lations of Ufford[8] and experimental data concerning the CN radical[1]. The discrepancy with the recent observations of Shenstone[9] will be dealt with in a future communication. It is in no sense responsible for the discrepancy between our conclusions and those of Springall[10] concerning the heat of atomization of carbon, this being due to entirely different reasons which are discussed in a forthcoming paper.

In conclusion, it seems to me that the expression 'mean bond-energy term' is an unfortunate choice. As originally employed for polyatomic molecules by Butler and Polanyi[11], a constancy in energy is assumed for any one kind of link from molecule to molecule, differences in the dissociation energies being attributed entirely to resonance energy of the resulting radicals. This point of view ignores changes in the energy of unruptured links during a dissociation process, whereas the statement that bond-energies according to Skinner and Springall's usage (*a*) show "a remarkable degree of constancy" seems difficult to maintain in the face of much experimental evidence. If this were so, then every process of the type

$$CH_4 + CO_2 \rightarrow 2H_2CO,$$

in which the number of each type of bond remains the same, would be thermoneutral, whereas this is far from being the case. The example quoted is endothermic to the extent of about 60 kcal., which must be attributed to changes in the energies of the C—H or C=O bonds or, more probably, both. The extent to which the bond-energies (as distinct from the dissociation energies) of C—H, C=O and many other bonds do, in fact, vary has received frequent consideration in the literature[12].

L. H. LONG

University College,
Exeter.

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[2] Pauling, L., "The Nature of the Chemical Bond", 47 ff. (Cornell Univ. Press, New York. 2nd Ed., 1945).
[3] See, for example, Coulson, C. A., *Quart. Rev. Chem. Soc.*, **1**, 144 (1947).
[4] Long, L. H., and Norrish, R. G. W., *Nature*, **15[illegible]**, 486 (1946).
[5] See the discussion to the paper by Norrish, R. G. W., *Trans. Farad. Soc.*, **30**, 103 (1934).
[6] Van Vleck, J. H., *J. Chem. Phys.*, **2**, 20, 297 (1934).
[7] Mulliken, R. S., *J. Chem. Phys.*, **2**, 782 (1934).
[8] Ufford, C. W., *Phys. Rev.*, ii, **53**, 568 (1938).
[9] Shenstone, A. G., *Phys. Rev.*, ii, **72**, 411 (1947).
[10] Springall, H. D., *Trans. Farad. Soc.*, **43**, 177 (1947).
[11] Butler, E. T., and Polanyi, M., *Trans. Farad. Soc.*, **39**, 19 (1943).
[12] See, for example, the discussions and references given by Walsh, A. D., *Trans. Farad. Soc.*, **43**, 60 (1947); *J. Chem. Soc.*, 398 (1948).

GERMAN MOTOR ROADS

BEFORE the War much interest was taken in Great Britain in the German *Autobahnen*. Their design and construction were well described then in both the technical and popular press. The system is the only modern road network planned on a national scale and is worthy of most careful study in order that practice in Britain and elsewhere may profit as much as possible from German experience. The recent B.I.O.S. Overall Report*, entitled "German Motor Roads, 1946", is therefore particularly valuable in that it gives comprehensive information on the present state of these roads. The report, which contains thirty-nine excellent plates, is clearly and succinctly written and can be strongly recommended to the general reader.

* British Intelligence Objectives Sub-committee Overall Report No. 5. (H.M. Stationery Office, 1948.) 1*s*. 6*d*. net.

The roads have been laid out on new ground, independently of existing roads, so as to link the main cities and industrial areas. The great extent of the system is emphasized by the fact that although a length of some 2,380 miles of dual-carriageway road is already in service, only about one half of the length originally planned has been completed. One of the chief impressions gained by the observers was of the high quality maintained throughout rather than of any exceptional excellence in particular sections, which were nowhere better than has been achieved elsewhere. This consistency is attributed to the policy of working to a single standard determined centrally, and of employing contractors carefully selected for their ability to undertake work of such a magnitude. The designs of the later roads were modified in the light of the experience gained from those already in service.

An admirable feature is the absence of extensive cracking of the concrete surfaces; this has been achieved by building on a gravel foundation, the material being imported if it was not already available locally. The elaborate plans adopted at crossings and road junctions to avoid the conflict of traffic lanes are well known; when adequately signposted, these are not found to be confusing. Another striking feature is the design of bridges; a great variety of construction has been used to suit local conditions and the workmanship is described as being of outstanding merit. Fifteen photographs in the report give a good idea of the lightness of effect achieved in over-bridges and of the pleasing design of the under-bridges; the latter carry the roads across valleys and are often larger than are met with in common practice owing to the stringent gradient restrictions which were maintained. Care has also been taken to blend the roads into the landscape by careful location, by rounding the slopes of cuttings and embankments, and by the method of planting adopted.

The report finally concludes that "the lay-out and alignment of the German motor roads are of a sufficiently high standard to suggest a degree of safety and sense of security above that obtained on ordinary main roads in Britain". Undoubtedly we can learn much not only from the felicities of this great experiment but also from its defects, a number of which are recorded and illustrated. R. H. MACMILLAN

CONSTITUTION OF THE PLANETS

MORE than thirty pages of the first part for this year of the Monthly Notices of the Royal Astronomical Society are devoted to "Reports on the Progress of Astronomy", under which is included "The Constitution of the Planets", "Solar Activity", "Comets" and "Double Stars". By far the longest of these is the first, and it is possible to glance at only a few of the points dealt with by Rupert Wildt.

Quite recently our view that satellites could not retain atmospheres has been shown to be incorrect, as methane absorption has been discovered in the spectrum of Titan. The atmosphere of Titan, which is stable under present conditions, would have its stability endangered if its temperature were raised by only 100° C. Hence, if the evolution of the satellite passed through a stage of high surface temperature—as is believed to have happened with all the members of the solar system—the atmosphere of Titan must have been formed subsequent to that period. Kuiper believes that the same argument applies, with almost equal force, to Mars and perhaps to Venus and the earth also. He points out that the existence of methane on Titan suggests a genetic relation to its primary or to the other giant planets, and shows that the satellite cannot be the product of capture from an elliptical orbit extending into the interior region of the solar system.

At the end of the review it is pointed out that there are four different groups of phenomena which are worthy of some attention as possible clues to the history of the solar system. These are: (1) The correlation between the mass of a planet and the size and composition of its atmosphere-oxides on the terrestrial planets and hydrides on the giant planets. (2) The existence in Saturn's system of two types of satellites with densities greater than that of rock and less than that of water. (3) The nature and origin of the envelopes of low density characteristic of all the giant planets. The theory of Kuhn and Rittmann rules out the possibility of gravitational separation leading to the formation of a heavy core and more especially in the giant planets; and if their view should be accepted, the marked concentration of density towards the centre of the giant planets would favour the accretion theory of planetary formation. (4) The mean chemical composition of the planets in relation to the composition of the sun. As it is possible to explain the scarcity of light elements on the terrestrial planets by dissipation, no further cosmogonic inferences can be made so far as this is concerned. Of course, if the planetary matrix were much richer in lighter elements than the bulk of the sun, some doubts would be thrown on the formation of the planets by sudden ejection from the sun, which would have been accomplished by an unavoidable loss of hydrogen. When more accurate values for the mean composition of the sun and giant planets are available, they may facilitate a choice between the rival theories of the origin of the solar system, through a sudden catastrophe with subsequent rapid condensation, or through gradual accretion.

OSLER AS A SCIENTIST*

By Sir ARTHUR MacNALTY, K.C.B.

SIR WILLIAM OSLER is famous for many things. He was a great physician of two continents, a scholar, a humanist, a teacher and a medical administrator. His work as a scientist has perhaps received less recognition, yet it is revealed on every page of his famous text-book of medicine. As Harvey Cushing wrote[1]: "The volume, indeed, was what might be called a practical pathology in which were given the results of modern investigation, microscopical, bacteriological, and chemical. On this foundation was built up the symptomatology and diagnosis of disease. . . ." His school-master, the Rev. W. A. Johnson, at Weston, near Toronto, introduced him to the study of biology, geology and the use of the microscope. At eighteen years of age, Osler began to tabulate and study his collection of the Diatomaceæ; and his interest in biology was stimulated further, when he entered the Toronto Medical School in 1868, by Dr. James Bovell. "I am at Dr. Bovell's every Saturday and we put up preparations for the microscope," he writes.

* A paper read to the Osler Club on July 12.

His first publication was a short sketch entitled "Christmas and the Microscope" (*Hardwicke's Science-Gossip*, London, Feb. 1, 1869), in which he describes the diatoms and Infusoria he identified in a bottle of water. In 1870 he presented to the Natural History Society of Montreal the results of his studies on the Diatomaceæ of Canada, enumerating 109 species under twenty-nine genera and describing the structure, mode of division and propagation of the diatom[2]. In 1877 he read a paper before this Society on Canadian fresh-water Polyzoa[3] and published a supplementary note on this paper in the *Canadian Naturalist*, 1881[4]. He mentioned a species of *Cristatella* as having been found in abundance and described a new species of *Pectinatella*.

In 1872–73 Osler had spent fifteen months in the Physiology Laboratory, University College, London, working at physiology and histology under Prof. Burdon-Sanderson. While there he was offered the chair of botany in McGill University; but declined it as insufficiently qualified for the post. At University College he began working "On the Action of certain Reagents—Atropia, Physostigma and Curare—on the Colourless Blood-Corpuscles"[5]. The published results were negative. In 1873 he made his most important contribution to scientific knowledge by investigating with Edward Schäfer the form and movement of the blood platelets. Though a few previous workers, for example, Bizzozero and Hayem, had observed these bodies, "the third element of the blood", it was Osler who saw them first in the circulating blood and carefully described them, and his observations were presented before the Royal Society by Burdon-Sanderson in 1874[6]. Afterwards, he published several papers and lectures on the blood, including one on the development of blood corpuscles in the bone-marrow[7]. All this work established Osler's reputation as an original investigator.

Returning to Montreal in 1874 as lecturer of Institutes of Medicine, he studied the 'entozoa', and R. Ramsay Wright, professor of biology at Toronto, named a trematode worm, which Osler had found in the gills of a newt, *Sphryanura Osleri*[8]. Osler, as professor of physiology in the Veterinary College, Montreal, and vice-president of the Montreal Veterinary Medical Association, also worked at comparative pathology, being one of the first to realize its importance in relation to medicine. He published several papers on this subject during the next few years. In the first of them, on a form of bronchopneumonia in dogs, he described a previously unknown parasitic nematode as the causal agent[9]. This organism was afterwards renamed *Filaria Osleri* by Cobbold in 1879. The most important of the other papers dealt with hog cholera[10], echinococcus[11], cestode tuberculosis[12] and the parasites in the Montreal pork supply[13]. As a by-product of this latter investigation he took up the subject of trichinosis and echinococcus infections in man. He studied the parasites in the blood of the frog, demonstrating and classifying *Rana mugiens*, the *Trypanosoma Sanguinis* (Grubby) and the *Drepanidium ranarum* (Lankester)[14].

Osler confirmed Koch's discovery of the tubercle bacillus as the cause of tuberculosis in 1882; but he never became an adept in bacteriological technique. Harvey Cushing, his biographer, considered that at first he inclined towards Bastian's belief in spontaneous generation, and by the time that Pasteur's views had been accepted, he had abandoned experimental medicine and comparative pathology for the clinical study of disease. The call to Philadelphia to be