carbide, WC, or the tungstide, Fe_2W, or in both forms according to the percentage of tungsten and carbon. In the normal state the tungsten carbide and iron carbide exist as a double carbide, $4Fe_3C.WC$, which has its critical point at 400° C. as compared with 725° C. for pure iron carbide. Above the Ac_1 point this double carbide dissociates into its components, but if the maximum temperature is not very high these recombine during cooling, and are deposited from solid solution at 400° C., forming a eutectoid with the ferrite. Above 1100° C. the following reaction occurs,

$$WC + 5Fe = Fe_3C + Fe_2W,$$

and during cooling the lowering of the transformation points occurs in consequence of the dissolved tungstide in austenite. The greater the carbon concentration in the system, however, the less does the above reaction proceed.

The lowering of the Ar_1 transformation due to heating increases with maximum temperature, and this depends on the tungsten, but not on the carbon content. Above 9 per cent. of tungsten, however, corresponding with the maximum solubility of this metal in iron, the lowered Ar_1 point is constant at about 440° C. If, now, a specimen which has a lowered Ar_1 point be reheated just beyond the Ac_1 point (about 900° C.), and then cooled, the transformation takes place at the normal point. This is due to the fact that tungsten carbide is formed in the Ac_1 range according to the reaction,

$$Fe_3C + Fe_2W = WC + 5Fe,$$

and during cooling the recombination of the tungsten carbide with the remaining iron carbide occurs. The authors are to be congratulated on their careful magnetic and metallographic analyses, which have enabled them to present a clear and very plausible conception of the chemical, structural, and phase changes which occur in tungsten steels both on heating and cooling.

H. C. H. C.

FUEL ECONOMY.

THE economical use of coal has been referred to frequently in these columns, but with all the various proposals for its more efficient application for power production the possibilities of effecting marked economies with existing boiler-plants have not been fully appreciated. In the columns of *Engineering* (July 12 and 19) Mr. D. Brownlie gives data of the examination of 250 boiler-plants, comprising 1000 boilers and using annually more than two million tons of coal. Seventy-six per cent. of the plants were hand-fired, the average net efficiency being 57·8 per cent.; the remainder, mechanically fired, show an efficiency of only 61·4 per cent. Only 9·6 per cent. of the plants show a higher efficiency than 70 per cent. Certainly these figures indicate very bad practice, for a net working efficiency of 75 per cent. may well be aimed at. Reorganisation of the plants examined to reach this figure would alone entail a saving of 430,000 tons of coal annually; throughout the country it would possibly lead to a saving of 15,000,000 to 20,000,000 tons. As Mr. Brownlie points out, "the question of the economical generation of steam will always be a very important part of the greater national scheme of coal economy, even if all the power of the country is generated by gas-engines and the by-products of the distillation of coal." As a large part of the power will undoubtedly be steam-generated in existing plants for many years to come, the improvement of the efficiency of these plants is urgently called for during the period which must elapse before the general reorganisation of the whole system of power production can be carried out.

Further evidence on fuel economy is contained in Bulletin No. 31, Circular 7, of the University of Illinois Engineering Experiment Station. This bulletin deals with the operation of hand-fired power plants, and the matter is presented in a manner readily understood by those who are not experienced engineers. About 6,000,000 tons of coal are consumed annually in Illinois in operating hand-fired power plants, and it is believed to be within the limits of practical attainment to effect a saving of from 12 to 15 per cent. of this fuel. Descriptions and drawings are given of simple appliances and the methods of using them explained, whereby the men who fire the coal may obtain precise information regarding the best working conditions for given steam consumptions. With proper attention these appliances enable the correct working conditions to be reproduced at any time, and also give evidence which leads to the detection of defects in the plant which would not otherwise be suspected. The section dealing with the storage of coal is of interest, and contains a very suggestive statement:—"Do not undertake to store coal until you are sure you know how to do it properly and safely." The circular has been compiled by a committee of the University authorities, aided by an advisory committee including several well-known names, and can be commended to the notice of all who desire to introduce scientific control in their boiler plants.

SALARIES IN SECONDARY AND TECHNICAL SCHOOLS, ETC.[1]

THE chief duty of this Committee, as defined in the terms of reference, was "to inquire into the principles which should determine the fixing of salaries for teachers in secondary and technical schools, schools of art, training colleges, and other institutions for higher education (other than university institutions)." They were specifically asked not "to consider the question of the amounts by which existing salaries should be improved."

Progress in the higher education of the nation depends, in the first instance, upon attracting and retaining, by means of adequate salaries and suitable salary scales, the services of the most capable and highly qualified teachers. The present rates of payment fail to secure this. The report states (p. 52) that the average salary of 3350 full-time assistant masters in 40 grant-aided boys' secondary schools in England and Wales on January 31, 1917, was only 187*l.* per annum. The average salary of 4294 assistant mistresses in similar schools was 130*l.* per annum. Out of 1050 secondary schools in England and Wales receiving grants from the Board of Education, in only 460 of these schools were salaries regulated by definite scales in January, 1917. Salary scales were, in general, only short scales covering a period of five or six years, the average maximum for graduates (men) being only 196*l.* 7*s.* The information in the report respecting salaries in technical schools, polytechnics, etc., is much less detailed and precise (p. 41). It would appear, however, that on March 31, 1914, the average salary of heads of departments and assistant teachers in these institutions was about 180*l.* per annum.

In view of the inadequate salaries just mentioned, especially with the higher cost of living, increased taxation, and the more generous remuneration now offered by commerce, industry, and the State services, it is no wonder, even allowing for certain recent improvements, notably in London, that the Committee

[1] Report of the Departmental Committee on Salaries in Secondary Schools, Technical Schools, etc. (Cd. 9140.) (H.M. Stationery Office.) Price 6*d.* net.