Chemistry, Physics, Technology, etc.

ON THE THEORY OF ILLUMINATING FLAMES.

BY KARL HEUMANN.*

Synopsis of article by HENRY PEMBERTON, Esq.

The views of different observers are widely opposed. Stein believes that the disilluminating effect of the admixture of indifferent gases is the result of dilution only, which permits the oxygen of the surrounding air entering the flame, and transforming all the carbon into carbonic oxide. R. Blochmann is of opinion that the cause of the disilluminating effect of neutral gases, is that a relatively smaller quantity of oxygen comes into contact with the combustible constituents of the flame; and that in the flame of Bunsen's lamp, the entrance of oxygen into the inner zone of combustion causes decomposition of the gas, giving rise to hydrogen and carbonic oxide; therefore, gases that under ordinary circumstances burn without illumination.

Frankland's hypothesis is that the illuminating power of the gas flame specially depends upon its degree of condensation. In opposition to these, F. Wibel shows that a flame rendered nonilluminating by air or an indifferent gas, becomes again brightly luminous when the "burner" is heated to redness. In this case, the dilution of the gases of the flame and the amount of the absorbed air are increased; nevertheless, the flame becomes luminous. Wibel draws conclusions from this, in direct opposition to the views of those above cited, and goes, I think, to the opposite extreme. His thesis urges that it is not the *dilution*, but the *cooling* of the interior of the flame by the entering gases, that robs it of light. This certainly cannot apply to the flame of the Bunsen lamp, for if he is correct, the Bunsen flame should be cooler than the luminous one, whilst daily experience proves that the blue burning flame possesses a much higher temperature.

The oxygen of the admixed air cannot be held to be the cause in this instance; for heating the burner could not alter the relation of the gases, yet the flame thereby becomes luminous. Perhaps it may

*From the *Journal für Gasbeleuchtung und Wasserversorgung*, Munich, Sept., 1875.

be suggested that the effect of heating the burner is to restore the temperature that had been lowered by the incoming oxygen, but this is contradicted by the fact that the flame mixed with air is much hotter than the luminous one. The possibility of a lower temperature is therefore not admissible.

It remains therefore to recognize as a fact that the dilution of combustible gases is one important factor, and can alone—without reference to the temperature—disilluminate the flame. It must be further admitted that a mixture of illuminating gas and an indifferent gas requires a higher temperature to become illuminating, than the undiluted gas alone does. Wibel's experiment does not therefore prove that the cooling of the flame is exclusively the cause of the disillumination, for by the admixture of indifferent gases its composition is very materially altered. The truth therefore may well lie between the opposing theories of the different observers, and the disillumination of a flame containing carburets by the introduction of air or an indifferent gas, depends not only upon the cooling effect, but also upon the dilution of the gases of the flame, which dilution may have formed a gaseous mixture needing a higher temperature to burn luminously than the illuminating (un?) diluted flame itself previously required.

The support that Wibel's theory derived from the behavior of a flame from coal gas and oxygen, is explained by my view in the most convincing manner. As Wibel found, such a flame is extremely difficult to disilluminate, because its temperature in the presence of pure oxygen is an extremely high one. The cooling effect produced by the cold oxygen entering, as well as the absolutely higher temperature required to enable the gaseous mixture to burn luminously, is nearly if not entirely compensated for by the intense heat produced by the concentrated, energetic combustion in the presence of pure oxygen; therefore the disillumination is rendered so much the more difficult. That it ultimately can be produced by a very strong stream of oxygen, and by means of a net of wire gauze, may readily be understood.

The introduction of pure oxygen in a suitable manner into a flame renders it very illuminating by producing an excessively high temperature, whilst the prejudicial dilution that would be caused if air had been used, does not occur. Too much oxygen or too little can produce the same conditions that dilution by an indifferent gas would do;

in the one case the oxygen penetrating the small flame and diluting it excessively, in the other the combustion being too languid to afford the needed temperature.

EXPERIMENTS GIVEN TO SHOW THE EFFECT OF EXCESS OR
INSUFFICIENCY OF OXYGEN.

An inverted flask filled with oxygen; into it introduce a small gas flame from the jet of a blowpipe. At first the outer portion of the flame expands enormously, consuming the lighting part of the flame, which decreases until it becomes only a little bright point. After a time, when the products of combustion have diluted somewhat the oxygen, the bright point increases until it reaches the mantle of flame; the brightly shining flame presents then the appearance that it would do in ordinary air. Gradually the products of combustion dilute still more the oxygen, the temperature of the flame sinks still lower, the flame becomes blue, then nearly invisible, and finally goes out.

To show that *cooling* alone can render a flame non-luminous, direct a small luminous gas flame against the bottom of a platinum dish or capsule, so that the flame will spread itself and become *blue*. Thus far, this result cannot be attributed solely to the *cooling* effect, since spreading out the flame might also mix it with the air and dilute it. But if the capsule be heated on the opposite (upper) surface to redness with the powerful flame of a large Bunsen's burner held horizontally, then with the rising temperature of the capsule, the flame beneath it will become brighter and brighter, until it will finally reach its original brilliancy. The capsule must of course be clean and free from traces of soda from the fingers. This proves that the disilluminated flame is again made luminous, simply by the temperature of the metallic plate. If the Bunsen flame be withdrawn, the small gas flame will remain luminous for a short time, and then as the metal cools it will become again blue.

In these experiments the question has not here been discussed upon what chemical or physical changes induced by the dilution or cooling, the disillumination depends; nor has the disputed point whether the material that heated to redness becomes luminous—be it carbon or dense vapor—been touched upon; but as concerning the opposing theories whether cooling or dilution is the cause of disillumination, it seems to me decided that at least three different causes, each by itself, can cause disillumination. In most cases, two or all three act simulta-

neously. I give as the result of my observations that *disillumination can occur*—

- a. By cooling.
- b. By dilution. The mixture of illuminating and neutral gases can only burn luminously when the flame possesses a much higher temperature than the ordinary luminous gas flame.
- c. By energetic oxydation of the illuminating material (experiment 1).

And the restoration of the lighting power will be produced

- a. By access of heat (experiment 5).
- b. By increase of the temperature of the flame produced by heating mixture of gases or of the indifferent gases before their combustion.
- c. By dilution of oxygen with indifferent gases.

ON THE DISTANCE BETWEEN THE FLAME AND BURNER.

R. Blochmann first investigated the phenomenon that the flame does not immediately touch the burner of a gas jet nor the wick of a candle. This is seen more clearly with a small flame than with a large one. As the gas jet is turned down, the relative distance between flame and burner increases. The distance between is much increased when an indifferent gas is mixed, such as nitrogen, carbonic acid, etc. Blochmann thought therefore that the *dilution* was the cause thereof, and explained the fact of the greater distance by stating that a certain fixed proportion must exist between the combustible portion of the gas and the air, and as the diluted gas required more volume for the same combustible quantity, so must a greater volume thereof be mixed with the air before combustion would occur; that is to say, the space between burner and flame must be larger. This somewhat forced explanation of Blochmann is, I think, wrong, for any cold object held in a flame produces a space between the flame and it. This space is the larger, the more diluted the gas.

It is more easily blown out the more it is diluted. A flame diluted with much carbonic acid will stand several inches above the burner, and be blown out with the slightest puff.

If the burner be heated, the flame will approach the burner more and more nearly as the temperature increases. If surmounted with a platinum tube heated to redness, it will approach and attach itself to the burner. The opening produced in a diluted gas flame by a

cold iron rod will close in proportion as the rod be heated; if the rod be made red hot, it will close completely. The above may all be noticed in an ordinary gas flame, but not so clearly or decidedly.

The space between the burner of a diluted flame being larger, is dependent upon the fact that the temperature is lower; for at the instant of combustion the evolved heat has to spend itself through the mass of indifferent gas. As the heat of the flame is low, any cool object will extinguish it in its immediate proximity by the further reduction of temperature.

It is thus beyond doubt that in all these experiments the cooling effect produced by the burner or other introduced cold object, is the *sole* cause of the above mentioned intermediate space.

ON THE DEVELOPMENT OF THE CHEMICAL ARTS DURING THE LAST TEN YEARS.*

By DR. A. W. HOFMANN.†

[Continued from Vol. lxx, page 279.]

Siemens' instrument consists essentially of two concentric tubes of glass, the inner tube being lined with tinfoil within, and the exterior coated with the same material without. The inner tube is closed at one end, and is sealed to the outer tube in such a manner that an interval remains between them. The outer tube is drawn out at one end to a thin junction piece, and a similar one is fused to it at the other end. Oxygen circulates in the interval. If the wire ends of the Ruhmkorff's apparatus are brought in contact with the tinfoil coating of the tubes, the intervening space becomes luminous, and the oxygen present is ozonized. Rumine‡ in England and Low in France,§ patented, in 1872, a process for obtaining ozone by blowing cold air into the Bunsen flame. There is no information as to the results of this process.

A patent obtained in England, and specified far from clearly, for

* "Berichte über die Entwicklung der Chemischen Industrie Während des Letzten Jahrzehends."

† From the *Chemical News*.

‡ Rumine, *Ber. Chem. Gesell.*, v, 123.

§ Löw, *Ber. Chem. Gesell.*, v, 740.