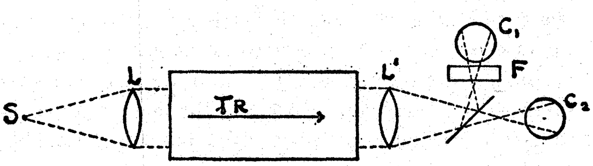
two similar photoelectric cells connected to an electrometer, both illuminated by the same source, but through different optical paths. The arrangement described has the advantage of being independent of intensity fluctuations in the source (provided that these are uniform over the area of the source), 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.

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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.

$^4P_1$	21364.3	$^4F_2$	20005.5	$^4D_1'$	17392.3
$^4P_2$	22194.0	$^4F_3$	20745.2	$^4D_2'$	17763.9
$^4P_3$	23289.4	$^4F_4$	21154.7	$^4D_3'$	17901.8
		$^4F_5$	21398.9	$^4D_4'$	18794.1
$^2P_1$	16487.2	$^2F_3$	18581.9	$^2D_2'$	16135.2
$^2P_2$	16428.8	$^2F_4$	17344.8	$^2D_3'$	15709.7

The quartet terms combine with the high ^4D term mentioned above, arising from the ^3D of the spark and give strong multiplets in the visible. They are analogous to the visible multiplets of highest multiplicity in the spectra of iron cobalt and nickel.

The following is the ^4F ^4D multiplet of this group. Wave numbers and intensities only are given.

	$^4F_5$ 21398.9	$^4F_4$ 21154.7	$^4F_3$ 20745.2	$^4F_2$ 20005.5
$^4D_4$ — 95.2	21494.1(8)	21249.9(6)	20840.4(2)	
$^4D_3$ — 640.2		21794.8(6u)	21385.5(2u)	20645.9(1u)
$^4D_2$ —1276.4			22021.7(4u)	21282.0(2u)
$^4D_1$ —2164.2				22169.7(4)

It will be noticed that the ^4D term is negative and that all the lines arising from $^4D_2$ and $^4D_3$ are diffuse. This is a peculiar characteristic of these two terms in all three multiplets.

In addition to the low terms given above there are eleven further terms which combine with ^2S and ^2D. They probably include the set ^2P, $^2D'$, ^2F, which arise from the ^1D spark term as well as terms arising from ^3F of the spark.

A set of thirty-five negative terms has been found from combinations with the low quartet and doublet terms. They account for some three hundred further lines, including practically every strong line in the spectrum as well as most of the weak lines above λ 2900. These negative terms should include the higher members of the two series which commence with the low ^2D term and which have as limits the ^1D and ^3D spark terms; but as yet it has not been found possible to pick out such terms with certainty.

As would be expected from the atomic structure which gives rise to this spectrum, it has many characteristics of a spectrum of the second rank, including g-values not at all in accordance with the Lande g's.

The structure of the copper spectrum here given is in complete disagreement with the analysis given by H. Stucklen.[2] A detailed discussion of the spectrum, including Zeeman effects and other evidence, will be published in the near future.

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[2] *Zs. f. Phys.*, 34, 562, 1925.

BLOOD STUDIES IN GENERAL ANESTHESIA[1]

IN a previous communication we showed that eclampsia is associated with the following changes in blood constituents: a high uric acid, an increased lactic acid, a decrease in the CO_2 combining power and a definite tendency towards a hyperglycemia, which is often associated with a high inorganic phosphorus. We have tried to reproduce this blood picture in dogs by the use of anesthesia. Thus far we have worked with ether, chloroform, nitrous oxide and ethylene. Blood specimens were obtained before the administration of the anesthetic, the animals were then anesthetized for half an hour and additional blood samples were withdrawn at regular intervals.

The blood samples were analyzed for sugar, lactic acid, uric acid, inorganic phosphorus, non-protein nitrogen, urea nitrogen and CO_2 combining power, and we found in every case that ether, chloroform and nitrous oxide, each, produced a marked hyperglycemia, a lowering of the CO_2 combining power and an increase in lactic acid. Normally the dog's blood contains no uric acid, or very little, but we were able to note that it increased in amount under any one of the three anesthetics. The inorganic phosphorus seems to follow the sugar curve. The non-protein nitrogen and the urea nitrogen showed only minimal changes from normal. In other words, we found changes practically identical with those observed in eclampsia.

With ethylene gas the blood changes are the same as with the other anesthetics, except that they are not nearly so marked. Our findings seem to indicate that in all the general anesthetics we have to deal with a single fundamental picture. We are aware that anoxemia may produce somewhat similar changes, but further work in asphyxia and its prevention in general anesthesia, as well as in the use of insulin following the administration of anesthesia, leads us to believe that at most asphyxia plays only a small part in the production of the profound changes in the blood here reported.

A full description of this work, with the necessary protocols, will appear in the near future in the *American Journal of Obstetrics and Gynecology.*

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