Fuel Research.

By Prof. John W. Cobb.

THE rising cost of coal will help to focus attention upon all such potential relief work as that of the Fuel Research Board, which has now issued its 1918-19 report over the signature of its director, Sir George Beilby. The report is of a comprehensive character, and gives evidence both of care in preparation and of a desire and competence to grapple in a scientific and effective manner with some of the more important problems with which the country is faced. The Board is not only undertaking experimental work at a station established for the purpose at East Greenwich, and conveniently placed near a works of the South Metropolitan Gas Co., but is also concerning itself with inquiries conducted elsewhere into the thermal efficiency of open fires and cooking ranges, the economic position of pulverised coal, the cutting, winning, and utilisation of peat, and the sources of raw material for the production of The report also includes a power alcohol. reasoned account of the proceedings of the Board in the matter of the new gas standards which had been wisely referred to it by the Board of Trade and on which it has made recommendations. A survey of the national coal resources from the physical and chemical points of view is promised, this work having been taken over from the Coal Conservation Committee, which recognised the importance of such a survey, but, being without a staff, did not feel able to carry it out.

The equipment and lay-out of the experimental station at East Greenwich are described at some length. Stress is laid upon measures taken to allow of striking a correct thermal balance for each piece of plant employed, although it is no doubt recognised that the smallness of each unit would have to be taken into account in translating results into terms of large-scale practice. It is interesting to note that the position of water-gas as a heating agent for such purposes as the firing of the gas-retort installations is now so far established that the Board has felt justified in making blue-water-gas its standard fuel. Recent experience has demonstrated that the traditional restriction in the use of water-gas to operations requiring intense local heat was unnecessary.

Apparently the first purpose to which the experimental plant is to be put is the complete investigation of low-temperature carbonisation, concerning which so many conflicting statements have been put forward. This is a very legitimate inquiry, and the report justifies it (if any justification is needed), by insisting upon the wisdom of probing all possible sources of supply for the fuel oil on which the Navy and mercantile marine are becoming increasingly dependent. It is plain that Sir George Beilby approaches this process with some predisposition in its favour. He has himself made preliminary experiments upon it, and in an appendix to the report there is reprinted a contribution which he made to the discussion of the subject at

the British Association meeting in 1913. The report displays a somewhat unfortunate tendency to rule out the carbonisation processes of the gas industry as being unlikely to produce larger quan-tities of fuel oil, because "present movement is all in the direction of obtaining the highest possible proportion of the total thermal units of the coal in the form of gas with a smaller consumption of coal per million thermal units distributed." Such ruling out is not justified, as a later qualifying clause admits. The further technical success of the gas industry would be expected to result in a large replacement of coal as a domestic and industrial fuel by gas, and although the thermal units carried by the gas from a ton of coal would increase, the margin for replacement is so considerable that the total amount of coal gasified would increase also. Moreover, it is unwise to assume that such developing processes as the distillation in vertical retorts of a descending stream of coal in an ascending stream of steam or other gas cannot be made a most effective and economical means of securing the maximum yield of volatile products, including tar oils if they are Most of the favourable "non-destrucwanted. tive " conditions claimed for low-temperature carbonisation may quite probably be secured in this way without the attendant disadvantages of that process as it has so far been described and worked. The whole matter is still sub judice.

The net commercial result of any carbonisation process is to a great extent dependent upon the relative market values of products, which change from time to time. From a thermal point of view, however, the movement towards obtaining a large proportion of the thermal units of the coal in gas is justified by the high thermal efficiency of gas in use, combined with the low thermal cost of production which can be made to attach to it. From the point of view of by-products, fuel oil has, no doubt, its importance, but it would be a mistake if sulphate of ammonia were to be deposed from its pride of place without due consideration, and it seems clearly to be established that low-temperature conditions are very unfavourable for the production of ammonia. It may be that national safety will be held to demand the working of a commercially unremunerative process, but, if so, the decision should be made with open eyes.

The results which Sir George Beilby, Prof. Thomas Gray (chief of the laboratories), and their staff are setting out to obtain in connection with the low-temperature carbonisation process will be of great interest to many who have been waiting for trustworthy data concerning it. The commercial success of low-temperature carbonisation on an extended scale is bound up with the creation of a demand for the soft coke or semi-coke which would be one of its main products. As compared with raw coal, this material, like any other coke,

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would have the outstanding advantage of smokeless combustion, but its ash content would, of necessity, be higher. It would have the great disadvantage of crushing more easily than ordinary coke in all the processes of transference from the retort to the consumer, but would be correspondingly easier to ignite. Like both raw coal and ordinary coke, it would deliver potential heat units at a cheaper rate than they are supplied in gas. The question of efficiency in use remains, and the report deals benevolently with the efficiency obtainable from coal and coke in the most widely used domestic appliance-the open fire. It is set out that with an open fire, which has apparently a chance of regaining a lost reputation if it will only consent to provide a market for large quantities of soft coke, "probably 30 to 40 per cent. of the heat escapes completely, 60 to 70 per cent. being used in warming the room itself and the general fabric of the building."

On this point careful statement is advisable. In view of the comparative unavailability of any heat from the coal fire which is not given up to the room, it would be quite wrong to take 60 to 70 per cent. as being the thermal efficiency of the open fire, just as it would be wrong in the other direction to take the radiant efficiency of such a fire (about 25 per cent.) as the total efficiency. Comparative tests are probably best made on radiant efficiency, and it is not surprising to find that the tests made by Dr. Fishenden and quoted in the report are made on this basis. Dr. Fishenden's tests on coal and coke fires have been carried out at Manchester by the method worked out at the University of Leeds for testing the radiant efficiency of gas fires, with such modifications as were found necessary. The work has undoubtedly been carried out with care and skill, but it should be borne in mind that, on account of the varying condition of a coal fire during the course of a determination, the quantity and distribution of radiation from it cannot be measured with anything like the same degree of precision as with a gas fire. Dr. Fishenden does seem to be satisfied, however, that the radiant efficiency of the coke fire is higher than that of the coal fire, and, according to the report, "the radiant efficiency of coal fires of different types varies from $19\frac{1}{2}$ to 25 per cent., while, with fires of low-temperature coke in the same grate and burning under the same conditions, this amounts to 31 to 34 per cent." It may be noted that the radiant efficiency of a modern gas-fire is approximately 45 to 50 per cent., but the report does not fail to point out that the real thermal advantage of the gas fire is much greater than would be indicated by any such comparison, because it can be used almost immediately at full efficiency for any period of time, great or small, this, of course, apart from any question of labour-saving and cleanliness. Cooking ranges were brought under test by Mr. A. H. Barker, and his reports are summarised in "Mr. Barker lays stress on the an appendix. extravagance in fuel involved by the necessity of heating the whole apparatus in the use of only |

one or possibly two of its appliances," and points out the further difficulty of obtaining high economy under ordinary working conditions because of the large excess of air employed.

It is plain that, whether coke or gas is used as a means of replacing raw coal for domestic uses, the smoke nuisance would be abated, and a section of the report given under the head "Air Pollution" shows this aspect of the fuel problem to be receiving attention from the Board. The pioneer work of Prof. J. B. Cohen (which should not be overlooked) was of great service in directing attention to the considerable quantity and evil effects of smoke in our atmosphere, and observations have since been multiplied by the Atmospheric Pollution Committee of the Meteorological Office, Dr. J. S. Owens, Mr. William Thomson, and others whose work is referred to in this report. The appointment of properly trained inspectors whose help and advice would be welcomed by industrial consumers of fuel is advocated, in addition to the establishment in every large works of an organised fuel control as the "only solid foundation on which to build more revolutionary or further-reaching methods of fuel economy."

It is pointed out usefully that soot from the burning of raw coal, ash and dust from the burning of coal or coke, and acid impurities derived from the sulphur contained in coal, coke, and unpurified gas, are all to be taken into account in a consideration of atmospheric pollution resulting from the use of fuel, and it may be emphasised that the liability to pour out large quantities of fine ash into the atmosphere is not to be overlooked in considering the advantages and disadvantages of pulverised fuel. The use of pulverised coal has not been developed in this country to the same extent as in America, and, therefore, although the Board is putting down a small plant in order to make experiments at East Greenwich, it has thought it advisable to secure full information upon the subject through a report made by Mr. Leonard Harvey after a special inquiry conducted in America. Mr. Harvey visited important installations and collected there the experiences and views of the leading consumers of pulverised coal. His report has already been "The advantages of the issued separately. method as an almost perfect means of burning coal must be weighed against the cost of producing and handling coal-dust and the difficulties which may have to be overcome in dealing with its ash."

Another special inquiry has been directed to the subject of peat. This work has been carried out mainly in Ireland, and has undergone vicissitudes, but a beginning seems to have been made, and reference is made to a paper, read before the Royal Dublin Society in March last, in which Prof. Purcell gave an admirable summary of the peat situation, not only in Ireland, but also in other countries. It is interesting to note, as indicating elasticity of method, that this paper will be printed as one of the special reports of the Fuel Research Board, and also that the help of the Department of Scientific and Industrial Research has apparently been accorded for the production of an English translation by Prof. Ryan of Hausding's "Handbook on the Winning and Utilisation of Peat."

As regards fuel alcohol, the position is summarised thus: "It is obvious that until an estimate has been made of the possible resources for the production of alcohol within the Empire, and until their probable amount and the cost of using them have been ascertained, it would be useless to embark upon research on any extended scale into methods of production or utilisation."

The report, under the head "Gas Standards," gives a summary of the steps taken by Sir George Beilby and the Board from the time they were asked to advise on the subject by the Board of Trade, which recognised the complete inapplicability to modern conditions of gas standards as they had existed before the war. Conferences were held with those interested in the matter in different ways, and at a final conference resolutions were put and adopted which were forwarded to the Board of Trade, and constitute a new and much more rational method of regulating gas supply by statute. The central principle is that the consumer shall be charged with the potential thermal units supplied to him in the gas. The permissible percentage of inert constituents is limited by another resolution, although, of course, the temptation to pull "inerts" into the gas is removed now that they have to be distributed at the same cost as combustibles, but have not to be paid for. The gas undertaking can decide on the calorific value of the gas it intends to deliver, a power which should open the way for extensive technical development of the industry, and allow of the realisation of economies which have hitherto

been rendered impossible by useless and out-ofdate restrictions. The refusal of Sir George Beilby and the Fuel Research Board to accept any restrictions in this regard, however pertinaciously and dogmatically they were put forward, unless they could be justified by some adequate reason, has exemplified in a striking way the advantage of referring a matter of this kind to a competent technical authority. The choice of a new standard is a new degree of freedom, but, the choice being made, the gas undertaking is required to adhere very closely to it. Recognition is here given to the valid principle that unsatisfactory performance of a gas-using appliance is far more likely to be due to variations from the standard than to any lowness (or highness) in the standard itself. It is recognised that if the standard is materially altered the burners in consumers' appliances may need alteration, and the gas undertaking has to make the adjustment. "The calorific value of the gas is to be continuously measured and recorded by a recording calorimeter of a standard type to be passed by the London Gas Referees," and by this means it is hoped that the control of gas quality can be made much more effective than it has been hitherto.

Sir George Beilby has had under observation for some time the Simmance recording gas calorimeter with apparently satisfactory results, but the strain will come when legal penalties are dependent upon the accuracy (or inaccuracy) of this or any other form of recording gas calorimeter. Presumably, however, the possibilities of error will receive full investigation, and the successful working of so promising a scheme for the regulation of public gas supply will not be endangered by the imposition of any rigid system of testing which is not one of fully proved trustworthiness.

Use of Sumner Lines in Navigation.¹

By CAPT. T. H. TIZARD, C.B., F.R.S.

'HE Sumner line as a means of aiding in the navigation of ships has been in use for certainly seventy years, and is one of the best methods of obtaining the position of a ship at sea, for by its means both latitude and longitude can be obtained simultaneously without difficulty, and it has certain other advantages. In obtaining both latitude and longitude simultaneously, observations of more than one heavenly body are required, and the Greenwich time must be known accurately, as well as the approximate latitude. The altitudes of two or more heavenly bodies can be observed at twilight, both morning and evening, when the weather is clear, the horizon distinctly visible, and the stars are yet to be seen before the sky is lit up by the sun. It is possible, too, even without using the Sumner line, to observe in daylight meridian altitudes of Venus

¹ "The Sumner Line or Line of Position as an Aid to Navigation." By G. C. Comstock. Pp. vi+70. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1930.) Price 6s. net.

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or Jupiter if they cross the meridian at least two and a half hours before or after noon, and occasionally both sun and moon are available during the day. In northern latitudes the pole star is always available in clear weather, at twilight, for observations for latitude, and one or two other stars for longitude, but if neither the pole star nor a heavenly object near, or on, the meridian is available for obtaining the latitude, Sumner's method affords a means of doing so.

Sumner's method briefly is as follows: If a straight line be drawn from the centre of the earth to any heavenly body, at the spot where this line cuts the circumference of the earth, the altitude of that heavenly body will be 90°, which spot is named by Mr. Comstock the sub-polar point; a more appropriate name would be the zenith point—that is, the point on the earth's surface where the heavenly object observed would be in the zenith; and if circles be drawn on the earth's surface round this spot, with it