The Ignition-point of Gases and its Relation to Volume and Pressure.[1]

AS part of the investigations on the ignition of gases undertaken by the Safety in Mines Research Board, Prof. H. B. Dixon and Mr. J. Harwood have measured the change of volume required to fire various mixtures of methane with air, and of hydrogen with oxygen, when these gas mixtures are suddenly compressed in steel cylinders.

As the compression was carried out originally, according to Prof. Nernst's suggestion, the piston was driven down by a falling weight until it was stopped by the explosion of the gases, the distance within the cylinder traversed by the piston registering the compression. Now the gases do not burst into flame at the moment the ignition-point is reached; an interval of self-heating occurs (varying in length with different gas mixtures) during which the piston will continue to descend—thus indicating a greater compression, and higher temperature, than was really needed to fire the gases. This error was corrected by stopping the piston mechanically by means of a head which was caught by steel collars of the desired thickness placed over the mouth of the cylinder. Later on another source of error was pointed out, namely, the possibility of the self-heating gases pushing up the piston and weight and thus losing heat by doing work at the beginning of the pre-flame period.

Methods have now been adopted which meet these two sources of error. The older apparatus was fitted with three powerful clamps which by means of strong springs should slide over the weight in its lowest position and hold it rigidly down on the piston. In practice it was found that the rebound of the weight when suddenly stopped prevented the certain action of the clamps: but the insertion of a small lead cylinder between the piston head and the weight allowed the weight to continue its fall (after the piston was stopped) for a fraction of a second, during which the clamps had time to make good their hold and keep the weight tight against the flattened-out lead disc.

A new machine has also been designed in which a toggle-joint (as used by Ricardo) is straightened out by a falling weight. This mechanism ensures that the motion of the piston may be stopped at any given point, and also that it may be held firmly in that position if the toggle-joint is kept horizontal. The new machine has a cylinder of twice the diameter of the old, and it is found that, while the rapidly firing mixtures such as electrolytic gas require nearly the same compressions in the two machines, the slower firing mixtures of methane and air show lower ignition-points in the larger cylinder.

To study the effect of differences in initial pressure on the ignition-point of gases—a question raised by the observation of the powerful compression-waves propagated in the firing of the high explosives used in coal-mines—Prof. Dixon, in collaboration with Mr. W. F. Higgins, has modified the concentric tube apparatus, designed some twenty years ago, so as to observe the ignition-point of various gases in air and in oxygen at pressures above and below the atmospheric pressure.

The silica cylinder surrounded by its electric furnace is encased in a strong steel vessel, and is fed from below with compressed air or oxygen—for high-pressure experiments—the excess of air escaping (with the products of combustion) at the top of the vessel. For low pressure trials the air, or oxygen, is allowed to enter below and is drawn off at the top by a motor-driven exhaust-pump, so as to maintain a constant pressure during each experiment. The combustible gas is admitted through the narrow central tube, which opens in the middle of the large cylinder, by turning a tap on the outside of the vessel —the gas passing from the holder through adjustable valves. Observation of the flame is made through a glass window, and the interval between the turning on of the gas and its ignition is timed by means of a pendulum and metronome ticking half-seconds. As the temperature rises, this interval or "lag" becomes shorter in successive experiments, and when it falls to 0·5 sec. (0·6 sec. in the case of methane) the temperature observed is called the rapid ignition-point.

The effect of variations of pressure on methane and on hydrogen was found to be very different. With methane in air, the rapid ignition-points fell regularly as the pressure was increased from 1 to 7 atmospheres, and when the pressure was lowered the ignition-points continued to *rise* so long as the gas would light, although the *rate of rise* fell off as the pressure was reduced from 150 mm. to 100 mm. of mercury. On the other hand, although the ignition-point of hydrogen in air fell regularly as the pressure was increased from 2 to 7 atmospheres, it also fell very sharply as the pressure was reduced from 150 mm. down to 75 mm. of mercury.

The experiments in oxygen confirmed these made in air, except that the rapid ignitions of methane in oxygen showed a maximum temperature at 200 mm. pressure; above or below this pressure, the ignition-point fell. This fall in the ignition-point at very low pressures appears to be a general property of gases: its cause is as yet unexplained.

[1] Substance of two papers, (1) "On the Firing of Gases by Compression," by Prof. H. B. Dixon and Mr. J. Harwood, and (2) "On the Ignition-point of Gases at Different Pressures," by Prof. H. B. Dixon and Mr. W. F. Higgins, read before the Manchester Literary and Philosophical Society on Tuesday, November 10.

British Marine Biology.

THE Marine Biological Association has now at Plymouth a laboratory in the same class as those at Naples and Woods Hole. It only lacks that cosmopolitan element, which largely makes the charm at Naples. It has its zoological, physiological, and fisheries departments and a research vessel that can visit even deep-sea areas. Its growth, while largely due to the recognition of the importance of basal scientific research work in the elucidation of practical problems by the Development Commissioners, is chiefly owing to the broadness and scientific insight of its Director, Dr. E. J. Allen, this being the main factor in attracting the fifty-six naturalists who occupied its tables in the past year; Dr. Bidder has also been generous and, as treasurer, active in obtaining money for several new buildings.

The journal of the Association (vol. 13, No. 4), by arrangement, includes the work of other British marine laboratories. Prof. Meek leads off with a critical account of legislation on the catching of crabs and lobsters on the east coast of England. The crab sheds its shell in autumn and takes some months to reform and harden its new coat. It is poor in quality then, and the fishing is a most destructive one. To protect it the Eastern, North Eastern, and Northumberland fisheries committees have closed the crab fisheries at different times during these months. The author analyses the results in comparative graphs, which