The magnitude of the error is determined largely by the hum of the photoconductive cell, and it may be decreased by employing a cell of higher quality (in the IKP-57 pyrometer, ordinary photoconductive cells suitable for automation purposes are used). The error of the spectropyrometer may be minimized also by cooling the photoconductive cell.

Extension of the spectrometer scale to high-temperature ranges, where it is impossible to introduce direct blackbody comparison, may be made by extrapolation using Planck's equation, that is, by the method used for extending the scales of the common optical instruments using the international temperature scale. This may be done because almost monochromatic radiation having accurately known values of effective wavelength is used.

LITERATURE CITED


A LABORATORY OBJECTIVE SPECTROPYROMETER

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The SPK-1 and SPK-2 spectropyrometers, developed at KhGIMP, were introduced in practical work on standards in metrological institutes, and they contributed to a considerable improvement of measurement accuracy in work on standards in the optical pyrometry field. In connection with this, it also became necessary to improve the accuracy in approval work which is performed by state control laboratories for measurement technique, and, mainly, to improve the accuracy in checking standard temperature lamps.

Moreover, in connection with the ever-increasing application of color pyrometers, it became necessary to check temperature lamps which are graduated for color temperatures. These new tasks can be performed by means of SPK devices, which, however, are not convenient for use in state control laboratories, since they are expensive and bulky.

The SPP-58 spectropyrometer, which has been designed for high-accuracy control work, is inexpensive, compact, and it permits the measurement of monochromatic brightness of various objects in the wavelength interval from 0.4 to 0.8 μ. The measurements are performed by comparing the brightness of the object with the brightness of a standard lamp, which is built into the device.

The operation principle of the spectropyrometer is similar to the operation principle of SPK devices; it has been described in detail in [2 and 3]. Briefly, it consists in the following: The radiation of the object under investigation and of the comparison temperature lamp is alternately directed to a photomultiplier through a monochromator by means of a modulator. If the brightnesses of the object and of the lamp are not equal, the photomultiplier current contains a variable component with the modulation frequency. After amplification and rectification by means of a synchronous detector, this component is supplied to an indicating instrument with a scale where the zero point is in the middle. The deviation of the instrument needle indicates the inequality of brightnesses, while the deviation sign depends on the brightness ratio of the sources. If the brightnesses are equal, the variable component is absent, and the instrument needle remains at the scale zero.

The equalization of brightnesses is effected by changing the heating current of the comparison temperature lamp. After measuring this current by means of a potentiometer, the brightness temperature of the object, which corresponds to that value of the effective wavelength for which the monochromator is adjusted, is found from the calibration curve.
The zero modulation method of comparing brightnesses [3], which has been applied in this spectropyrometer, makes it possible to eliminate errors connected with instability of the photocathode sensitivity, and also reduce to a great extent the photocurrent fluctuation effect.

The interaction of the basic spectrometer parts can be analyzed by considering the optical system given in Fig. 1. An achromatic objective 3, which is located in front of an absorber 2, forms a diminished image of the object 1 to be measured in the mirror plane 8 of the modulator. By means of objective 5, the magnified image of the filament in the comparison temperature lamp 4 is obtained in the same plane. The image width is adjusted to be equal to, or somewhat larger than, the modulator mirror width (1 mm).

Before reaching the modulator mirror, the light from the comparison temperature lamp is reflected from a dividing mirror 6, which has a sharp edge. The lens 7 forms the image of the dividing mirror edge in the plane of the collimator objective 10 of the monochromator. The mirror 6 is placed in such a manner that each of the two sources to be compared illuminates one-half of the collimator objective when the modulator mirror is immobile.

The modulator mirror 8, which is similar to the mirror of a magnetoelectric loop, is fixed on two small wires, which are extended into the field of a permanent magnet. When the modulator operates, the mirror oscillates, and the collimator objective 10 is alternately illuminated by the sources to be compared. The light flux which leaves the monochromator falls on photomultiplier 12. The alternating voltage, which arises at the photomultiplier anode, is amplified by a narrow-band amplifier and is then rectified by a synchronous detector. The latter is monitored by the same generator which controls the instrument modulator. The rectified signal then passes through a low-frequency filter and is supplied to a symmetrical direct-current amplifier, the output of which is connected to the measuring instrument.

Regardless of the similarity of operation principles of the SPP-58 spectropyrometer and of SPK devices, these instruments are basically different. The SPP-58 spectropyrometer is constructed as a portable table instrument, while the SPK devices are stationary and are of a rather large size. Moreover, the SPP-58 spectropyrometer has a built-in comparison temperature lamp and can be, consequently, used for measuring the temperature of different objects. The SPK devices are highly accurate spectropyrometric comparators, whereby the brightnesses of only two objects can be compared.

The SPP-58 spectropyrometer consists of two units. A UM-2 universal monochromator and a standard optical bench are mounted on the first unit stand. A mechanism for fastening and moving the temperature lamp to be checked, which provides three translatory and three rotational freedoms of movement, is mounted on the bench. The external optical system unit with the temperature comparison lamp is fixed on the monochromator collimator tube. A photocell is fixed on the monochromator chamber tube. The electronic device with a control panel is built into the second unit.

The modulator which is used in the spectropyrometer [2 and 4] can operate at any frequency from 0 to 1000 cps; it is reliable and does not require any tuning and adjusting after the instrument is switched on. The modulator mirror makes it possible to obtain very clear temperature lamp images, and it does not restrict the field of view of microscope 9, which serves for sighting.

The specially constructed miniature temperature comparison lamp is located in the lower part of the external optical system unit. The temperature lamp consists of a vacuum lamp with a tungsten filament with a cross section of 0.8 x 0.03 mm²; it uses a current of 2 to 4 amp (for temperatures of 800 to 1500°C), which makes it possible to feed the lamp from small-capacity storage batteries (60-100 amp-hr).

The entrance slit of the monochromator which is used in the spectropyrometer is removed, and its function is performed by the modulator mirror 8, and, therefore, the entrance slit has a constant width. The exit slit 11 has

Fig. 2. Block diagram of the electronic device. 1) Photomultiplier FEU-27; 2) anode follower (6S1P); 3) narrow-band amplifier (6Zh2P); 4) phase inverter (6N3P); 5) synchronous detector; 6) low-frequency filter and direct-current amplifier (6N3P); 7) microammeter; 8) modulator generator (6Zh5P and 6P1P); 9) modulator; 10) high-voltage source (6P1P and 1Ts11P).