optical reflection, even of the metallic type, from some crystals had been known and understood in its main features for a long time.[1] It was left for Rubens to develop it into what amounted to a new kind of spectrum analysis for invisible rays far down in the infra-red, by sifting the radiation by successive reflections. By this means he discovered and isolated precise narrow bands of dark radiation (*Reststrahlen*) very remote from the visible spectrum: just what was most needed at that time for the wider verification and consolidation of ideas regarding the general laws of radiation. In collaboration with Rubens in these investigations his friend E. F. Nichols first made his mark, soon to be followed up at home in America.

In later years by use of the *Reststrahlen* he was able to discover that in metals the defect from perfect reflection, for radiation of great wave-length, depended on their conductances alone. This was readily intelligible in a general way: for the square of the complex index of refraction for rays of frequency $p/2\pi$ is of the form $K - 4\pi c^2 p^{-1}\sigma\iota$, and as both terms of it are found to be effective in metals for ordinary light, the second term, involving p^{-1} and the specific conductance σ, must predominate far in the infra-red. But the entirely unexpected feature was that the agreement was so close that optical observations by themselves could give a good value for the ordinary conductance σ of a metal for continuous currents. In other words, the response to electric force in metals is so prompt that the mechanism of conductance becomes completely established within the fraction 10^{-13} of a second of time, thus giving an essential datum for the understanding of the process of transfer of electrons in metallic bodies.

The decisive completeness of this incidental verification of the Maxwellian scheme of radiation naturally attracted general attention, in its contrast with the long years that elapsed in the early time before the cause of the imperfect correspondence of the refractive index with $\sqrt{K}$ for transparent media was fully appreciated.

One was struck with the ease and simplicity of Rubens' modes of thought. The problems which he wished to attack came naturally to him, without any incrustation of theoretical complexities. Like Faraday and many another experimenter, he was an example of how far simple physical intuition could lead. The directness and cordiality of his personal qualities must have won and retained the regard of all who knew him.

JOSEPH LARMOR.

LIEUT.-COL. G. L. TUPMAN.

LIEUT.-COL. GEORGE L. TUPMAN, who died at Harrow on November 4 at an advanced age, was for many years a devoted amateur astronomer. He was elected a Fellow of the Royal Astronomical Society in 1863, being one of the oldest Fellows at the time of his death. He was on its council from 1873 to 1880, and secretary from 1884 to 1889. His earliest astronomical work was on meteor radiants; he made numerous observations of meteors while on service in the Mediterranean, 1869–1871, and published a catalogue of radiants in Mon. Not. R.A.S., vol. 33. Tupman observed the transits of Venus in 1874 and 1882 from Honolulu and New Zealand respectively. He worked for some time at Greenwich Observatory as a volunteer, both in preparation for the transits and in their subsequent discussion; his preliminary result from a discussion of the 1874 transit, 8″·813, is very near the value now accepted. Since many of the stations were dependent on lunar observations for longitude, he studied carefully the errors of the lunar ephemeris from the results of all the leading observatories.

Tupman had a well-equipped observatory at Harrow, with two equatorials, reflector and refractor, and a transit circle. He made many meridian observations of stars, also occultations (especially during the lunar eclipses of 1884, 1888, 1895 for the determination of the moon's diameter), comets, transit of Mercury, etc.; he also frequently invited other astronomers to use his instruments.

A. C. D. CROMMELIN.

[1] Cf. *ex. gr.* Stokes in discourses at the Royal Institution and to the Chemical Society, as early as 1864: "Math. and Phys. Papers," vol. iv. pp. 244, 261.

H. J. POWELL.

By the death of Harry J. Powell, on November 26, at the age of sixty-nine years, the country has lost one of the earliest pioneers in the scientific manufacture of glass. For some years he lived in the works at Whitefriars, and during this time, and for many years afterwards, he superintended personally the weighing out and mixing of the material for the next week's batch of glass. For forty-five years he was making experiments with the object of improving the quality of the flint glass made at Whitefriars, and attaining perfection of colour in the glasses. These have led to the magnificent results seen in the windows of the cathedrals of Salisbury, Liverpool, and New York, and in those of many churches in this country and abroad. He not only improved the nature and colour of the glass, but he was a designer of the first rank. Few of the art museums of this country are without specimens of his artistic skill.

Mr. Powell was well known to most scientific men, and was always ready to put his knowledge and technical skill at their disposal. The vacuum flask, the idea of which was conceived by Sir James Dewar, was made first by him, and it was to his experiments that the success of Sir William Crookes's cerium glass, for cutting off the ultra-violet and heat rays, was mainly due. At the outbreak of war, foreseeing the shortage of glass for chemical purposes, he worked out, in conjunction with his son-in-law, a soda-lime glass with very great resistance to changes of temperature and action of water. This glass was used by the Admiralty for the construction of the horns of submarine mines.

Mr. Powell retired from the business three years ago, and devoted his time to an attempt to make generally known the results of his knowledge and experience. He worked up to the last, the final revision of a book, "Glass-making in England," and of an article for Sir Richard Glazebrook's "Dictionary of Applied Physics," in which he propounded a new theory of the origin of colour in glass, being completed only a few days before his death.

By the death of Dr. Herbert Langton on October 12, in his seventieth year, the Museums Association loses its honorary treasurer, the museum sub-committee of Brighton its chairman, and the British Ornithological Union a valued member. A portrait appears in the *Museums Journal* for November.