SOME ACHIEVEMENTS OF INDUSTRIAL LEGISLATION AND HYGIENE.*

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INDUSTRIAL hygiene is a comparatively recent branch of medicine. Although Ramazzini published his treatise on *Occupation Diseases* in 1700, it was the utilization of steam as a motive power which stimulated the growth of modern industry. The manufacture of pottery, also of bricks for building purposes, is one of the oldest trades. Coal mining, on the other hand, is one of the most important industries, as it is one of the most dangerous.

Coal Mining.

The Romans during their occupation of Great Britain made use of the coal obtained from "drifts" in the city and neighbourhood of Newcastle-upon-Tyne. There was no deep mining for coal in those days. It was in the early part of the thirteenth century that permission was granted by Henry II to dig for coal in the North of England. During the early part of last century coal mining in Great Britain was a procedure attended by great hardships; physical and social, upon those who followed the vocation. A hundred years ago the hours of work were long—twelve to thirteen a day; boy labour was exploited and female labour underground was utilized; there was only one shaft leading into the mine, which served both for men and material, and as a consequence not only was there no "through ventilation" of coal mines, but in the event of the single shaft becoming blocked there was no escape for the men underground or means of their comrades above ground reaching them. It was the occurrence of such an accident at a pit a few miles from Newcastle, and known as the Hartley Colliery disaster, sixty years ago or thereabouts, which led to the compulsory provision of two shafts into a mine, and which led to the "through ventilation" in use to-day.

Two months ago I was called professionally to see a retired coal miner, 72 years of age, who told me that he began work in the mine at the age of 9 years; that he worked from 4 a.m. till 5 p.m., and for this thirteen hours' work a day he received 10d. He had to be awakened at 3 a.m., left the house at 3.30 a.m., and had to walk more than a mile to the mine, where at the pit head he was obliged to be ready to descend at 4 o'clock in the morning. He often slept while he walked to and from his work, and, like the boys younger than himself employed in the mine, he frequently fell asleep at his work, and was ill treated for this by the foreman. In the winter months collier boys never saw daylight except on Sunday.

It is impossible to say what the number of fatal accidents was three-quarters of a century ago, for statistics at that period were not kept, but the death roll was heavy. Before 1814 it was not the custom for inquests to be held on colliers who met their death by an accident in the mine. As showing the death rate from mine accidents during the latter half of last century, the following data supplied to me by Professor Louis of the Mining Department, Armstrong College, are of interest. Taking quinquennial periods, the death rates from mining accidents per 1,000 men employed underground in Great Britain were—

1851-55	5.149	1876-80	2.709
1856-60	4.628	1881-85	2.312
1861-65	3.791	1886-90	2.042
1866-70	3.995	1891-95	1.704
1871-75	2.736	1896-99	1.479

If we take two later decennial periods for comparison, we find that the average annual deaths from accidents in British mines due to all causes were, from 1873 to 1882, per 1,000 men employed, 2.5, and from 1911 to 1920 1.3. With the exception of the United States of America the statistics of other countries also show a decline in the accident fatality rates. In Germany the rate, which was 3.18 per 1,000 men employed in 1879, had fallen to 2.40 in 1914; in the United States the fatal accident rate had risen from 3.5 per 1,000 in 1890 to 3.62 in 1920, while during 1920 the rate for Belgium was 1.13, for France 0.77, for Great Britain 0.88, and for Germany 2.40. Coal mining in the United States is a comparatively modern industry; the men

have not been so long trained as those in the older countries. In addition many foreigners are employed, and, as a consequence of difficulties incidental to language, orders given by officials may not be readily understood. The men, too, in order to make high wages, work harder than in most countries. If the accident rate is measured by the number of men killed for every million tons of coal raised, the figures for the United States compare most favourably with those of other countries.

Speaking generally for all countries, but especially for my own, the figures show that improvement has taken place in the reduction of fatal accidents in coal mining, largely consequent upon freer ventilation, daily inspection of the mine for gas before the men descend, greater use of safety lamps, substitution of the higher explosives for ordinary black gunpowder, also the employment of skilled men to place *in situ* the cartridges and fire them.

Although one of the most dangerous of occupations, coal mining in Great Britain remained free from protective legislation until 1842, when, owing to the serious condition of affairs revealed by a Royal Commission, women and girls were excluded from working underground. It was not, however, until thirteen years afterwards that measures were introduced to protect the health, life, and limbs of the workers. For the saving of life in coal mines we are indebted to the attention given to the subject by men engaged in chemical and physical research. The employment of the "safety lamp" recommended by Sir Humphry Davy has prevented many explosions, just as the daily inspection by trained men of the areas at the working face of the mine before commencing to hew coal has been the means of saving many a miner from becoming "gassed." One other important circumstance has added considerably to the safety of the miner's vocation. Three-quarters of a century ago the dangers of explosive gases in coal mines had been recognized, but it was not until a few more decades had passed that Professor Galloway and Mr. H. Hall showed that as widespread explosions frequently followed the firing of cartridges in mines, some of these explosions were due to the dry coal dust which was raised into the atmosphere catching fire, and travelling with explosive rapidity through the underground passages. Men were thus killed partly by gas, partly by burns, and in other instances, where death was not immediate, by pneumonia. Coal mining on a large scale in France, Belgium, and Germany is of recent date compared with that of Great Britain. It was not, for example, until 1766 that coal mining in Westphalia became a prominent industry. Other coal-producing countries have profited by the experience, the mistakes, and the failures of British mining methods.

As an illustration of how hygienic measures introduced to protect the workers in one direction may inadvertently lead to disaster in another, I cannot do better than reproduce the experience of the German mining authorities in the Ruhr a few years ago. Before the war several of the coal mines in Central and Western Europe had become infected by ankylostomiasis. I visited the Belgian, German, and Hungarian coalfields, and I descended into the Lothringen mine near Bochum. I was much impressed by the excellent organization, the sanitary measures which had been carefully prepared by Dr. Tenholt, and the adequate hospital provision made by the mine authorities for combating the disease in Westphalia. Although the parasite had gained entrance into the tin mines of Cornwall, British coal mines, fortunately, remained free. Ankylostoma ova and larvae require heat and a considerable amount of moisture for their development. A few years previous to my visit to Westphalia there had occurred explosions in the German coal mines for which high temperatures and the dry coal dust were partly believed to be responsible. With the view of reducing such risks it was decided to introduce water spraying into the mines. This, however, only caused fresh trouble, for the mines became infected by the ankylostoma parasite, which it was believed had been brought thither by Polish and Italian workmen, also probably by some of their own miners, who, during the summer months, had worked in the brickfields around Cologne and elsewhere. At any rate, in 1900 water spraying of mines became general and the result was as follows: Cases of ankylostomiasis numbered 107 in 1896, 113 in 1897, 99 in 1898, 275 in 1899, 1,030 in 1901, and 1,355 in 1902. The rapid and great increase in the number of cases of ankylostomiasis after water spraying can hardly be regarded as a coincidence.

As a class, coal miners suffer less from pulmonary tuberculosis than most men employed in dusty occupations, but, as Professor Collis remarks, "low as their phthisis mortality is, the experience for coal miners displays certain statistical characteristics which are distinctive of dust phthisis," and these are "(1) an unusually late age of maximum incidence, and (2) an association with high mortalities from other respiratory diseases." Miners who are working at the coal face suffer from phthisis rather more than other miners below ground and

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workers above ground. Phthisis in coal miners commences to express itself at and after 35 years of age :

Periods.	Age periods :			
	35.	45.	55.	65 and over.
1890-92 ...	1.45	2.07	2.23	2.03
1900-02 ...	1.03	1.52	2.04	1.47
1910-12 ...	1.02	1.31	1.43	1.02

This shows the improvement which has taken place in the mortality rate of coal miners from phthisis.

Manufacture of Lucifer Matches.

There must be many in this audience who, like myself, twenty to thirty years ago, were witnesses of the ill health experienced by men and women who worked in match factories wherein white phosphorus was used. The men who dipped the matches in the phosphorus paste, and the women who filled the boxes, frequently suffered from necrosis of the jaw bones or died from septic meningitis or bronchopneumonia. In other instances where the poisoning was less severe the workers suffered from gastric trouble, anaemia, and albuminuria, or from a tendency of the long bones to become fractured owing to peculiar fragility of the bones. So great were the sufferings of the persons affected that it became imperative that some united action should be taken by various countries to produce matches which would strike anywhere without, in their manufacture, the workers incurring risk to their health. As far back as 1879 Switzerland introduced a bill to prohibit the use of white phosphorus. In 1899 the British Government invited Sir Edward Thorpe, Dr. Cunningham, and myself to visit match works at home and abroad with the view of ascertaining how the workers might be protected against the risks they were exposed to. Like many of our Continental confreres, we were of the opinion that the time had come when a harmless substitute should be found for the dangerous white phosphorus. It was Lorinzer of Vienna who, in 1845, first drew attention to necrosis of the jaw bones as an occupational disease, but in every country in which lucifer matches had been made from white phosphorus there had occurred cases of "phossy jaw." Chemists vied with each other to find a safe substitute for the dangerous metalloid. To French scientists fell the honour of showing how, by employing phosphorus sesquisulphide, lucifer matches could be made without risk to the health of the workers. After a congress of the various Governments, held in Berne in 1906, the match-producing countries of Western Europe decided to manufacture lucifer matches by the safe method, and so successful has been the result that the occupation is now free from the risks of three decades ago. Phosphorus necrosis has disappeared.

Manufacture of Mirrors.

Chemical research has also proved helpful in other trades. It is not so long ago since quicksilver was used in the manufacture of mirrors. Many of the men then employed suffered from mercurial poisoning. Apart from the unhealthy conditions set up in the mouth, through vaporization of quicksilver, the workers became the victims of muscular tremor and occasionally of paralysis. Since making use of silver nitrate preparations the men have had good health, and the industry is now regarded as a healthy one.

Arsenical Pigments.

Just over twenty years ago I was a member of the Dangerous Trades Committee of the Home Office to which was given the task of investigating several trades which were regarded as inimical to health. One of these was the manufacture and use of wallpapers which contained arsenic, also the manufacture, mixing, and use of "emerald green." It had been found that illness hitherto unrecognized was the result of sleeping in bedrooms the walls of which had been covered by paper containing arsenical pigment. Men employed in the grinding and mixing of such colours suffered from ulcers on their hands and fingers and upon the genitalia. In other instances a painful neuritis was established, which occasionally ended in paralysis. In the United States, in Holland, and other countries, the subject had also received attention. In Massachusetts, for example, a law had been passed in 1900 limiting the amount of arsenic in wallpaper to the extent of 0.1 grain per square yard; but at the time of the British inquiry alluded to we found manufacturers had been placing several grains in a square foot of wallpaper. The use of arsenical pigments in wallpaper

in Great Britain was subsequently prohibited, their place being taken by aniline and other safe colours. To the fortunate results which have followed in all the trades wherein arsenical compounds are used, stringent regulations, improved ventilation, and the employment of means for the removal of dust have contributed.

Carbon Bisulphide.

Thirty years ago in the manufacture of india-rubber goods in Great Britain there was much serious illness among the men and women employed in the factories. The illness was traced to the use of carbon bisulphide as a solvent for sulphur monochloride in the vulcanization of rubber. The vapour of bisulphide when inhaled causes intoxication not unlike that which follows the drinking to excess of alcoholic liquors. In the milder forms there are headache, vomiting, and a staggering gait; in the more pronounced form the symptoms, while primarily of the nature of aggravated hysteria, occasionally become those met with in acute mania; in other instances, again, there are indications of peripheral neuritis followed by paralysis of the limbs. Since new methods of vulcanizing rubber by means of the incorporation of flowers of sulphur in a closed chamber under the influence of heat have been introduced, the trade has become healthier, and there are no longer the distressing and crippling forms of illness which attacked the workers less than half a century ago.

Lead and its Compounds.

If there is one metal more than others which, since the rise of the modern industries, has exacted in all manufacturing countries a high toll of human life, it is lead and its compounds. One thing characteristic of industrial lead poisoning is the insidious manner in which it may develop; ill health may gradually steal over the workers, while, on the other hand, symptoms rapidly show themselves—as, for example, by the sudden onset of acute abdominal pain, or there occurs loss of power in one or both hands between night and morning. As lead and its compounds are used in over 130 industries, this circumstance renders lead one of the most important metals from an industrial point of view, just as, regarded medically, it is one of the most interesting. In Great Britain and in Western Europe lead is present in ore as galena or sulphide, and as this is rather insoluble in weak acid solutions, miners who blast the ore and are exposed to dust do not suffer from plumbism but from a dust disease of the lung called silicosis. In the Broken Hill mines of Australia lead was present a generation ago in the form of cerussite or carbonate; this, when inhaled as fine dust, is readily soluble, and becomes, not only a source of plumbism, but of the severer type of the malady known as saturnine encephalopathy. It was a fortunate circumstance for the owners of the Broken Hill mines that after the cerussite layer had been worked out the subjacent ore was found to be galena, for the mining of this was followed by a marked declension in the number of cases of lead poisoning. A strange circumstance, however, has arisen at Broken Hill: recently there has been a recrudescence of lead poisoning; this was found to be due to the lead ore in places having become changed into cerussite.

It is hardly likely, owing to fuller knowledge among the workers of the value of personal hygiene and cleanliness, improved ventilation where dusty processes are carried on, periodical medical examination of the workers, and enforced compliance with regulations, that the extremely serious and fatal types of lead poisoning with which some of us were familiar thirty to forty years ago, will ever again be met with to the same extent as formerly. In Newcastle-upon-Tyne, where it was once so frequent, lead poisoning has ceased to be the menace to the health of the workers it was a few years ago, and what is true of Newcastle is equally true of the country generally. In 1900 the number of cases of industrial plumbism reported to the Home Office was 1,058; in 1923 the number was 337. The records for 1924 show a slight increase, and particularly is this the case for the manufacture of pottery, but as many of the men and women who have recently died had worked in the pottery trade for from thirty to forty-seven years it is more than probable that the seeds of their illness were sown before the introduction of the new methods in vogue. The fact remains that there is no comparison, so far as number of cases and severity of the illness are concerned, between industrial lead poisoning to-day and half a century ago.