METHOD OF MEASUREMENT OF LASER BEAM ENERGY WITH „BLACK HORN" CALORIMETER

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The paper gives the description of a "rat's nest" calorimeter. The absorbing element consists of wires laid in the shape of a bent cone (horn) and placed in a passage Dewar vessel. The reflection coefficient measured was 0.1%. Ventilation by mean of a fan makes the bolometer suitable for multiple measurements.

One of the most common devices for measuring laser beam energy is the "rat's nest" calorimeter [1]. Various improvements of this calorimeter consisted either in the design of better electronics [2] or in the obtainment of greater absorptivity by suitable choice of the layout of wires, *e. g.*, in the form of a sphere [3]. The present paper describes an attempt of constructing a "rat's nest" calorimeter with a larger absorptivity and better efficiency.

The essential part of the calorimeter, *i. e.* the absorbent, was made of 390 m of insulated copper wire with the diameter of 0.09 mm and the resistance of about 1000 ohms. The wire was wound in the form of a conic horn and placed in a passage Dewar vessel. This vessel consists of a bent glass tube placed in a vacuum bulb with silvered inside walls. The wires are supported by a lucite plug. Inside the plug there is an aperture of the diameter of 14 mm. The winding is bifilar to avoid the magnetic field. The narrow end of the tube containing the wire is connected with a chamber having a fan inside. The motion of the fan is such that it draws out the air of the absorbing element. Behind the fan a coil of wire is placed of the same length and diameter as that in the bolometer. This coil is connected to the second arm of the Wheatstone's bridge to avoid the galvanometer drift. The vessel containing the galvanometer and the chamber with the fan are surrounded by foam plastic and placed in cylindrical housing. The cross-section of the bolometer is shown in Fig. 1.

If the bolometer operates in Wheatstone's bridge circuit whose arms have all the same resistance then a change of the bolometer resistance by ΔR ($\Delta R \ll R$) results in a current flowing through the galvanometer:

$$I = V \cdot \Delta R/4R(R_g+R)$$

where R is the resistance of one arm, R_g the resistance of the galvanometer and $\Delta R = \beta \cdot R \cdot E/4.19\, M \cdot c$ (β — temperature coefficient of resistance),

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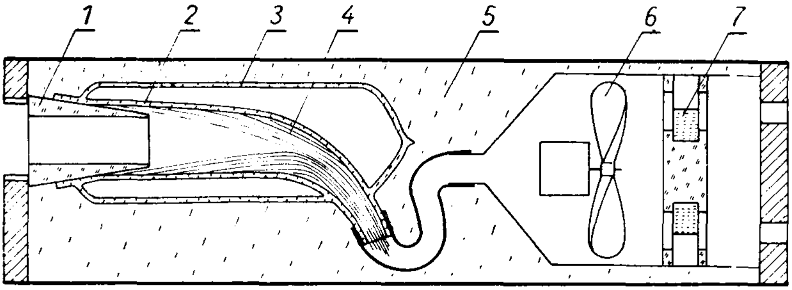

Fig. 1. Cross-section of the bolometer. *1* – lucite plug, *2* – glass tube, *3* – vacuum bulb with silvered inside walls, *4* – bolometer wire, *5* – foam plastic, *6* – fan, *7* – wire of the second arm of the bridge

M — mass of the wire, c — specific heat of the wire and, E — the total absorbed energy.

Defining the sensitivity of the galvanometer as $C_g = I/\alpha$ (where α is the deflection angle of the galvanometer) we obtain the following formula for the sensitivity of calorimeter

$$C_p = \frac{16.76\, cC_g(R_g+R)}{\beta}\,\frac{M}{V}$$

where V is the voltage applied on the bridge.

Thus the sensitivity and the range of the calorimeter can be changed by changing the voltage on the bridge. Using a *GL*-1 galvanometer with the sensitivity of $2 \cdot 10^{-9}$ A/sc. division and the voltage 2V and 10V, the following ranges and sensitivities were obtained, respectively: range 0–12 J, sensitivity 0.1 J/sc. div., and 0–2.4 J, sensitivity 0.02 J/sc. div.

Conclusions

Owing to the wiring in the shape of a black horn the absorptivity of the calorimeter described is very big. The backwards reflection coefficient measured amounts to about 0.1%.

The Dewar vessel walls isolate the bolometer from the influence of surrounding medium.

The possibility of rapid cooling makes the calorimeter suitable for frequent measurements.

A major disadvantage is the limitation of energy density to 10 J/cm^2 [1] or 10 MW/cm^2 in 50 nsec [4].

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