DEVICE TO MEASURE THE POWER OF VISIBLE LASER RADIATION

Z. T. Bikbulatov, V. G. Samusev, and V. P. Tsoi

UDC 615.849.19.015.3.07

KEY WORDS: measuring device; laser radiation; power

Because of its unique properties (monochromatic nature, acute polarization and coherence) laser radiation is finding increasingly wide application in experimental and clinical medicine [2]. In all cases when laser radiation is used in medicine, strict dosage is essential. One of the most important controllable parameters is the power of the radiation. To measure power of continuous radiation produced by experimental and industrial laser systems, the IMO-2 instrument and its IMO-2N modification, which are in mass production, are widely used. However, these measuring instruments are cumbersome and heavy, they possess high inertia, and they have to be heated up for a long time before measurements can be made. They are therefore not suitable for efficient use in medical practice.

We have attempted to develop and make a compact, low-inertia device for measuring the power of laser radiation in the visible band of the spectrum, which can be easily incorporated into any system.

The power measuring device consists of two functional units: the measuring head (Fig. 1) and the electronic unit (Fig. 2). The measuring head consists of a hollow sphere 1, the inner surface of which is coated with magnesium oxide (MgO). Because of this design feature, the targeted radiation is evenly scattered inside the hollow interior of the sphere, and this increases the accuracy of the measurements considerably. A hole is made diametrically in the wall of the sphere, into which the light receiver 2 is fitted. The light receivers most commonly used in measuring technology are those based on the internal photoeffect, namely photodiodes and photoresistors [1]. These light collectors have justified their use well in the visible region of the spectrum (emission wavelength λ = 400-700 nm). In the measuring device now being described, a silicon photoresistor of the SFZ type is used to measure power. To compensate any errors of measurement caused by a change of temperature inside the hollow sphere, a similar photoresistor 3, located in the immediate vicinity of the receiver 2, is used. However, radiation does not fall on the temperature-compensating photoresistor, unlike the light receiver. The internal diameter of the sphere is chosen so that it is 10 times or more greater than the diameter of the light receiver.

The receiving aperture is drilled perpendicularly to the light receiver, and the tube 4 with revolving reflecting screen 5 is fitted. The tube is 12 times longer than its diameter in order to prevent scattered light from falling into the measuring head at the time of measurement. The revolving reflecting screen 5, with a concentric circle inscribed on its mirror surface, is used for rapid adjustment of the measuring head during measurements by coincidence of the incident and reflected beam. By means of the adjusting device, the laser beam can be made to coincide with the axis of the tube 4, after which the reflecting screen 5 is revolved, opening the entry into the tube. Adjustment of the measuring head is performed by moving it along horizontal and vertical axes and by rotation around these axes. Rotation around the horizontal axis is effected by means of a cylindrical hinge connection (details 6, 7, and 8). Displacement in the vertical direction and rotation of the measuring head around the vertical axis are achieved with the aid of a cylindrical connection (details 8 and 9); fixation in a certain position is effected by means of the set screw 10. The measuring head, assembled with all the above-mentioned parts, is fixed to a baseplate 11.

The electrical circuit of the device for measuring the power of radiation (Fig. 2) consists of a transducer, operative amplifier, and power unit. The transducer, of bridge type,

Laboratory of Lymphology, Institute of Physiology, Siberian Branch, Academy of Medical Sciences of the USSR, Novosibirsk. (Presented by Academician of the Academy of Medical Sciences of the USSR, Yu. I. Borodin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 107, No. 6, pp. 695-696, June, 1989. Original article submitted October 10, 1988.

 0007-4888/89/0006-0810$12.50

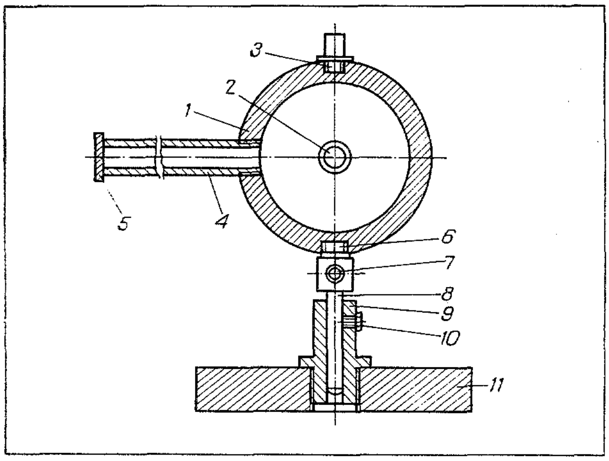

Fig. 1. Measuring head. Explanation in text.

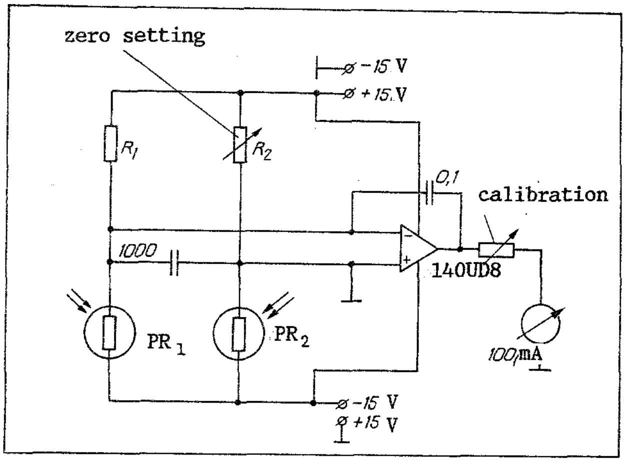

Fig. 2. Theoretical electrical circuit of device for measuring power of laser radiation. Explanation in text.

consists of a measuring photoresistor PR_1 and a temperature-compensating photoresistor PR_2, and of current-setting and balancing resistors R_1 and R_2. The value of R_1, moreover, is chosen to ensure maximal output of the bridge:

$$R_1 = \sqrt{R_{pr_1} \cdot R_{pr_2}},$$

where R_{pr_1} denotes the resistance of the measuring photoresistor at maximal brightness; R_{pr_2} the resistance of the temperature-compensating photoresistor.

The ratings of the current-setting and balancing resistors are chosen to be equal to $R_1 = R_2 \approx 100$ MΩ.

The operative amplifier (140UD8, 544UD1, 284UD2, 574UD1) is used to match the high output resistance of the bridge with the low resistance of the measuring microammeter.

The electronic unit is powered by a bipolar source with stabilized voltage $U_{st} = +15$ V. Advantages of the unit for measuring the power of laser radiation include the simplicity of its design and the fact that it can be assembled from elements and components manufactured by Soviet industry.

The above device for measuring power can be effectively used in clinical practice and in experimental research and is easily incorporated into mass-produced medical laser systems.

LITERATURE CITED

1. B. Ya. Burdaev, R. A. Valitov, M. A. Vinokur, et al., Measurement of Energy Parameters and Characteristics of Laser Radiation [in Russian], Moscow (1981).
2. A. A. Uglov, The Use of Laser Technology in the National Economy [in Russian], Moscow (1988), pp. 80-94.