

economic value. He pointed out that the situation created by the war had intensified the national interest in questions of economic importance, and that the abuse and neglect of the natural resources of this country were now being closely investigated, as evidenced by the report of the Coal Conservation Committee. Coal is certainly at present, and will probably be for some time to come, our principal source of power, but it should not be overlooked that 1 cubic foot of water per second falling through 11 ft. can supply a horse-power unit to any modern turbine. The past neglect of the water resources of the country is, therefore, an economic waste which should not be tolerated any longer. Of a total of  $10\frac{1}{2}$  million horse-power generated in industrial engines in 1907 in Great Britain and Ireland, only about 180,000, or 1.6 per cent., was attributable to water.

Unfortunately, few of the larger English rivers are trustworthy enough in discharge, or possess sufficient intensity of fall, to render them utilisable to any great extent. On the other hand, there are large rivers in the Scottish Highlands which have falls of 14 ft. to 16 ft. per mile, and several Irish rivers have very considerable falls almost at the points where they enter the sea. Scotland, particularly the region which lies north of the Forth and the Clyde, possesses greater potentialities of supply than any other part of Great Britain. Taken as a whole, it has the greatest rainfall, the only localities comparable with it being Seathwaite, in Cumberland, and Snowdon, in Wales. (An annual rainfall of 160 in. has been recorded on Ben Nevis, 182 in. in Cumberland, and 193 in. on Snowdon.)

Mr. Newlands computed that in Scotland—chiefly in the Scottish Highlands—there are about 11,500 sq. miles of country with a rainfall of 50 in. or more, as compared with 3360 sq. miles in England, 3390 sq. miles in Wales, and 5910 sq. miles in Ireland. By impounding the discharge from the lock basins, and assuming an average rainfall of 42 in. (representing a yield from the catchment area of 3 cubic feet a second per sq. mile), of which two-thirds, or 28 in., would be available for power purposes, he estimated that the supply in Scotland would amount to 375,000 horse-power in round figures. This is exclusive of the basins of the Clyde, the Forth, and the Tweed, on account of their other important interests, and of rivers and small streams. By diversions and the linking-up of adjoining catchment areas, and by impounding in excess of the quantity provided for in the estimate, it might be assumed that for, say, 100 days' supply 650,000 horse-power would be available.

According to the figures of Mr. Archibald Page, of Glasgow, the power requirements of Scotland in 1916 were 1,119,000 horse-power units, and it would appear, therefore, that there is sufficient water-power in the Scottish Highlands to meet a large proportion of this demand, though it is doubtful whether, after development and transmission to existing industrial areas, the cost would be less than that of power generated there at the

pit-head. One of the most interesting features of this water-power was that it existed in a territory destitute of coal.

In surveying the situation in regard to England, Wales, and Ireland, Mr. Newlands remarked that the absence of large lochs and the lack of sufficient elevation in the country as a whole detracted from the possibilities of any great development of water-power, which, so far as it was available, would have to be derived from river-flow. The paper concluded with a plea for more support and recognition of the work of the British Rainfall Organisation and of the Scottish Meteorological Society than those bodies receive.

BRYSSON CUNNINGHAM.

#### SOME AMERICAN VIEWS ON AERONAUTICS.

ON April 14, 1917, the American Philosophical Society held at Philadelphia a "Symposium on Aeronautics," of which the papers are now published in the society's Proceedings (vol. lvi., No. 3).

The titles of some of the papers contributed to the conference—namely, "Dynamical Aspects," by Prof. A. G. Webster; "Physical Aspects," by George O. Squier; "Mechanical Aspects," by Dr. W. F. Durand; "Aerology," by William B. Blair; and "Engineering Aspects," by Dr. Jerome C. Hunsaker—show that every attempt was made to ensure a thoroughly representative discussion. But in reviewing the proceedings one cannot help being struck with the opinion that modern aeronautics is too straggling a subject or collection of subjects to be dealt with efficiently in a meeting of this character. Thus, Dr. Webster, the author of a standard treatise on "Rigid Dynamics," reproduces certain familiar diagrams of lines of flow and explains the meaning of lift and drag; Mr. Squier tells us that in the past few years several elements, helium, argon, neon, krypton, and xenon, have been found in the air; Dr. Durand enumerates the problems which have to be solved in the development of the aeroplane—problems more often enumerated than solved; while in Mr. Blair's paper a large amount of space is taken up with twelve diagrams, although he fails to explain what connection these figures have with the mean of wind observations in "Highs" and "Lows," or what the different parts of the diagrams represent. The three pages which Dr. Louis A. Bauer devotes to his subject refer to difficulties attending the use of the compass in aeroplanes arising from deviations of the apparent vertical due to normal and other accelerations.

An original composition to the programme of the meeting is represented by Prof. Edwin B. Wilson's second paper on "The Theory of an Aeroplane Encountering Gusts." The first of these papers was published in 1915 by the American Government Advisory Committee. Together the two constitute a mathematical extension of the theory of small oscillations from free to forced oscillations. Apart

from any questions as to how best to deal with the gust problem, the study of the forced oscillations of an aeroplane is a problem proposed for solution many years ago, which has to be solved sooner or later in the development of the aeroplane, and the sooner the better. Of course, the treatment is limited to the consideration of small disturbances, but we believe it was Mr. Bairstow who, in the earlier days of his experiments, pointed out that a theory so formed might give useful approximations for practical purposes, just as our knowledge of the pendulum was largely based in the first instance on the study of oscillations of small amplitude. It will be seen that both longitudinal and lateral disturbances are considered, although the inconvenient notation renders it a little difficult to know what is longitudinal and what lateral, or even whether the aeroplane is supposed to be flying forwards or backwards. An alternative method of treating gusts has been developed and worked out by Mr. Brodetsky in this country, although only his first paper has yet appeared in print.

The value of mathematical work of this kind has been called in question by certain meteorologists who have claimed that theirs was the proper method of solving the problems of aviation. A study of the present collection of papers, however, shows that while meteorological investigations are required to ascertain the conditions under which flights are made, it is necessary to resort to very long, hard mathematical calculations in order to ascertain *how* these conditions can be met in the construction of a flying machine. Of course, work such as that of Prof. Wilson requires developing from the experimental side, but the mathematics must be done previously.

G. H. B.

#### NOTES.

THE present position of nitrogen fixation in this country was stated in the House of Commons on May 2 by Mr. Kellaway, Parliamentary Secretary to the Ministry of Munitions, in reply to a question by Sir William Beale. The various proposals for fixing nitrogen have been examined in detail by the Nitrogen Products Committee of the Munitions Inventions Department, and, as a result, intensive research has been concentrated upon the Haber process. A research staff composed entirely of young British scientific workers has accumulated the knowledge requisite to the translation of the vague outlines of this process of ammonia synthesis, as revealed in the patents of the German industrial concerns, into a commercially practicable process. This has involved two years of unremitting laboratory research, during which period numerous departmental patents have been taken out for improvements in ammonia synthesis, as well as in the subsidiary branches of the problem, such as hydrogen manufacture. These patents are held in the names of the members of the research staff, and are assigned to the Secretary of State for War. The research work of the staff of the Munitions Inventions Department is now far advanced, so that the results have been placed at the disposal of the Explosives Department for application on a factory scale. The manufacturing operations will be conducted at present for war purposes, the production of synthetic ammonia being applicable to the manufacture of explosives, as

well as to the production of ammonium sulphate for agriculture. The results of the research work on synthetic ammonia have not been made public, but may be communicated confidentially to concerns proposing to erect plant under financial arrangements approved by the Treasury. The availability to manufacturers of the general research work of the staff of the Munitions Inventions Department is now being considered by committees representing the several departments concerned.

THE Gas Traction Committee, appointed in November last to consider the employment of coal-gas as a substitute for petrol and petroleum products in motors, its general safety, and conditions for use, has issued an interim report (H.M. Petroleum Executive, price 1d.). This deals chiefly with the present use of gas, mainly at low pressures, in suitable fabric bags; the work is to be continued to cover its use under higher compressions when the necessary appliances and plant are obtainable. The Committee is satisfied that gas can be efficiently, safely, and promptly substituted for motor spirit (only two minor accidents have been reported). Two hundred and fifty cubic feet are considered equivalent to one gallon of petrol, so that gas at 4s. per 1000 cub. ft. is equivalent in cost to petrol at 1s. per gallon. No restrictions, except in so far as the shortage of coal or other war conditions may demand, should be imposed on the use of gas in suitable containers. A specification for the bags is given; the material should be two-ply diagonally doubled, and proofed with 6 oz. per square yard of proofing containing 90 per cent. of high-class rubber, this being vulcanised by the hot process. The permeability of prepared fabric to hydrogen must not be more than 10 litres per square metre per twenty-four hours (0.3 cub. ft. per square yard per twenty-four hours). The working life of such containers would normally be eight months. Top ventilation should be provided in any garage, and a container should be completely deflated after standing idle for two weeks. For use under higher compression it is undesirable that semi-rigid containers of rubbered canvas should at present be charged to a greater gas pressure than 90 lb., or be of greater internal diameter than 4 in. Encouragement should be given to the construction of semi-rigid containers of rubber and woven wire up to a working pressure of 300 lb., and it is considered desirable to encourage experiments with rigid metal cylinders working up to 1800 lb., particularly in connection with their application to motor-omnibus use and for the transport departments of municipal authorities.

A LETTER to the Press on the subject of food crops and the protection of birds, recently issued by the Royal Society for the Protection of Birds, directs attention to the serious diminution in the numbers of our resident insectivorous birds, due to the severe winter of 1916-17, and also to the widespread destruction of birds and eggs, which is a cause of grave anxiety at the present time. That everything possible should be done to protect and preserve such species is beyond dispute. As the signatories of this letter point out, all are agreed that insect-eating and vermin-eating species of wild birds are invaluable to man. Further, the farmer and fruit-grower have everything to gain by responding to the present appeal to take the matter up promptly with the view of checking the destruction of these birds and their nests and eggs. Plagues of various species of injurious insects have already been reported from different parts of the country, and but for the services of our resident and migrant insectivorous birds these would each year grow worse. As it is, they already inflict very serious