of pressure acts on a diaphragm and shuts off the supply of heat to the room.

For testing work, the *globe thermometer* is a very useful instrument. It consists of an ordinary mercury thermometer, with its bulb placed in the center of a sphere from 6 to 9 in. in diameter, usually made of thin copper and painted black. The temperature thus recorded is termed the *radiation-convection temperature*.

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PROBLEMS IN PRACTICE

1 ● Where did radiant heating derive its name?

The term radiant heating was introduced about 28 years ago to designate flat heating surfaces made to give off practically all their heat by radiant ether waves instead of relying on convected warm air.

2 ● What is actually meant by radiant heating and what are its underlying principles?

The term radiant heating now applies to methods of heating where, instead of heating the air in a room to a predetermined temperature, flat heating surfaces are placed in a room so that the average effective temperature of walls, ceiling, glass and floor surfaces exposed to the body is just sufficient to prevent the body losing too much heat by radiation. It takes into consideration that the body generates more heat than it requires, so that it does not require any heat from without. The surplus heat, however, must be given off according to the physiological requirement of the body.

3 ● What kind of heating surfaces are in general use?

The heating units may have flat iron surfaces heated with steam or hot water and placed in side walls or under windows, or they may be supported on the ceiling and suitably decorated and connected as ordinary steam or hot water radiators. Hot water pipes may be embedded in the floor, walls or ceiling, and when in the floors they may be covered with concrete and wood blocks or other suitable material; the finish of the surface being more important than the composition of the material. When in the ceiling or walls, they can be covered with plaster to harmonize with the rest of the room. Electrical radiant heaters are made by embedding resistance elements in porcelain, or electric conductors may be woven into thick paper and fastened to the walls and ceilings, electric wires may be woven with tapestry to form portable screens for local heating.

4 ● What surface temperatures are generally used?

Where hot water pipes are embedded in plaster, the surface temperature varies from 90 to 130 F. Where flat iron plates are used these may vary from 140 to 220 F. With electric resistances embedded in porcelain the surface temperature may vary from 200 to 500 F. High surface temperatures are not recommended.

5 ● What kind of heat rays are commonly generated for radiant heating?

All heat rays are generally assumed to be the same as light rays; they travel at the speed of light, but they are invisible and longer. The rays used in heating are 0.00005 to 0.0001 in. long, compared with invisible red rays of about 0.000027 in.

6 ● When and why does the human body feel cold?

The body feels cold not only when it loses heat at a greater rate than it can generate it but also when heat is abstracted from the body disproportionately. Since the human body generates more heat than is necessary, it is only necessary to provide conditions that will regulate the correct ratio of losses; the provision of suitable radiant heating surfaces is one way to establish these conditions.

7 ● Why is the heat loss from the body by radiation important?

The heat loss by radiation is proportional to the fourth power of the temperature difference between the surface of the body and the average surface temperature of the surrounding walls, windows, etc.; whereas, for convection losses, it is only proportional to the 1.25 power.