

Tables will be published¹ showing, (a) values of per cent. candle-power and per cent. voltage at 1.20 watts per candle from any given efficiency within the range from 2.0 to 0.7 and probably to 0.5 in steps of 0.02 watts per candle, and (b) percentage values of watts and candle-power and actual watts per candle for every volt ratio from 0.6 to 1.3 and probably to 1.6. Tabular differences will be given and their use explained. From these tables others based on any efficiency included can be easily calculated.

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A DISPLACEMENT OF ARC LINES NOT DUE TO PRESSURE.²

BY CHARLES E. ST. JOHN AND HAROLD D. BABCOCK.

WHEN the light from the different parts of the iron arc is examined by a powerful spectrograph, it is found that there are variations in the wave-lengths of the lines depending upon the portion of the arc used. A direct comparison has been made by us between the center of the iron arc and the region very near the negative pole. It has been extremely difficult and in fact practically impossible to obtain with certainty non-simultaneous photographs of spectra and comparisons that do not show minute relative displacements which must be referred to the instrumental conditions, even though the apparatus is very stable and the optical parts are in a constant temperature underground compartment.

By an arrangement of prisms over the slit of the plane grating spectrograph of 30-foot focus we now obtain *simultaneous* exposures, and are able to determine the absolute shifts between the pole and the center of the arc. There are some groups of lines—groups *a*, *b*, and *c* 4 of the Mount Wilson classification—that show no determinable displacements between the center and the negative pole, there are other groups, such as *c* 5, *d*, and *e*, the wave-lengths of which vary with the portion of the arc used, by such increments that, if pressure were the cause, a pressure difference of more than an atmosphere would be indicated between pole and center. The pressure shift for lines of group *b* in the red is 0.009 Å per atmosphere, as found by Gale and Adams. These lines are among the best lines in the iron spectrum, and they do not show displacements greater than the accidental errors of measurement which in the case of these lines do not amount to 0.001 Å.

It appears then that the displacements shown by the groups *c* 5, *d* and *e* between pole and center are not due to pressure. In general these lines are widened unsymmetrically at the negative pole, and the displacement was at first ascribed to the unsymmetrical broadening as the negative pole was approached, but the intensity curves obtained by Koch's *microphotometer* show that the maxima are displaced in the direction and by the amount

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² Abstract of a paper presented at the Washington meeting of the Physical Society, April 24-25, 1914.

indicated by the measured shift. Provisionally we are inclined to ascribe these displacements to increase of density, but the effects of other conditions are still under investigation.

The following table shows the results in the case of a few typical lines:

Negative Pole minus Center of the Arc.

Group <i>a.</i>		Group <i>b.</i>		Group <i>d.</i>		Group <i>e.</i>	
λ	$P-C$	λ	$P-C$	λ	$P-C$	λ	$P-C$
5,323	-0.0060 $\text{\AA}$.	6,136	+0.0007 $\text{\AA}$.	5,281	+0.018 $\text{\AA}$.	5,364	-0.022 $\text{\AA}$.
5,332	-0.0002	6,137	-0.0004	5,283	+0.019	5,367	-0.026
5,341	-0.0006	6,213	+0.0003	5,324	+0.022	5,369	-0.020
5,497	-0.0003	6,219	+0.0010	5,339	+0.016	5,383	-0.024
5,501	-0.0004	6,230	+0.0004	5,393	+0.017	5,400	-0.024
5,506	+0.0004	6,252	+0.0000	5,653	+0.014	5,410	-0.024
Mean.....	+0.0002 $\text{\AA}$.		+0.0003 $\text{\AA}$.		+0.018 $\text{\AA}$.		-0.023 $\text{\AA}$.
Displ. per atm....	+0.0036		+0.0094		+0.015		-0.018

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ON THE GROWTH AND DECAY OF COLOR SENSATIONS IN FLICKER PHOTOMETRY.¹

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IT has been well established that photometric measurements obtained by the direct comparison and flicker methods do not agree in most cases. Under favorable conditions this disagreement is only a few per cent., but where there is a large color difference such as obtains when red or green lights are compared with "white" light or with each other the results by the two methods often differ by many per cent. A comparative study has been made of the two methods and a further study has been made of the phenomena involved in the flicker method in order to account for the difference between the results by the two methods. The results by both methods are of course primarily effected by the variations in the color vision of various observers. For instance observers having so-called normal color vision on comparing red or blue with "white" light obtain results differing by as much as 100 per cent. But the fact that the two methods give different results indicates that the different phenomena underlying these two methods are of importance.

When flickering lights are observed it is at once obvious that the rates of growth and decay of the color sensations are liable to be involved. Broca and Sulzer have shown that there is an overshooting of luminous sensation varying with the intensity and color of the light. The writer has used complementary colors, red and blue-green, in studying the phenomena involved in flicker photometry. These have been intercompared in various ways and also com-

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