"Paints, Varnishes and Colors," by Henry A. Gardner.

"Portland Cement," by G. A. Rankin.

"Chemistry, Radio and Incandescent Lamps," by Mary R. Andrews.

"Railroad Chemistry," by William M. Barr.

"Rayon, Man-Made Silk," by M. G. Luft.

"Chemistry in Refrigeration," by Frederick G. Keyes.

"Rust-Resisting Metals," by F. M. Becket.

"Soap," by Martin Hill Ittner.

"The Relation of Chemistry to Water Supplies," by W. W. Skinner.

In the third volume, "Chemistry in Agriculture," we find the following monographs:

"Crops and the Soil," by R. W. Thatcher.

"The World's Food Factory," by John M. Arthur and Henry W. Popp.

"Soil Life," by Jacob G. Lipman.

"Where the Nitrogen comes from," by Harry A. Curtis.

"Maintaining Soil Fertility," by G. S. Fraps.

"Cereals," by C. H. Bailey.

"Sugar and Sugar Crops," by C. A. Browne.

"Fruit and Vegetables," by E. M. Chace.

"Fermentations of the Farm," by J. J. Willaman.

"Chemical Warfare to save the Crops," by Andrew J. Patten.

"Agriculture and the Evolution of our Diet," by C. F. Langworthy.

"Vitamins in Human and Animal Nutrition," by R. Adams Dutcher.

"Meat in its Relation to Human Nutrition and Agriculture," by C. Robert Moulton.

"Chemistry as a Guide in Animal Production," by E. B. Forbes.

"The Chemistry of Milk and its Products," by L. L. Van Slyke.

"The Chemist as Detective and Policeman," by B. B. Ross.

In the above list one of the monographs on chemistry in refrigeration is on the very subject which led Napoleon to the luminous description of the value of chemistry in industries. Another one of them, however, is a discussion of fermentations on the farm and, you might add, in the home which is now very much in the limelight in the hearings on prohibition before the Senate committee. One would think that the list was full, but there is yet much to be done before we have a complete chemistry in the form of monographs of all the industries in which chemistry is the leading science. That means practically all.

I have no time here to enter into any particular discussion of any of these monographs. The high standing of the authors, being experts in the very industries about which they write, is a guarantee of the character of this addition to our industrial literature. Expert editorial control of a high order has secured a fair degree of unity of style.

The chemist, of course, has no intention of assuming that chemistry is the only science in industry, but I believe he will be able to maintain, without any serious challenge, that there is no other one science so important in industry as chemistry. Imagine for a moment the condition of our industries if all chemical control were suddenly withdrawn, with no possibility of ever having it restored. An environment of complete paralysis would soon ensue. There would be no further progress in methods of research and of commercial treatment of articles.

In the one industry of pharmacy, I was told recently at Indianapolis, where I was addressing a luncheon of chemists of that city, that Eli Lilly and Company alone employed forty chemists in their research laboratories, and this is only one of the great manufacturing drug firms in this country.

The American Chemical Society now has sixteen thousand members, and there are still many practicing chemists who are not members. If I should say that the total number of persons engaged in chemistry in one way or another in this country was close to twenty thousand, I would not be far from the truth. There is no industry of any kind now extant and flourishing in our country that is not in some way or another connected with direct chemical control. The progress of our industries in extent and in economy is more dependent upon the work of the chemists than of any other group of men. This is fully recognized now by the great captains of industry. When the American Chemical Society celebrated its twenty-fifth anniversary, I had the honor to be the orator of the occasion and took for my subject "The Dignity of Chemistry." I called attention to the fact that too often the chemist was regarded as the hewer of wood and the bearer of water; that he had not attained the dignity in industrial life which was his due. Another twenty-five years have now passed and we see a great change in the standing of the chemist. He has attained his due dignity.

H. W. WILEY

WASHINGTON, D. C.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

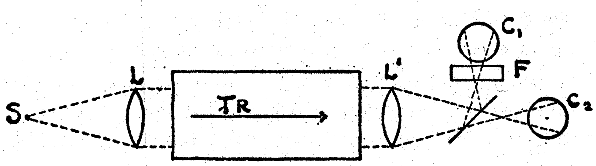
THE USE OF ARCS AND OTHER FLUCTUATING SOURCES IN PHOTO-ELECTRIC PHOTOMETRY

IN his paper on the registering microphotometer P. P. Koch[1] describes an arrangement consisting of

[1] P. P. Koch, *Annalen der Physik*, IV, 39, p. 705 (1912).

two similar photoelectric cells connected to an electrometer, both illuminated by the same source, but through different optical paths. The arrangement described has the advantage of being independent of intensity fluctuations in the source (provided that these are uniform over the area of the source), since the electrometer reading depends only upon the *ratio* of the intensities falling on the two cells. An example is given in which a change from 10 to 100 in the light intensity of the source produced only a one per cent. change in the electrometer deflection. However, it remained impossible to use arcs, or other light sources which not only fluctuate in intensity, but also flicker or change their position; for since the two beams come from different parts of the source, and traverse different optical paths, flickering changes the ratio of their intensities as well as the absolute values.

It is the purpose of this note to point out that in most cases the optical paths to the two cells may be made practically identical by using a partially reflecting plane mirror to divide the beam. The arrangement is shown in the accompanying figure:



S is the source (a carbon or mercury arc, for example); L and L′ are lenses whose purpose is obvious; TR represents an optical train of any kind (lenses, prisms, filters, polarizers, etc.); M is the partially reflecting plane mirror, C_1 and C_2 the two similar cells, and, before C_1, F, the filters, photographic plates, crystals, analyzing nicols, etc., whose variable transmission or absorption it is desired to measure. (The electrical connections of the cells, and the electrometer, etc., are not shown: they are described in detail by Koch, *l. c.*). Under these conditions flickering and wandering of the light source will alter both intensities in the same ratio, provided that the variable absorber F takes the full beam of light, *i.e.*, requires no further diaphragms. This will be true, for instance, in measuring the absorption of filters, large crystals, large areas of a photographic plate, etc.

If the variable absorber F requires a diaphragm, troubles may arise due to the fact that fluctuations may change the distribution of energy over the cross-section of the beam of light. The intensity of the beam diaphragmed out may then change, whereas that of the full beam going to C_2 does not. There are then two alternatives: if the diaphragm in F may be removed some distance from the absorber, the dividing mirror M may be placed between the diaphragm and the absorber. But if, as in the microphotometry of spectral lines, the diaphragm must be very close to the object whose transmission is to be measured, an attempt must be made to diaphragm the beam going to C_2 in an exactly similar manner, so that the two diaphragms or slits are situated at corresponding points of the cross-sections of the beams (which, fortunately, are themselves similar). How well this compensation will succeed depends on the fineness of the slits, on the optical system and on the constancy of the light source.

The proper ratio for the intensities of the two beams is determined by the experimental conditions. It can be altered at will by interposing a uniform filter before either cell. One must, of course, take precautions to ensure that the variations in the intensity of the source are not too great. From Koch's data and from results obtained in testing the present modification, variations of even several hundred per cent. are permissible.

Thus it is possible to use arcs and similar light sources giving high intensity in all regions of the spectrum for a large number of problems involving photoelectric photometry.

B. KURRELMEYER
NATIONAL RESEARCH FELLOW,
JEFFERSON PHYSICAL LABORATORY,
HARVARD UNIVERSITY

SPECIAL ARTICLES

QUARTET AND DOUBLET TERMS IN THE COPPER SPECTRUM

THE theory of the relation of electron configurations to spectral terms developed by F. Hund[1] when applied to the copper atom yields the following results. The lowest term of the spark spectrum which arises from ten d-electrons should be a ^1S and the addition of one electron should give a doublet spectrum of ordinary type. This spectrum is known. The next higher terms of the spark arise from nine d-electrons and one s-electron and are ^3D and ^1D. These, by the addition of a further s-electron, give terms ^4D, ^2D and ^2D which merge in the lowest state into ^2D alone. This term is $^2D_3 = 51105.5$ and $^2D_2$ 49062.6 and is discussed in my paper in *Phil. Mag.*, Vol. 49, p. 951, 1925. The addition of a p-electron to the spark ^3D and ^1D should result in low terms ^4P, $^4D'$, ^4F, ^2P, $^2D'$, ^2F and a second higher set ^2P, $^2D'$, ^2F. Such terms have now been found. Their values are:

[1] *Zs. f. Phys.*, 33, 345, 1925.