Explosions in Gaseous Media.

A GENERAL discussion on different aspects of explosions in gaseous mixtures took place at a meeting of the Faraday Society held on June 14 at the Institution of Mechanical Engineers, Westminster. The afternoon session, presided over by Prof. H. B. Dixon, was devoted to the consideration of explosions viewed quite generally. In an introductory survey of the subject, Dr. Garner pointed out the large number of factors which have to be considered. The rate of travel of a flame in a gaseous mixture appears to be intimately connected with the amount of preheating—probably by radiation from the flame-front—and with the thermal conductivity of the mixture. It is probable that catalysis also plays an important part in the spread of flame, and a number of substances were mentioned which can be regarded as positive and negative catalysts respectively. Dr. Garner described a possible mechanism which he termed energo-thermal catalysis.

The ignition temperatures of gas mixtures are very important both from the academic and the practical points of view; Prof. Dixon described recent results which he in conjunction with Messrs. Harwood and Higgins had obtained. Using the concentric-tube method, the temperature to which the furnace must be heated before ignition of the gas mixture takes place is dependent upon the time the hot gases are allowed to remain in contact; the true ignition temperature is taken as being that at which the gases unite immediately after mixing. There appears to be a crucial pressure for each gas at which the ignition point is highest; above and below this pressure the ignition point falls. Using the method of adiabatic compression, comparisons were made between the results obtained with two different pieces of apparatus in which the rates of compression were not identical: the lag between the completion of the piston stroke and the recoil due to explosion is shortest when the compressions are highest.

Methods of measurement of the radiation emitted during explosions in closed vessels were described by Prof. David. The infra-red radiation in coal-gas air explosions is at a maximum during the explosion period and before the mean gas temperature attains its maximum value; it is assumed that the radiation is therefore mainly due to chemical activity and not simply to temperature. The introduction of infra-red radiation can speed up the combination in a closed vessel provided that (1) the radiation is of the kind which is absorbed by the combustible gas; (2) nitrogen is present as a constituent of the inflammable mixture; and (3) the mixture composition is such as to be favourable to the formation of oxides of nitrogen during combustion. In the discussion, Mr. Finlayson suggested that the shape of the explosion vessel might have an important effect upon the results obtained, and Dr. Ellis showed some interesting photographs of the mode of flame propagation in closed vessels of different shapes.

The subject of ionisation in gas explosions was introduced by Dr. Garner and Dr. Saunders. It was pointed out that the results obtained by different investigators are not in entire agreement, but the following tentative conclusions can be drawn: (1) The ionisation occurring in gas explosions is mainly thermal, although certain experiments seem to indicate that a small fraction is due to chemical change. (2) Ionisation plays no part in the ignition of gases. (3) It appears unlikely that the ionisation of the gas in front of the explosion is the cause of the propagation of the detonation wave. (4) The action of anti-knocks and knock inducers in the petrol engine cannot be explained on the theory that these substances change the ionisation in the explosion wave. Similar views were expressed in a communication from Dr. Lind.

The importance and the applicability of rates of flame propagation were discussed by Dr. Payman in presenting the results of experiments by Prof. Wheeler and himself. The conditions of flame propagation under which the 'law of speeds' has been found to hold were considered, and it was pointed out that from this law it is possible to calculate the speed of uniform movement in any mixture with air of an industrial gas, the speed of uniform movement of the individual gases with air being known. In the discussion on this paper the point was raised whether the speed of uniform movement could truly be regarded as a physical constant. A short account of recent experiments in Prof. Bone's laboratory was given by Dr. Fraser, and photographs were exhibited showing the movement of the flame in carbon-monoxide-oxygen mixtures. Prof. Jorissen contributed to the discussion some remarks on the limits of inflammability of gases.

The rates of detonation of cyanogen-oxygen mixtures were dealt with in a paper by Dr. Campbell and Prof. Dixon. The detonation velocities in the rapid mixtures appear to be almost independent of the diameter of the containing tube. This is not the case with mixtures largely diluted with nitrogen; in the most highly diluted, the detonation wave is probably never established. From the velocities in the rapid mixtures the mean specific heats of mixtures of carbon monoxide and nitrogen at high temperatures have been calculated.

At the evening session, under the chairmanship of Sir Dugald Clerk, explosive reactions were considered in reference to internal combustion engines. In a brief introduction Sir Dugald Clerk reviewed the work on this branch of the subject carried out by himself and others during the last fifty years. Prof. David discussed the extent to which incomplete combustion of the charge is responsible for limiting the pressures developed in gas engines; about 10 per cent. of coal-gas remains unburnt at the moment of maximum pressure. Various factors which may affect the rate of combustion in gas engines were touched upon. The greater the degree of turbulence of the gaseous charge the more rapidly will inflammation spread; the temperature of the gas engine charge appears to have only a slight effect on the rate of inflammation, but it seems possible that the radiation from the cylinder walls may exert an appreciable influence.

From his experiments with petrol engines Mr. Tizard advanced the view that the dissociation of carbon dioxide at the temperatures reached is sufficient to account for the important fact that maximum power first occurs with slightly 'rich' mixtures and remains practically constant over a considerable range in strength of mixture. In regard to the possibility of detonation of a 'pure' fuel, this appears to depend upon whether a certain temperature, characteristic of the substance, can be exceeded. Anything which lowers the maximum temperature reached during the explosion will tend to stop detonation. The view was put forward by Messrs. Sims and Mardles that metallic anti-knock compounds suffer thermal decomposition, and that the colloidal metal so produced brings about a decrease in volume of the unburnt charge ahead of the flame. Easily oxidisable metals like lead, nickel and iron give positive results as anti-knock compounds, whilst silver and gold are not effectual. Prof. Dixon, Prof. Marks, Messrs. Finlayson, Kay, Sutton, Whatmough and others, contributed to the discussion.

C. C.