

A NOTE ON AN ACETYLENE-IN-OXYGEN FLAME.

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In the conclusion of a report made to this INSTITUTE in 1896 by a sub-committee on Standards of Light of which Professor Nichols was chairman, it was stated that the sub-committee had in hand the investigation of a possible standard in which a pure gas, burning in a pure atmosphere should furnish the constant flame required. Since these investigations, which were being carried on by myself, have now been at a standstill for some time, this note is presented with the hope that it may be of some interest.

The idea underlying the work was to produce a flame which should be isolated from fortuitous outside influences, such as atmospheric purity and moisture content, which have so large an influence on ordinary flames.

A long series of experiments was conducted on a flame produced by the combustion of a mixture of equal parts of acetylene and hydrogen in an atmosphere of oxygen. The special burner employed gave a flame long, slender and of great brilliancy and steadiness. It was found, however, that its intensity was not reproducible from pressure measurements made on the gases. This was attributed to the fact that the acetylene-hydrogen mixture was stored over water. Since the solubility of these gases in water is not equal, and their temperature coefficients of solubility are not the same, the relative proportions of the two gases in a mixture so stored would not remain constant. Thus, the first requisite of a standard of light, namely, a fuel of perfectly definite composition, was lacking.

The reason for adopting the acetylene-hydrogen mixture instead of pure acetylene as a combustible had been that, with the

burner employed, pure acetylene deposited graphitic carbon about the jet with such rapidity that the flow of gas was seriously obstructed after only a moment's burning. With the diluted gas this did not take place. After the failure of the mixture to yield the constant flame required, experiments were made to determine what form of burner would permit the pure acetylene to be used. This was found to be as shown in Fig. 1.

The acetylene passes through the tube *A*, which is surrounded by the water-jacket *J*, in which a circulation of water is maintained to keep the acetylene tube cool, and issues at *a*. The

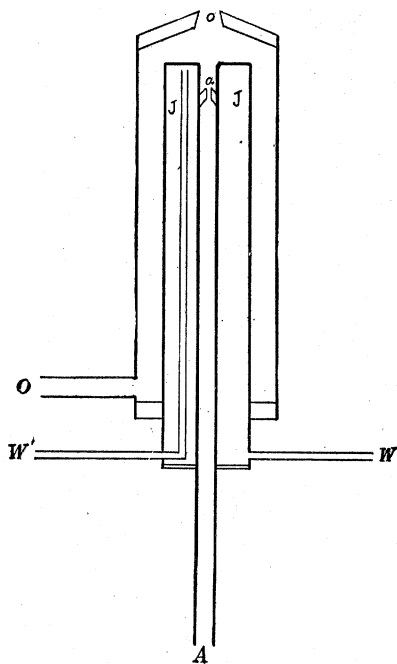


FIG. 1.

oxygen enters at *O*, a concentric tube and issues through *o* in a stream about the stream of acetylene. The water-jacket is carried above the acetylene jet so that a mixture of the two gases, and consequently combustion takes place only after the acetylene is well away from the jet from which it issues. With this arrangement there is no troublesome deposit of carbon and the experiment can be carried on indefinitely.

The flame so produced is capable of enormous variations, according to the relative supplies of the gases. When the oxygen is not turned on at all, the flame is tall, unstable, murky and

smoky. With increasing supply of oxygen, the flame shortens and increases in whiteness, brilliancy and luminous intensity. It also becomes stable and is little affected by drafts. If the increase in oxygen supply is carried beyond a certain point, the luminous intensity begins to fall off, due to the non-luminous combustion of a larger proportion of the acetylene, until with a large excess of oxygen the flame becomes almost entirely blue.

Barring practical difficulties, the intensity of this flame should be definable as follows: with a given rate of flow of the gases, the height of the flame should be a given one, and the luminous

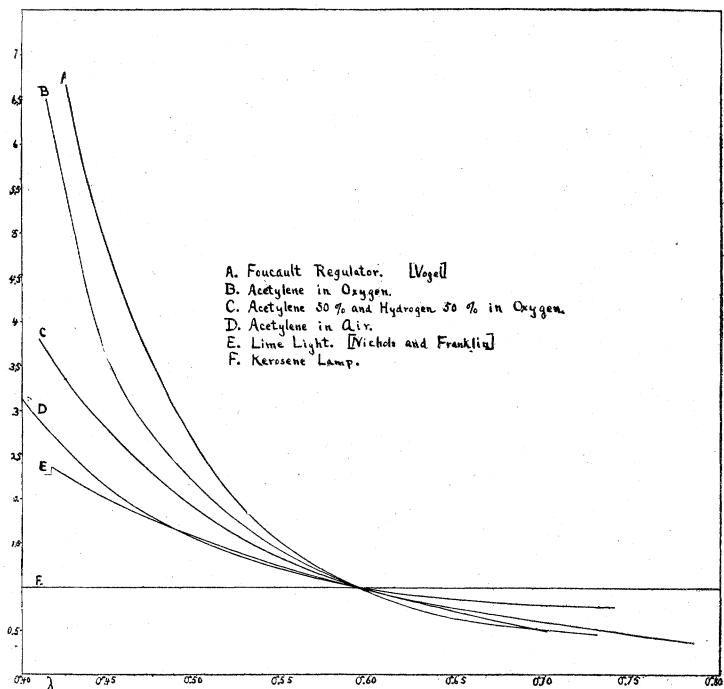


FIG. 2.

intensity of the flame as a whole should be a maximum, and the luminous intensity of a portion of the flame isolated from the rest by a horizontal slit of a given width in a screen placed in front of the flame in such a way that the amount of light passing through the slit should be a maximum, would then be perfectly fixed. The criteria mentioned are not all independent ones, but serve as checks on each other, and increase the certainty with which the flame can be reproduced.

In my experiments I measured the height of the flame by projecting an image of it on a graduated screen. To measure the

flow of the gases a diaphragm with a very small opening was interposed in each feed pipe and the gas pressure behind was determined by inclined tube manometers filled with alcohol. This method was not found to be sufficiently sensitive and reliable. It would probably be far better to fix the relative pressures of the gases by passing them through small gasometers, the bells of which are fixed to opposite arms of a balance, as Petavel¹ has done in his experiments with the Violle platinum standard, and then to determine with only a moderate degree of accuracy the absolute pressure of one of the gases. The gas supply was regulated by micrometer cocks. The temperature of the diaphragms should be controlled and the gases should be dried.

The flame so produced is the most brilliant gas flame known. The results of spectrophotometric measurements on it are shown in Fig. 2 in comparison with those made on other sources of light. Its color adapts it admirably for use as a secondary standard in arc light photometry, but it is too white for the incandescent lamp, just as the candle and the Hefner lamp are too red. This fault is at least in the right direction, since it is desirable that the color of the primary standard of light should approximate to the color of the average source of light in practical use, and the constant tendency of this color average is towards the white.

1. Proc. Roy. Soc. Vol. LXV, p. 481, 1900.