Spontaneous Combustion in Coal Mines.

THE final report of the Departmental Committee appointed by Mr. McKenna in 1912 "to inquire into the circumstances in which spontaneous combustion of coal occurs in mines, its causes and the means of preventing it or of dealing with it," has now been issued.[1]

In form it is a model of what such a report should be; it opens with an historical review of the subject from the seventeenth century, it proceeds to summarise and analyse the scientific evidence collected during the last ten years, and then considers the conditions which are found in practice to be conducive to spontaneous ignition in coal-mines and the means of preventing or extinguishing such fires.

The question whether coal can ignite *per se*, or whether this is effected through the heating of an impurity, *e.g.* iron pyrites, has long been in dispute, the older opinion, both among practical men and chemists, inclining strongly to the view that the oxidation of pyrites is the primary cause of the ignition.

In an interesting quotation from Dr. Plott's "Natural History of Staffordshire" (1686) we learn that the shale and small coal left in the hollows of old workings will fire "natural of themselves," and "have done beyond all memory." The seat of the heating is said to be a mixture of the "laming," that lies between the measures of the coal, and the "sleck" when "very much mixed with brass lumps." Plott evidently leans to the pyrites theory, and quotes Dud Dudley and Dr. Powers as vouching for the statement that small coal and sulphurous sleck when moistened and exposed to the air will turn red-hot of themselves. The experience of mining engineers, who found as a fact that fires mainly occurred in seams rich in pyrites (as in South Staffordshire) and were absent in coalfields (such as the Durham field) where the pyrites is very low—backed as this experience was by the authority of chemists from Berzelius to Liebig—led to the almost universal belief in pyrites being the sole cause of ignition. Dr. Percy in 1864 seems to have been the first to suggest that coal could itself absorb oxygen and become heated, and this view received much support from the experiments of Dr. Richters, of Waldenburg, who showed that fine coal with very little pyrites in it would absorb oxygen and heat up, while the pyrites itself showed very small absorption. The Royal Commission appointed in 1876 to inquire into the spontaneous combustion of coal in ships regarded pyrites as the primary cause, but found that the condensation of oxygen on the surface and the subsequent oxidation of the coal matter were "contributory" causes.

Since that date experiments in France, mainly those of Henri Fayol, and in Germany on the seams of Upper Silesia (where fires are frequent), have shown that the condensation and absorption of oxygen from moist air by coal itself—especially when the coal is in a thick layer—are the important factors in spontaneous combustion, while the oxidation of pyrites (marcasite) is a less important factor. Up to the end of the last century we may say that the pyrites theory had the larger following; but since the report of the German Commission in 1910 scientific opinion has changed, and the opinion of practical men has been doubtful.

The verdict of the Committee—a body of men practically familiar with coal-mining—that they are satisfied on the scientific evidence brought before them that coal subject to spontaneous firing owes this property, not to its pyrites content, but to the direct oxidation of the coal matter, should set at rest all reasonable doubt and concentrate attention on the real cause. That some heat may be generated by the oxidation of marcasite is admitted, but its direct effect is negligible. Where pyrites may play a part is in the disintegration of coal whereby the latter may become more permeable by air, and so more readily oxidised.

In arriving at their conclusions the Committee was largely influenced by the experimental work of Prof. Bedson, Sir R. Threlfall, Dr. Wheeler, and Dr. Haldane, who were in close agreement; and where there still appeared to be some doubt, *e.g.* in the case of the Bullhurst seam (North Staffordshire) and in that of the Barnsley seam (Yorkshire), the Committee requested Dr. Wheeler to carry out special experiments for them. These experiments are quoted in full and appear conclusive. The Committee directs attention to Dr. Wheeler's statement that the higher the oxygen content of a coal the lower is its temperature of self-ignition, and emphasise the practical importance of the fact that a coal containing more than 10 per cent. of oxygen is liable to inflammation—or, at all events, is suspect—whereas a coal containing less than 6 per cent. may be regarded as non-suspect.

It is interesting to note that the work of the palæobotanists is not neglected, and that the "fusain" of Dr. Marie Stopes—the mother-of-coal—(shown by her to be woody fibre) forms at its juncture with "vitrain"—glance coal—the critical point of any piece of coal with regard to inflammation—a conclusion which recalls Dr. Plott's statements as to the mixture of "laming" with "sleck."

The remaining sections of the report deal with the practical aspects of the subject, and give many technical suggestions for preventing and dealing with gob-fires. One of the most important points discussed is the practicability of hydraulic stowage—a certain cure if it could be worked.

[1] Departmental Committee on Spontaneous Combustion of Coal in Mines. Final Report of the Departmental Committee on Spontaneous Combustion of Coal in Mines. (Cmd. 1417). (London: H.M. Stationery Office.) 1*s.* 6*d.*

Lighting of Factories and Workshops.

IN 1913 a Departmental Committee was appointed by the Home Secretary to inquire into the lighting of factories and workshops. The Committee issued in 1915 an interim report containing much valuable information which attracted much attention and still holds a unique position amongst official literature on this subject. On that occasion statutory provisions requiring adequate and suitable lighting in every part of a factory and workshop were recommended. Values of illumination were also prescribed in the interests of safety and convenience, but detailed recommendations on the order of illumination necessary for various industrial processes were deferred.

The work of the Committee, suspended during the later stages of the war, was resumed in 1920, and a second report defining with greater precision the phrase "suitable lighting" has recently been issued (Cmd. 1418, 1*d.* net). The report deals specially with the three factors of glare, shadow, and constancy.

Glare may arise through the presence of unduly bright lights in the direct field of vision or on the edge thereof, or through inconvenient direct reflection of light from shiny or polished material. Four requirements bearing on the above points are now suggested :—

(1) Every light source (except one of low brightness[1]) within a distance of 100 ft. from any person employed shall be so shaded from such person that no part of the filament, mantle, or flame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20°, or in the case of any person employed at a distance of 6 ft. or less from the source not less than 30°.

(2) . . . "Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct reflection of the light from a smooth or polished surface into the eyes of the worker."

(3) . . . "Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."

(4) . . . "No light sources which flicker or undergo abrupt changes in candle-power in such manner as to interfere with the safety or efficiency of any person employed shall be used for the illumination of a factory or workshop."

In view of the fact that extensive alterations may be occasioned by compliance with these requirements, it is further prescribed :—

(5) "That, as regards existing installations, a reasonable time limit should be given before the above requirements become operative."

An appendix to the report contains extracts from codes adopted in various American States and recommendations made by the Illuminating Engineering Society in Germany.

[1] *I.e.* with an intrinsic brilliance not exceeding 5 candles per sq. in.

The World's Wheat Supply.

THE statistics dealing with the wheat supply of the world are discussed by Sir James Wilson in an interesting and exhaustive paper entitled "The World's Wheat," contributed to the Journal of the Royal Statistical Society (vol. 84, part 3, May, 1921).

Having pointed out the varying accuracy of available statistics and explained the system of calculation adopted, the author gives the pre-war five-year average yields for all wheat countries, together with the exports and imports. For this period the world's yield was 107 million metric tons, of which 22·2 million metric tons—more than one-fifth of the whole—were produced by Russia. The net world exports amounted to 18·5 million metric tons, of which Russia again contributed the largest proportion, nearly one-fourth of the whole; while of the net imports of 18·0 million metric tons Great Britain was the largest importer with 5·9 million metric tons, followed by Germany with 1·9 million metric tons. Naturally, these figures were all profoundly affected by war conditions. Statistics are not available for such important countries as Germany, Austria, and Belgium among the importers, nor for Russia, Rumania, Hungary, and Bulgaria among the exporters, but for the twenty-one countries where figures have been published the average yield was 66·8 million metric tons during the war, compared with 63·1 million metric tons before the war. The importing countries on the average produced less than before the war, but they also imported less. Britain increased her average yield from 1·6 to 1·9 million metric tons and reduced her average net import from 5·9 to 5·2 million metric tons and her average consumption from 7·5 to 7·1 million metric tons. The exporting countries—United States, Canada, and Argentina—all increased their yields considerably, and also their exports. Australia increased her yield, but her average export was much the same as the pre-war average, probably on account of the large loss of stored wheat by mice and weevil depredations. India's average yield during the war was practically the same as the pre-war average, but owing to the export restrictions enforced by the Government in the interests of the consumers her average net export fell from 13·5 million metric tons before the war to 8·2 million metric tons during the war period.

With regard to the supplies of 1919 and 1920, excluding Russia and Rumania (which in the pre-war average exported nearly one-third of the world's net exports) and India (export from which country was practically prohibited), the other exporting countries began the cereal year on August 1, 1919, with about 6·1 million metric tons of exportable supplies still in hand, while there was also a large quantity on its way to the importing countries. All the importing countries together in 1919–20 imported 18·2 million metric tons, which is about the pre-war average, and during that year the Argentine and Australia got rid of their embarrassing surplus, while towards the end of the year the United States had practically a monopoly of export, and so obtained very high prices. Sir James Wilson estimates that for the current year ending July 31, 1921, there will be 18·9 million metric tons available to meet the estimated demand of 17·0 million metric tons, which will leave a sufficient, though not excessive, margin on the eve of the ripening of the new harvests in the northern hemisphere.

It is to the temporary advantage of consumers that there should be an excess of supply over demand, and to the temporary advantage of producers that the demand should exceed the supply; but for the world as a whole it is better that supply and demand should approximate. In the author's opinion, from the information available at the time, this condition should be reached as regards wheat on August 1, 1921, and according to present prospects (excluding Russia, Rumania, and India) the harvest to be reaped after that date will yield sufficient to meet the world's probable demands. For the more distant future fears are sometimes expressed that the growth of the world's population, and especially of the number of wheat-eaters, will result in a permanent dearth of wheat, but it must be remembered that the great majority of mankind prefer grains other than wheat, and even the wheat-eaters substitute other grains without much sense of hardship.

With regard to wheat prices, in most European countries at the present day the high prices of wheat are largely due to the depreciation of the various paper currencies. The author discusses the different factors which will affect the wheat prices—rates of exchange, freight charges, etc.—and concludes that, so far as Britain is concerned, the price of wheat will be lowered if "the rate of exchange with the United States of America improves, and if Asia and South America continue to absorb gold at a great rate, and so help to reduce the prices of all commodities, measured in gold, all the world over."