amount of scattered radiation in the lines is however only a small per cent. of the total scattered radiation, a large part of it lying in between the maxima. Theory predicts a large intensity of scattering at very small angles from the primary beam, but these experiments show that the scattering approaches zero at these small angles. Determinations of the absorption coefficient in aluminum of the scattered radiation at fourteen angles about equally distributed in the region of investigation failed to show any difference in quality of the scattered and primary radiation.

State University of Iowa,
Iowa City, Iowa.

The Spectrum of Secondary X-rays.

By Arthur H. Compton.

An examination of the secondary rays excited in different materials when x-rays rendered nearly homogeneous by filtering were employed, showed that the secondary radiation was of a softer type than the primary rays which struck the radiator.[1] More recent experiments have shown that this phenomenon is not confined to heterogeneous x-rays, but occurs also when the rays incident upon the radiator have been reflected from a crystal.[2] The most obvious interpretation of these results was that in addition to scattered radiation there appeared in the secondary rays a type of fluorescent radiation, whose wave-length was nearly independent of the substance used as radiator, depending only upon the wave-length of the incident rays and the angle at which the secondary rays were examined.

In order to obtain more definite information with regard to the characteristics of the secondary x-radiation, a study has been made of the spectrum of the secondary rays excited in various substances by the x-rays from a Coolidge tube having a molybdenum target. A small piece of radiating material, such as celluloid or aluminium, placed in front of the first slit of the spectrometer, was illuminated by incident x-rays at approximately 90° with the secondary beam under investigation. The spectrum was studied by means of a calcite crystal grating, using both the ionization and photographic methods.

The spectra obtained show lines identical in wave-length with the primary K lines from molybdenum, thus proving that a part of the secondary radiation is truly scattered and unchanged in wave-length. In addition to these lines, a general radiation is observed which is more prominent in the secondary than in the primary beam. When the x-rays incident upon the radiator were unfiltered, the general secondary radiation had a broad intensity maximum at a wave-length slightly under 1 Å. U. On introducing a zirconium filter between the x-ray tube and the radiator, thus giving a primary beam consisting principally of the $K\alpha$ line from molybdenum together with some fluorescent K rays from zirconium, a much sharper maximum in the secondary fluorescent

[1] Phys. Rev., 18, 96 (1921).

[2] Nature, Nov. 17, 1921.

radiation was observed. This result has been verified by means of photographic spectra, which show a maximum of the general radiation at about 0.95 Å.U., which is about 35 per cent. greater than the wave-length of the exciting ray.

The energy in this general radiation is roughly 30 per cent. as great as the energy of the scattered K rays. Previous experiments have shown that when shorter wave-lengths are employed, the energy in the fluorescent rays may be even more prominent than the truly scattered rays. If we suppose that the incident x-ray beam ejects electrons moving forward with a kinetic energy hC/λ, where λ is the wave-length of the exciting ray, and if the ejected electron is oscillating at such a frequency that as observed in the direction of motion the wave-length is λ, on account of the Doppler effect the wave-length of the radiation at right angles with the primary beam will be very close to that of the fluorescent rays observed in these experiments.

WASHINGTON UNIVERSITY,
SAINT LOUIS.

OSCILLATIONS OF TEMPERATURE OF AN INCANDESCENT FILAMENT, AND THE SPECIFIC HEAT OF TUNGSTEN.

BY K. K. SMITH AND P. W. BIGLER.

THE primary object of this experiment was to test the practicability of using thermionic currents to record rapid changes in the temperature of a filament. By means of a double high-frequency oscillograph we have obtained continuous photographic records showing simultaneously the cyclic variations in thermionic emission from an incandescent tungsten filament in vacuo, and the variations in the alternating voltage across the filament. The thermionic current is a direct current on which are superposed oscillations of twice the supply frequency, which is 60 cycles per second. The constant potential difference, 220 volts, between the filament and the cylindrical anode was more than sufficient to secure saturation, and consequently variations in the thermionic current were produced wholly by changes in temperature. The thermionic current was returned through one strip of the oscillograph to the middle of a high resistance, and thence to the two ends of the filament so that the disturbing effect of the thermionic current was negligibly small. The other strip of the oscillograph was in series with a voltmeter, and this strip and the voltmeter formed a second shunt across the filament.

From observations on the change in the mean thermionic current resulting from a known change in the mean temperature, the measured variations on the plates have been translated into oscillations of temperature above and below the mean value. The lag of temperature behind the power has been found on the assumption that the thermionic emission is in phase with the temperature.

The theoretical relation between the oscillation in temperature and the heat capacity of the filament was deduced by Corbino[1]

[1] Phys. Zeitschr., XI., pp. 413–7, 1910.