

# Design of forehead temperature gun not affected by ambient temperature

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## Abstract

**In order to solve the problem that the infrared forehead thermometer is dependent on the ambient temperature, this study aims to use the integrated temperature compensation module to solve the influence of the ambient temperature on the measurement of the forehead thermometer, and design a forehead thermometer that is not affected by the ambient temperature, while improving the accuracy of temperature measurement.**

## Keywords

**Forehead temperature gun; Temperature compensation, infrared.**

## 1. Introduction

Infrared thermometer is a kind of instrument that uses the principle of radiation to measure the body temperature. The infrared sensor used in the infrared thermometer only absorbs the infrared rays radiated by the human body and does not emit any rays to the outside world. It senses the temperature of the human body through a non-contact method [1-2]. The forehead thermometer is an infrared thermometer which is mainly design for measuring that body temperature of a human body, but also can be widely apply to other fields, is convenient to use, has fast temperature measurement speed, and can save a large amount of time; and the existing forehead thermometer is mainly subjected to thermometry by two main parts, namely an infrared probe and a receiver, Since the outbreak of novel coronavirus pneumonia at the end of 2019, it has played a very important role in the detection and prevention and control of the epidemic [3-7].

The forehead thermometer is used in a relatively wide range of areas and places. Due to the relatively large temperature difference between the areas and places, and the relatively small temperature range that the infrared probe of the forehead thermometer can withstand, the minimum ambient temperature requirement is basically higher than 10 degrees Celsius and lower than 40 degrees Celsius [7]. Therefore, the performance of the infrared thermometry probe is easy to be limited when the thermometry is carried out under the conditions of low temperature and high temperature, so that the infrared probe fails to detect the temperature or the detected temperature is inaccurate, which is not conducive to the promotion in hot or severe cold areas. Therefore, it is urgent to design a forehead temperature gun which is not affected by the ambient temperature and can measure more accurately, so as to increase the user experience, avoid the situation that the queue can not thermometry in low temperature or high temperature weather, and at the same time, it is also a humanistic care for the front-line workers and the people.

## 2. Design frame

Therefore, this study aims to design a forehead thermometer with adjustable internal temperature, and solve the influence of ambient temperature on the measurement of forehead thermometer by integrating temperature compensation module. Which comprises a forehead temperature gun body, a display screen, a thermometry probe, a receiver, a temperature measuring key, a circuit board, a constant temperature mechanism and a control unit, and is used for solving the problem of inaccurate thermometry caused by performance limitation of an infrared thermometry probe in a low-temperature or high-temperature environment in the prior art.

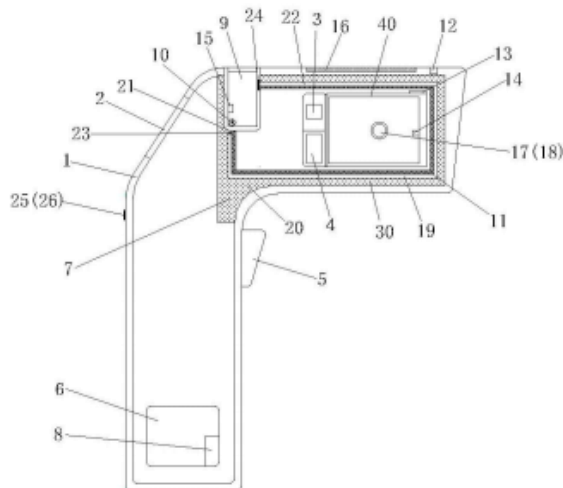


Figure 1: a schematic diagram of the overall structure of the forehead temperature gun with adjustable internal temperature according to the present invention

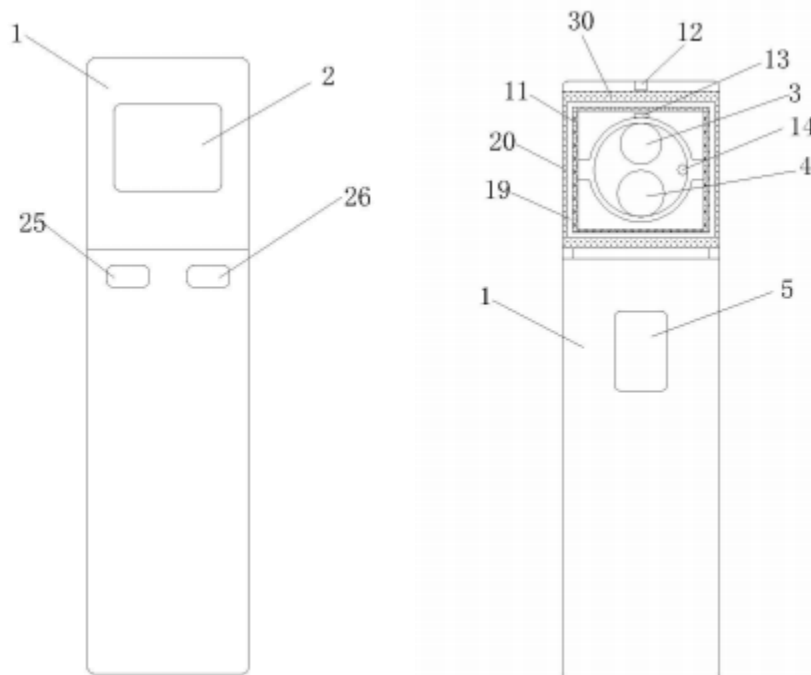


Figure 2: a rear view (left) and a front view (right) of the adjustable internal temperature forehead thermometer of the present invention

As shown in figure 1 and figure 2, the overall structure of the forehead thermometer gun with adjustable internal temperature in this study comprises a forehead thermometer gun body 1, a display screen 2, a thermometry probe 3, a receiver 4, a temperature measuring key 5 and a circuit board 6, and further comprises the following parts.

The constant temperature mechanism 7 is used to keep the thermometry probe 3 at a constant temperature, and includes a first constant temperature layer 30, a second constant temperature layer 40, a cooling liquid tank 9, a circulating water pump 10, a heating strip 11, a first temperature sensor 12, a second temperature sensor 13, a third temperature sensor 14, a fourth temperature sensor 15, and a solar thin film battery 16. The first constant temperature layer 30 and the second constant temperature layer 40 are both hollow structures, a third communicating pipe 17 and a fourth communicating pipe 18 are arranged between the first constant temperature layer 30 and the second constant temperature layer 40, a cooling liquid pipe 19 is arranged on the inner wall of the first constant temperature layer 30, and a heat insulation material 20 is arranged on the outer inner wall of the first constant temperature layer 30. The outer wall of the inner side of the first constant temperature layer 30 is also provided with a heating wire 11, the cooling liquid box 9 is arranged on the temperature gun body 1 and is connected with a cooling liquid pipe 19 in the first constant temperature layer 30 through a first communicating pipe 21 and a second communicating pipe 22, the first communicating pipe 21 is provided with a first valve 23, the second communicating pipe 22 is provided with a second valve 24, The third communicating pipe 17 is provided with a third valve (not shown in the figure), the fourth communicating pipe 18 is provided with a one-way valve (not shown in the figure), the circulating water pump 10 and the fourth temperature sensor 15 are arranged in the cooling liquid box 9, the first temperature sensor 12 is used for detecting the outdoor temperature and is arranged on the shell of the forehead thermometer body 1, The second temperature sensor 13 is used to detect the temperature of the first thermostatic layer 30 and the second thermostatic layer 40, and is disposed in the side cavity between the first thermostatic layer 30 and the second thermostatic layer 40. The third temperature sensor 14 is disposed on the inner outer wall of the second thermostatic layer 40. The control unit 8 is arranged on the circuit board 6 and used for controlling and starting the heating wire 11 to increase the temperature of the thermostatic mechanism 1 when the outdoor temperature is too low and controlling and starting the circulating water pump 10 to reduce the temperature of the thermostatic mechanism 1 when the outdoor temperature is too high; Which are respectively electrically connected with the circulating water pump 10, the heating wire 11, the first temperature sensor 12, the second temperature sensor 13, the third temperature sensor 14, the fourth temperature sensor 15 and the solar thin film battery 16.

### 3. Implementation principle

The core of the design is a constant temperature mechanism which is used for enabling the thermometry probe to be in a constant temperature environment and comprises a first constant temperature layer, a second constant temperature layer, a cooling liquid box, a circulating water pump, a heating wire, a plurality of temperature sensors and a solar thin film battery. The first constant temperature layer and the second constant temperature layer are of hollow structures, the inner inner wall of the first constant temperature layer is provided with a cooling liquid pipe and a heat insulation material arranged on the outer inner wall, the inner outer wall of the first heat insulation layer is also provided with a heating wire, the cooling liquid box is arranged on the forehead temperature gun body and is connected with the cooling liquid pipe in the first constant temperature layer, one of the temperature sensors is used for detecting the outdoor temperature, Wherein the temperature sensor is arranged on the shell of the forehead temperature gun body, is used for detecting the temperature of the first constant

temperature layer and the second constant temperature layer, is arranged in the side cavity between the first constant temperature layer and the second constant temperature layer, and is also required to be arranged on the outer wall of the inner side of the second constant temperature layer for detecting the temperature of the constant temperature layer.

In order to realize intelligent temperature regulation, a control unit is introduced for controlling and starting a heating wire to increase the temperature of a constant temperature mechanism when the outdoor temperature is too low and controlling and starting a circulating water pump to reduce the temperature of the constant temperature mechanism when the outdoor temperature is too high, the control unit is arranged on a circuit board and is respectively connected with the circulating water pump, the heating wire, a temperature sensor and a solar thin film battery, A preset low temperature range  $T_{a0}$  and a preset high temperature range  $T_{b0}$  are set in the control unit, and  $T_{a0}$  ( $T_{amin}$ ,  $T_{amax}$ ) and  $T_{b0}$  ( $T_{bmin}$ ,  $T_{bmax}$ ) are set, wherein  $T_{amin}$  is the minimum value of the preset low temperature range,  $T_{amax}$  is the maximum value of the preset low temperature range, and  $T_{bmin}$  is the minimum value of the preset high temperature range.  $T_{bmax}$  is that maximum value of the preset high temperature range, the control unit measure feedback data according to the outdoor real-time temperature detect by the sensor, the real-time temperature in the cavity between the first constant temperature layer and the second constant temperature layer and the like, when the outdoor temperature is in a low temperature state, the control unit controls to start the heat strip to heat the forehead temperature gun, The control unit utilizes the temperature of the heating wire to compensate according to the difference value of the outdoor real-time temperature and the real-time temperature of the constant temperature layer, or when the outdoor temperature is in a high temperature state, the control unit compensates the power of the circulating pump according to the temperature rise rate of the constant temperature layer in the process of controlling the temperature of the heating wire to be reduced, and utilizes the cooling liquid to reduce the temperature.

#### 4. Expected effect

As that constant temperature mechanism is arrange on the forehead temperature gun body, the forehead temperature gun can keep the internal temperature constant under the work environment of low temperature or high temperature, and the thermometry probe can measure data with high efficiency and high precision; the constant temperature mechanism comprises a first constant temperature layer and a second constant temperature layer, the thermometry probe and the receive are wrapped by the two constant temperature layers, and when the temperature of the working environment is reduced, The reduction rate of the temperature of the thermometry probe is reduced, and a low temperature range and a high temperature range are further preset in the control unit, so that the forehead temperature gun can adjust the internal temperature in real time under a low temperature or high temperature working environment, and the detection accuracy of the forehead temperature gun is further improved.

#### 5. Sum up

The forehead temperature gun is not affect by that environmental temperature, can be normally used in a low-temperature or high-temperature work environment, solves the problem that the forehead temperature gun cannot be normally popularized and used in torrid or severe cold area, can play an important role in emergencies such as novel coronavirus pneumonia epidemics, and realizes unconditional continuous accurate thermometry.

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