EXPERIMENTS WITH COAL GAS.

The following extracts are from a communication of Dr. Frankland, F. R. S., to the *Journal of Gas Lighting* (London), on the above-named interesting topics :—

The temperature at which coal gas will ignite under ordinary, or extraordinary conditions, is a circumstance of considerable importance, both to manufacturers and consumers of gas. The difference of opinion which evidently prevails, even amongst those who are intimately acquainted with the properties of coal gas, proves that the subject has not hitherto received that attention which it obviously merits. Under these circumstances, the following experiments, and the conclusions drawn from them, although they are far from exhausting the subject, may not perhaps be altogether unacceptable as a contribution to this part of the history of coal gas.

The heterogeneous mixture of gases and vapors, known as coal gas, may, for our present purpose, be assumed to consist of :—

Olefiant gas and other luminiferous hydrocarbons.
Light carbureted hydrogen, or fire damp.
Hydrogen.
Carbonic oxide.
Bisulphide of carbon.

Now, as these constituents can, to some extent, become separated from each other, under certain circumstances, it is desirable, at the outset of the inquiry, to examine separately their respective igniting points.

1. Olefiant gas, which may be taken also as the type of the remaining luminiferous hydrocarbons, could not be inflamed by a hot iron, unless the latter were heated until it appeared of a cherry-red color in the day light of a tolerably well-lighted room.

2. The igniting point of light carbureted hydrogen was carefully determined by Davy. He says that, "light carbureted hydrogen can be inflamed by white hot sparkling iron, but not by iron at a red heat ; it is, therefore, much less inflammable than hydrogen or carbonic oxide, and less so than olefiant gas."

3. Hydrogen inflamed at a lower temperature than olefiant gas, but it could not be ignited by a rod of iron, unless the latter were heated to a temperature considerably beyond visible redness in a tolerably well-lighted room.

4. Carbonic oxide inflamed at a temperature somewhat greater than that at which hydrogen ignited, but lower than that necessary for the inflammation of olefiant gas.

5. Bisulphide of carbon vapor ignited at 300° Fah.

In some experiments recently made, Prof. Frankland had occasion to observe that when coal gas is allowed to mix with air contained in a space, partly inclosed, but still communicating freely with the atmosphere, such as an open gas main, there occurred an approximate separation of the lighter from the heavier constituents of the gas ; thus samples of the explosive mixture taken from such a space were found on analysis to contain olefiant gas, luminiferous hydrocarbons, carbonic oxide, and bisulphide of carbon, without a small per centage of light carbureted hydrogen, and mere traces of hydrogen, although the two latter gases constitute the chief bulk of coalgas. These gases must, therefore, have rapidly made their way out of the partially inclosed space into the atmosphere. This behavior of the different constituents of coal gas, when the latter is slowly admitted into one end of an open gas main containing atmospheric air, may not inaptly be compared to that of a number of birds, of different powers of flight, entering at one end of the pipe, and making the best of their way toward the opposite extremity. At every moment from the entrance of the birds, the per centage of those of swift flight would diminish near the entrance end of the pipe, while that of the birds of slower velocity would obviously increase in the same ratio.

The Master of the Mint, Prof. Thomas Graham, has proved that the rapidity with which gases diffuse into each other, or into a vacuum, is inversely proportional to the square roots of their specific gravities; and, although there are some circumstances in the case of the open gas main, or partially inclosed space, which would somewhat interfere with this ratio, yet, for all practical purposes, Mr. Graham's law may be assumed to express correctly the different velocities with which the constituents of coal gas would hasten to escape from the space in question.

These velocities of diffusion are as follows :—

Bisulphide of carbon	1
Olefiant gas	1·66
Carbonic oxide	1·66
Light carbureted hydrogen	2·19
Hydrogen	6·23

All other luminiferous hydrocarbons existing in coal gas must have a diffusion velocity lower than that of olefiant gas.

Thus the effect of diffusion of coal gas in an open horizontal pipe, or other similar partially-inclosed space, would be to form an explosive mixture, containing chiefly hydrogen as the combustible gas, at o near the open extremity of the pipe ; while the explosive mixture, formed near the end of the pipe where the gas entered, would contain chiefly carbonic oxide, olefiant gas and bisulphide of carbon.

In order to ascertain the effect of the presence of a considerable per centage of bisulphide of carbon vapor upon the inflammability of the constituents of coal gas, and especially of carbonic oxide and olefiant gas, the following experiments were made.

6. Carbonic oxide was mixed with about 3 per cent of the vapor of bisulphide of carbon, and was then allowed to issue from a jet into the air. The jet of gas readily ignited on the approach of a glass tube containing oil heated to 410° Fah., the igniting point of the gas being probably not higher that 350° Fah.

7. Hydrogen, containing the same amount of bisulphide of carbon vapor, ignited by contact with a tube containing oil at 420° Fah.

Here, then, was a phenomenon which would seem to indicate the alarming possibility of the ignition, at a comparatively very moderate heat, of explosive mixtures of coal gas and air ; fortunately, the next experiments entirely allay any apprehensions on this score.

8. Olefiant gas, impregnated with 3 per cent of the vapor of bisulphide of carbon, did not inflame at a perceptibly lower temperature than when free from the admixture of the sulphur compound.

9. To the highly inflammable mixture of carbonic oxide and vapor of bisulphide of carbon, used in experiment No. 6, a minute trace (not 0·1 per cent) of olefiant gas was added ; instantly, the igniting point of the mixture was raised to that of pure carbonic oxide.

10. A similar experiment with the hydrogen mixture (No. 7), gave a corresponding result.

Thus, the extraordinary inflammability which is imparted to carbonic oxide and hydrogen by the vapor of bisulphide of carbon, is entirely removed by mere traces of olefiant gas ; and it is probable that the other luminiferous hydrocarbons contained in coal gas would produce the same effect. In order to complete this part of the inquiry, it now only remained to extend these experiments to coal gas itself.

11. Coal gas could not, even under the most favorable circumstances, be ignited at a temperature perceptibly below that described in experiment No. 4, as necessary for the inflammation of carbonic oxide.

12. When coal gas was mixed with 3 per cent of bisulphide of carbon vapor, its igniting point was not lowered in the slightest degree.

Having thus proved that any amount of diffusion can have but a very slight effect upon the inflammability of explosive mixtures of coal gas and air, the following experiments were made, to decide the disputed point, whether coal gas can be inflamed by sparks.

13. Hydrogen was readily inflamed by sparks struck from flint and steel.

14. Carbonic oxide was also readily ignited in a similar way.

15. The mixture of coal gas and air, issuing from a wire-gauze burner, was repeatedly and easily inflamed by the sparks struck from flint and steel.

These results are quite in conformity with the experience of gas engineers. Coal gas has been ignited from the sparks elicited by the contact of a workman's pickaxe with stones, the chipping of a pipe, &c. The notion that coal gas will not inflame under these circumstances has, doubtless, arisen from the impossibility of so igniting the gas of coal mines ; but the combustible gas existing in coal mines has been proved, by very numerous analyses to be light carbureted hydrogen only—no trace of hydrogen, carbonic oxide, or olefiant gas being ever present in it. Now, the igniting point of light carbureted hydrogen, is very much higher than that of the other combustible gases present in coal gas. A word of warning to the use of the safety lamp in gas works may perhaps not be here out of place. The Davy lamp was known, by its inventor, to be unsafe in certain conditions—as when placed in a strong draught or rapidly swung to and fro. Any degree of insecurity thus attaching to the safety lamp in mines is increased tenfold when it is used in explosive mixtures of coal gas, and hence it is highly desirable that the gauze of such lamps should be finer than that used in the miner's lamp, and also that the workmen should be stringently prohibited from placing the lamps in a draught of explosive gas, or swinging them to and fro, since the neglect of these precautions may easily cause disastrous explosions.

In conclusion, the results arrived at may be thus shortly summed up :—

1. Coal gas cannot, even under the most favorable circumstances, be inflamed at a temperature below that necessary to render iron very perceptibly red hot by daylight in a well lighted room. But this temperature is considerably below a red heat visible in the open air on a dull day.

2. This high igniting point of coal gas, under all circumstances, is due in a great measure to the presence of olefiant gas and luminiferous hydrocarbons.

3. The igniting point of explosive mixtures of the gas of coal mines is far higher than that of similar mixtures of coal gas ; consequently, degrees of heat, which are perfectly safe in coal mines, may ignite coal gas ; hence, also, the safety lamp is much less safe in coal gas than in fire damp.

4. Explosive mixtures of coal gas and air may be inflamed by sparks struck from metal or stone. Thus an explosion may arise from the blow of the tool of a workman against iron or stone, from the tramp of a horse upon pavement, &c.

5. Explosive mixtures of coal gas may also be ignited by a body of a comparatively low temperature, through the medium of a second body, whose igniting point is lower than that of coal gas. Thus sulphur, or substances containing sulphur, may be inflamed far below visible redness ; and the contact of iron below a red heat with very inflammable substances, such as cotton waste, may give rise to flame, which will then, of course, ignite the gaseous mixture.

We trust that some of our chemists will make experiments of the same character as the above with the vapor of petroleum, as several explosions have taken place in schooners containing this oil, and it has been proposed to us, that Davy lamps should be used in all vessels which carry petroleum, and in all refineries, and stores in which it is kept. We have no doubt but the Davy lamp will afford additional security to persons engaged in carrying and refining petroleum, but the directions given above must be carefully followed. The foregoing information should be disseminated throughout every corner of the civilized world.

A Land Battery.

Joseph Harvey, of Philadelphia, sends a plan for a portable land battery, to be rolled along with the troops, by means of a steam engine inside. He proposes to make an immense iron barrel, say 15 feet in diameter and the same in length, to hang a plat. form in it on an axle passing through the ends, and to suspend his steam engine below the platform, the guns resting upon the upper side of the platform and firing through embrasures made for the purpose. The engine is to turn a gear wheel, meshing into a circle of cogs running round the interior of the barrel, and thus to roll the battery along. Of course the thing could be transported only along roads. The inventor thinks that it would be very formidable to infantry and cavalry, and that it might be made of sufficient thickness to be invulnerable even to light artillery. The plan does not seem to us very promising of success.

ENAMELING IRON.—The notice that an article prepared for, and published on page 106, Vol. VI. SCIENTIFIC AMERICAN (new series), on the above-named subject, has been published by quite a number of our cotemporaries and credited to the London *Engineer*.