

may be termed, was compared with the corresponding chemical flames, that is, with the oxhydrocarbon and oxynitrocarbon jets of gas burning in air. The characteristic lines were present in every case. Lastly, by similar inter-observation a few other lines in the electric spectrum of the hydrocarbon were proved to be due to the presence of hydrogen, and several others in the electric spectrum of the nitrocarbon to be caused by the presence of nitrogen.

"The spectrum under investigation having then been obtained in one case when only carbon and hydrogen were present, and in another when all elements but carbon and nitrogen were absent, furnishes to my mind, sufficient evidence that the spectrum is that of carbon."

"But an interesting confirmation of the conclusion just stated is found in the fact that the same spectrum is obtained when no other elements but carbon and oxygen are present, and also when carbon and sulphur are the only elements under examination. And first with regard to carbon and oxygen. Carbonic oxide burned in air gives a flame possessing a continuous spectrum. A mixture of carbonic oxide and oxygen burned from a platinum-tipped safety-jet also gives a more or less continuous spectrum, but the light of the spectrum has a tendency to group itself in ill-defined ridges. Carbonic oxide, however, ignited by the electric discharge in a semi-vacuous tube, gives a bright sharp spectrum. This spectrum was proved, by the simultaneous method of observation, to be that of carbon plus the spectrum of oxygen. With regard to carbon and sulphur almost the same remarks may be made. Bisulphide of carbon vapor burns in air with a bluish flame. Its spectrum is continuous. Mixed with oxygen and burned at the safety-jet, its flame still gives a continuous spectrum, though more distinctly furrowed than in the case of carbonic oxide; but when ignited by the electric current its spectrum is well defined, and is that of carbon plus the sulphur. That is to say, it is the spectrum of carbon plus the spectrum that is obtained from vapor of sulphur when ignited by the electric discharge in an otherwise vacuous tube."

"Having thus demonstrated that dissimilar compounds containing carbon emit, when sufficiently ignited, similar rays of light, I come to the conclusion that those rays are characteristic of ignited carbon vapor, and that the phenomena they give rise to on being refracted by a prism is the spectrum of carbon."

This question was next taken up by Morren. He wrote¹ (in 1865) fifteen years ago:

"A la réception de cet intéressant et substantiel Mémoire, j'avoue que je ne regardai pas d'abord comme fondée l'assertion de M. Attfield.

"Je me suis donc mis au travail avec la pensée préconçue de combattre l'assertion anglaise par le savant anglais; mais pas du tout, il résulte au contraire des expériences auxquelles je me suis livré que M. Attfield a raison, et que c'est bien la vapeur du carbone qui donne le spectre indiqué plus haut.

"Si on fait brûler le cyanogène au moyen du chalumeau à deux courants, en faisant arriver au centre de la flamme du cyanogène un courant d'oxygène très-pur (cette condition est indispensable), on voit se produire un des plus beaux effets de combustion possible, et cette expérience est certainement une des plus magnifiques qu'on puisse réaliser sur la combustion des gaz. Il se produit, au milieu de la flamme rosé-violet de la cyanogène, une boule d'un blanc vert éblouissant qui rappelle la lumière électrique produite par le courant de la pile entre deux charbons de corne. Si le spectroscopie est dirigé sur cette brillante lumière, on aperçoit, avec une splendeur merveilleuse, le même spectre de la partie bleue des flammes hydrocarbonées. Ainsi donc c'est du charbon seul, mais à l'état de vapeur, qui forme cette boule brillante qui plus loin, par son union avec l'oxygène, va passer à l'état d'acid carbonique. Du reste ce spectre n'est pas seul; avec lui on voit, mais très-effacé, le spectre spécial du cyanogène, et celui-ci tend de plus en plus à disparaître à mesure que l'oxygène arrive avec plus d'abondance et brûle de mieux en mieux le

cyanogène. Quant au spectre de l'azote, on ne l'aperçoit pas dans cette vive lumière. Le magnifique éclat de ce beau spectre, le plus beau qu'il m'ait été donné de voir, permet de bien comprendre l'aspect creusé et ombré avec une teinte croissante qu'on remarque dans les parties qui n'ont pas de raies brillantes, et même entre ces raies."

Four years later Dr. Watts devoted himself to this subject, and in 1869 his work was thus summarized by himself:

"This spectrum [that consisting of the flutings in question] may be obtained from the flame of any hydrocarbon, though in many cases, owing to the faintness of the spectrum, only some of the groups can be recognized. In the flame of an ordinary Bunsen burner δ and ϵ are easily seen, γ and f are much fainter, and the red group can not be detected.

"This spectrum is proved to be that of carbon, inasmuch as it can be obtained alike from compounds of carbon with hydrogen, with nitrogen, with oxygen, with sulphur, and with chlorine. I have obtained it, namely, from each of the following compounds: olefiant gas, cyanogen, carbonic oxide, naphthalin, carbonic disulphide, carbonic tetrachloride, amyl alcohol, and marsh-gas."

That these conclusions, successively arrived at by Attfield, Morren, and Watts, are sound, I shall show in my next notice.—("Nature.") J. NORMAN LOCKYER.

(To be continued.)

VALUE OF BISULPHIDE OF CARBON IN MICROSCOPICAL DEFINITION.

At the last meeting of the R. M. S. (the last of the session), on the 9th instant, a paper was read by Mr. J. W. Stephenson, treasurer of the society, discussing the relative visibility of objects mounted in media of different refractive indices. Some time ago, Mr. Stephenson called attention to the fact that if diatoms were mounted in bisulphide of carbon their fine structure was rendered far more visible than when mounted in Canada balsam. Since the explanations given by Professor E. Abbe on the introduction of his new expression for apertures (*i.e.*, "numerical aperture"), by which the relative resolving power of different objectives is seen by the reading of the numerical apertures, Mr. Stephenson has come to the conclusion (in which he stated Professor Abbe agreed with him) that the visibility of objects is dependent on the difference of the refractive indices of the object observed and the medium in which it is placed. This he illustrates as follows:

Taking the refractive index of air as 1.0, and diatomaceous silex as 1.43, the visibility may be expressed by the difference 43.

Refractive indices (taken approximately).	Visibility of silex (Refr. index = 1.43).
Water	= 1.33 . . 10
Canada balsam	= 1.54 . . 11
Bisulphide of carbon	= 1.68 . . 25
Sol. of sulphur in bisulph.	= 1.75 . . 32
„ phosphorus „	= 2.10 . . 67

These data relating to visibility must, doubtless, be regarded in direct connection with the numerical aperture of the objectives of the illumination, as pointed out by Mr. Stephenson. He gave practical demonstrations of the views explained in his paper by exhibiting several slides mounted in the different media. I mention one slide of *Pleurosigma Elongatum*, mounted in sol. of phosphorus in bisulphide of carbon, as presenting to the eye the strongest image that has come under my notice. According to Mr. Stephenson's theory, the visibility under these conditions would be about six times as great as that of the same object mounted in balsam. Is it possible to induce our professional object-mounters to take up the subject? Surely there are many amateurs of fine definition who would like to see the conditions of visibility pushed to the highest point, and who would amply repay the modicum of exertion needed to produce them.

¹ *Annales de Chimie et de Physique*, 4 série, tome iv. p. 309, 312.

¹ *Phil. Mag.*, October, 1869.