Dr. A. Chiesa, from the Pirelli rubber laboratory in Milan, gave the next lecture on some experimental investigations which they had undertaken on the noise inside cars. After a general discussion on the various origins of the noise, Dr. Chiesa described the basic experimental method which is used. The noise produced in a running car varies in intensity and in frequency content. It must therefore be investigated by using statistical methods. Most of the important information about the noise could be obtained from its frequency spectrum, and Dr. Chiesa discussed the instruments which were used in the Pirelli laboratories to obtain this spectrum completely automatically. He then showed how the various kinds of vibration could be distinguished by an inspection of the spectrum, illustrating his remarks with slides of typical spectra obtained by driving over various kinds of road. Dr. Chiesa again emphasized the importance of co-operation between car and tyre manufacturers, and described the kind of research programme they carry out when a certain manufacturer considers fitting one of their tyres.

The final lecture of the symposium was on the subject of hovercraft noise and was given by Prof. Richards. He began by pointing out that hovercraft present an extremely difficult noise problem, much greater than that of conventional aircraft or helicopters. They operate at ground-level, very often near to dwellings; their most likely means of propulsion is an airscrew, which is basically noisy, and at present they develop very high horse-power in a relatively flimsy structure. Prof. Richards went on to define the various noise sources—engines, propellers, fans, air jets, etc. All these sources can generate noise, which in turn can produce resonances in the aircraft structure. He then stressed that a fair estimate of the likely noise production of a hovercraft could not be obtained from prototypes, which inevitably were constructed from components already in use in aircraft, motor-cars, etc., and which were not designed specifically for hovercraft. Provided that proper attention was directed to the components, the design of the hovercraft could undoubtedly be modified to minimize the noise that was generated. Prof. Richards directed attention to the fact that the noise problem for conventional aircraft was realized only when they had been in use for many years, but that, provided sufficient pressure was exerted on designers, it could and should be dealt with at an early stage of the development of hovercraft.

Reports on the research work on which some of the lectures were based are to be published in forthcoming issues of the new *Journal of Sound and Vibration* (Academic Press, Inc., London, Ltd.).

G. M. L. Gladwell

FUNDAMENTAL ASPECTS OF COMBUSTION

THE annual Coal Science Lecture of the British Coal Utilization Research Association was established in 1951 in the belief—to use the words of Sir Charles Ellis, then its president—"that a Research Association should in its own particular field play a part analogous to that of the great learned societies and should, in addition to applying knowledge and attempting to produce immediate results, also take its share of responsibility in the progress of the fundamental work of its subject". The previous Lectures, which have proved eminently successful, were given by eight leading British scientists and three from overseas: Prof. D. W. van Krevelen (University of Delft), Monsieur R. Cheradame (Centre d'Etudes et Recherches des Charbonnages de France), and in 1962, Mr. H. Seidl (Deutsche Babcock and Wilcox Dampfkesselwerke).

The twelfth of the series was delivered by Dr. D. T. A. Townend at the Institution of Civil Engineers on October 16. Dr. Townend, who was until 1946 Livesey professor of coal gas and fuel industries in the University of Leeds, retired as director general of the British Coal Utilization Research Association in September 1962 and, when inviting him to give the lecture, the Association's Council suggested that he should speak on a subject to which his earlier work on the fundamental aspects of combustion was relevant: hence his title "Some Reflexions on Combustion".

Dr. Townend said that, on reflecting on a suitable theme, he had been led more and more to appreciate how dominating an influence the combustion of the elementary combustibles, hydrogen and carbon monoxide, must play in the overall combustion and gasification of all solid fuels. For coal was first pyrolysed to yield combustible gases, volatile hydrocarbons and coke, the primary combustible gases being hydrogen and methane; and at temperatures above 700° C, hydrogen was almost the sole product. Carbon monoxide was the primary product of the oxidation of coke and the volatile hydrocarbons yielded on pyrolysis ultimately hydrogen and carbon. Finally, even hydrocarbons were first transformed essentially into carbon monoxide and hydrogen before their overall combustion was completed. Some 30 per cent of the potential heat in coal was released during the production of carbon monoxide by the direct oxidation of carbonaceous material, and the remainder was released from the combustion of carbon monoxide and hydrogen. The presence of hydrogen and carbon monoxide in the combustion gases within a pulverized-fuel-fired furnace was illustrated from the present work of the International Flame Foundation at Ijmuiden.

Dr. Townend next directed attention to the important part played by hydrogen and oxygen atoms in the chain mechanisms inherent in the combustion of hydrogen and carbon monoxide; in flames their concentrations were greater than would be expected from theoretical considerations. The presence of hydrogen atoms was readily demonstrated by the phenomenon of candoluminescence whereby certain activators (for example, oxides of bismuth, manganese and lead) added to the oxides of host materials (for example, calcium, strontium and barium) cause a characteristic light emission (fluorescent spectra) when brought in close proximity to the flames of hydrogen-containing combustibles. The hydrogen atoms recombine, however, in the presence of diluent gases and at critical diluent concentrations the light emission is repressed. Moreover, at the point of the repression (*a*) the flames of hydrocarbons are rendered non-luminous, and (*b*) in the presence of sodium salts the yellow *D*-line emission is also quenched. In further illustration of the part played by hydrogen atoms and their recombination by molecular collisions or on surfaces, it was shown how the heat conduction from a hydrogen flame to a surface was 20 per cent greater than that from a fairly dry carbon monoxide flame, although the calorific values are much the same.

The presence of oxygen atoms in carbon monoxide flames had been established some years ago in connexion with work on boiler availability, and there was little doubt that they were mainly responsible for the oxidation of sulphur dioxide to sulphur trioxide with the ultimate formation of sulphuric acid.

Another important problem concerned with the combustion of carbonaceous fuels was the presence of chemisorbed layers on the fuel surface. At low temperatures, an unstable carbon–oxygen–water-complex (peroxygen)

controlled the oxidation of the coal substance; at about 70°–80° C its breakdown could lead to rapid oxidation and with certain fuels to spontaneous ignition. At combustion temperatures the presence of a layer, defined as oxycarbon, was an important factor in the combustion process.

Reviewing the overall picture, Dr. Townend pointed out that in the practical field a matter of importance was the control of the aerodynamics of a combustion system to provide adequate mixing of solid particles with the reactant gases, including hydrogen, carbon dioxide, water and atoms and radicals; for gasification and oxidation were mutually involved. He also considered the likely advantages to be gained by combustion under pressure, having regard to the chemical and physical factors involved.

In conclusion, Dr. Townend emphasized that many combustion phenomena accepted to-day as commonplace would not have been predicted forty years ago; and as an illustration he mentioned the manner of his discovery of the two-stage process of the ignition of hydrocarbons which had proved the key to the elucidation of the problem of 'knock' in internal combustion engines.

After the lecture a dinner in honour of Dr. Townend was held at the Savoy Hotel; at this function the Coal Science Medal was presented to Dr. Townend by Mr. E. H. Browne, president of the British Coal Utilization Research Association.

A CHANNEL LINK

ALTHOUGH the report of the working group of British and French officials on *Proposals for a Fixed Channel Link** was published two months later than the Broadsheet *Transport in the Common Market*, issued by Political and Economic Planning in July †, it is significant that in the Broadsheet Mrs. Trench makes no reference at all to either a tunnel or a bridge for the English Channel. After indicating the three objectives of a common transport—removal of obstacles which transport would offer to the establishment of the general Common Market; creation of healthy competition of the widest possible scope; provision of means of transport meeting in quantity and in quality the requirements of the European Economic Community—the Broadsheet reviews the measures proposed. These include a tariff policy for freight, and after considering the general proposals the Broadsheet considers international transport by road and the domestic road transport of goods.

The investigation finds that there is still no sign of an agreement between member States on the proposals or even of the policy being implemented in 1963–65, and it is unlikely that there will be any substantial progress towards implementing a common policy until after this. The proposals in the Action Programme for the Common Transport Policy presented to the Council of Ministers in May 1963 are themselves the result of compromises between conflicting objectives of the policy and also between existing practices in the member States; they are so framed that they stand some chance of being acceptable to all the countries in spite of the differences between their present transport systems. The objectives of the policy are much more ambitious and extensive than the minimum necessary to secure the free working of the Common Market, and the instruments chosen, notably the system of forked tariffs, have far-reaching implications. Nevertheless, some of the major transport problems are left untouched. Own-account transport of goods is left free to develop in a way which could well frustrate the objectives of the policy to secure an optimal use of transport facilities of the Community as a whole. There are no proposals about private cars, although the growth in their numbers and the pattern of their use affect road expenditure and traffic congestion, and thus the cost of operating goods vehicles, as well as the passenger revenue of the railways, the size of the railway system and its costs of provision.

Any attempt to secure a real improvement in a community's use of transport resources should, the Broadsheet points out, rest on a full investigation of the social benefits and costs of transport operations, and the Commission is at present studying 'infra-structure costs' in order to reconstruct the basis of taxation on different forms of transport to redistribute the burden of Government expenditure as between different users. It is suggested that the Commission should broaden these investigations to take into account costs and benefits dispersed among the community as a whole as a result of the expansion or contraction of different kinds of transport. Policy could then be based on a much better knowledge of what different developments are likely to cost the community in terms of lost amenities, increased congestion, reduced scope and frequency of public services, etc.

This kind of consideration is lacking in the report on the proposals for a Channel tunnel and Channel bridge. Unfortunately, the report is also markedly lacking in either imagination or enthusiasm, and it appears to be preoccupied with financial and economic considerations in the narrower sense to the exclusion of social and political and even technical aspects whether short or long term. Charged with considering the project for a tunnel proposed in March 1960 by the Channel Tunnel Study Group and the project for a bridge proposed in October 1961 by the Channel Bridge Study Group, its findings are in favour of the rail tunnel project. It finds this means satisfactory from the technical point of view and constituting from the economic point of view a preferable solution to the continued use and development of established means of transport, while at the same time being free from the practical disadvantages of the bridge—which is likely to have a capital cost almost double. The working group foresees no increase in traffic or other advantage to offset this higher cost, and even the financing of the rail tunnel it regards as an uncertain risk and recommends that the two Governments should contemplate direct guarantee of loans, but also that the bounds of the privately owned undertaking should be guaranteed. This would be a new departure in United Kingdom practices and one that in France is only used on an extremely limited scale.

It is recognized that the bridge, which offers a continuous road and rail Channel link in the open, is a more attractive proposal to road users than the tunnel project, in which vehicles are driven on and off special car ferry trains operating at intervals of 5–30 min according to demand, carrying either 150 or 300 cars, and completing the journey in an average of 65 min, of which 45 min would be occupied by the journey proper. The working party regards the bridge as offering a new and serious hazard and source of delay to shipping; also its construction would involve international agreement as to safety regulations for sea traffic as well as to the bridge in principle. It does not consider that these objections would be removed by foreseeable developments in navigational aids within the next few years. However, it did not seriously consider a third proposal, for an immersed road-rail tunnel, which was submitted in March 1963 and for which the capital cost is estimated to be £236 million, compared

* Ministry of Transport. *Proposals for a Fixed Channel Link*. Pp. iv + 60. (Cmnd. 2147.) (London: H.M.S.O., 1963.) 6*s*. 6*d*. net.

† *Planning*, Vol. 29, No. 473 (8 July, 1963): *Transport in the Common Market*. Pp. 223–286. By Sylvia Trench. (London: Political and Economic Planning. 1963.) 6*s*.