# DEVICE FOR MEASURING CALORIE EXPENDITURE AND DEVICE FOR MEASURING BODY TEMPERATURE

## CONTINUING APPLICATION DATA

This application is a divisional of U.S. patent application Ser. No. 09/011,554, filed Feb. 9, 1998, now U.S. Pat. No. 6,030,342 which is incorporated herein in its entirety by reference.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a calorie expenditure measuring device which can accurately measure the calorie expenditure by a subject regardless of whether the subject is resting or active, without being effected by such factors as the temperature of the surrounding environment, daily or annual fluctuations in the subject's physical state, this device accordingly being useful in maintaining health. The present invention is further related to a body temperature measuring device suitably employed in the aforementioned calorie expenditure measuring device which can continuously measure a body temperature which is as close as possible to the subject's deep body temperature, and is therefore also useful in maintaining health.

2. Description of the Related Art

In this time of abundant food, calorie expenditure during exercise or daily activities has been recognized as one important index for maintaining health. Accordingly, the determination of calories expended is very significant. The standard total number of calories expended daily may vary widely, from a minimum of 1,000 kcal for a 1-year old child to a maximum of 3,800 Kcal for a 17-year teenager.

When measuring calorie expenditure, accuracy of within about 5% of the minimum value is considered necessary. Accordingly, the measurement error must be within 50 kcal.

Calorie expenditure measuring devices, such as that disclosed in Japanese Patent Application Hei 8-52119 for example, has been proposed as devices for measuring the body's calorie expenditure. Such calorie expenditure measuring devices record the subject's sex, age, height, body weight, body fat ratio, and other constants in advance, as well as a table of standard basal metabolism values per unit of surface area on the body. These devices also use formulas for calculating the calorie expenditure when the subject is at rest or is exercising. When measuring the calorie expenditure, the measured pulse rate value and each of the constants cited above are substituted into formulas according to whether the subject is resting or exercising. Calorie expenditure is then calculated by referring to the aforementioned table of standard basal metabolism values.

However, the conventional devices for measuring calories expended described above have the following problems.

First, these conventional calorie expenditure measuring devices are provided with a comparison and determination device which determines the calculation formula to be used by comparing the measured pulse rate and the "pulse rate threshold value (pulse rate when standing quietly)". However, it is well known that the pulse rate may rise due to various factors, including stress. Thus, since these devices determine the calculation formula which will be used according to the pulse rate only, they cannot discriminate between whether an increase in the pulse rate is due to factors other than increased activity, such as stress, or because the subject is actually exercising. As a result, calorie expenditure may be incorrectly calculated.



Second, in recent years it has come to be understood that there are a variety of physiological parameters, pulse rate included, that are subject to cyclical variation (daily, monthly or annually). For this reason, if the calculation of calorie expenditure is not corrected for this variation, then the accuracy of the calculation is suspect. Conventional calorie expenditure measuring devices do not take into consideration the fact that pulse rate varies cyclically, so that accurate measurement of calorie expenditure is difficult.

Thus, measurement accuracy of within 50 kcal as described above cannot be obtained using these conventional calorie expenditure measuring devices.

## SUMMARY OF THE INVENTION

The present invention was conceived in consideration of the above-described circumstances, and has as its first objective the provision of a calorie expenditure measuring device which can accurately discriminate between resting and active states, and which can calculate the calorie expenditure with high accuracy by taking into consideration physical and psychological effects as well as cyclical variation in the pulse rate.

Further, the present invention has as its second objective the provision of a body temperature measuring device suitably employed in this calorie expenditure measuring device which continuously measures a body temperature which is as close as possible to the subject's deep body temperature.

In order to achieve the above stated first objective, the present invention is firstly characterized in the provision of a basal metabolic state specifying means for specifying the subject's basal metabolic state; a correlation recording means for recording the correlation between the pulse rate and calorie expenditure; a correlation correcting means for correcting the correlation stored in the correlation storing means by using the basal metabolic state specified by the basal metabolic state specifying means; and a calorie calculating means for applying the subject's pulse rate in the correlation stored in the correlation storing means, to calculate the calorie expenditure corresponding to this pulse rate.

In order to achieve the aforementioned second objective, the present invention is secondly characterized with the provision of a pulse wave detecting means for detecting over a specific range the pulse pressure around a site at which the subject's pulse is present; a temperature detecting means for detecting temperature, which is provided near the pulse wave detecting means; and a body temperature specifying means for specifying the temperature which was detected at the site at which the largest pulse pressure was detected from among the pulse pressures which were detected over the aforementioned specific region, as the body temperature.

As a result of the first characteristic described above, it is possible to calculate the calorie expenditure per unit time with excellent accuracy since the subject's psychological state, and of course his resting or active state, are taken into consideration. Further, it is also possible to more accurately determine calorie expenditure since monthly and annual fluctuations in the subject's state are taken into consideration.

Further, as a result of the above described second characteristic, the pulse pressure is detected over a specific area near where a pulse is present, and the temperature at the site where the pulse wave having the highest pressure within this area was detected is measured as the body temperature. As a result, it is possible to measure at the periphery a body