aged at the top and bottom of the circles, and in the upper left-hand corner. The proportion of calms to winds is shown by the shading of a sector in the central circle (none noted in the square here copied). Number and average of barometer and air-thermometer observations are in the lower left-hand corner, with the average difference between dry and wet bulb thermometers. Temperature and specific gravity of the sea are similarly recorded on the right. The advantage of such record over final averages is at once apparent: it shows not only how well the various observations agree, but also the measure of trust to be placed in the results, as indicated by the number of observations. It is, of course, a little difficult to read at first, but, with a few days' practice, there is no further trouble. The charts for the Cape give less detail than those for the equatorial district, and their diagrams are of a much simpler pattern. Some of the more recent charts will be considered in a second article. W. M. DAVIS.

THE INDUSTRIAL ARTS AS FACTORS IN MODERN HISTORY.[1]

AT the outset the lecturer suggested, as perhaps a more appropriate title for his remarks, 'Coal as a factor in modern history,' or 'Coal as the great reformer and revolutionizer.'

By reviewing past history, it would be noticed that certain great events had taken place, each of which marked a step in the advance of civilization. The connection between these events was not always apparent; but in fact they were interdependent, and formed a logical sequence, in many cases one directly or indirectly causing the next. The ancient Greeks were famed for their literary and aesthetic culture, in which they excelled all other peoples, ancient or modern. Their passionate temperament, however, and system of slavery, left unlaid the material foundations of permanent national prosperity. Again: the genius of the Romans had displayed itself in their military achievements; and, doubtless, Rome would have continued to be the mistress of the world, had it not been for the luxurious and profligate habits into which her people drifted, and through which she fell an easy prey to the barbarians. So monstrous were their excesses, that their punishment was inevitable and overwhelming. The excellence which those nations had attained had, no doubt, benefited succeeding generations.

The secret of true and permanent progress consisted in the application of science to the useful arts; and the development of this fundamental principle of progress had commenced only during more recent years. This was the power that had revolutionized social and political life. No one revolution had effected thorough and permanent changes. By the instrumentality of each, the light of liberty had shone for a brief interval, but the intolerance which was put down by it had been too often succeeded by equal oppression on the part of those who had come into power. Yet each change had brought about a condition whereby the masses of the people had gained a greater or less advantage; and the power which each revolution had taken from the sovereign had been given to the people. These exchanges of power were more apparent in the history of England than of any country on the European continent. There the reign of every king had been despotic until the time of King John, when the Magna Charta was wrested from him, and thus was taken the first step towards the true liberty of the subject. Henry VIII., disregarding all laws, human and divine, had assumed as much despotism of action as was compatible with the then slowly advancing state of civilization. Elizabeth, too, was conspicuous for her assumption of unlimited power. Nor was Cromwell's power less supreme than that of the kings and queens before him. Then followed the court of Charles II., with all its splendor and vice. But soon after, when the house of Hanover flourished, a certain popular power began to undermine the autocracy of royalty. Then the Earl of Chatham, the elder Pitt, albeit with much individual pride and haughtiness, and with no special sympathy with democracy, became champion of the English people, and wielded a power which had never before been held by any subject of the crown. Pitt declared that he represented the people of England, and Wilke's resistance to the royal party again and again caused his election as a member of the House of Commons. The last attempt at despotic power, on the part of the reigning monarch, was the unjust taxation by George III. of England's American colonies. Since that time the power of the subject had been increasing in England, and at this day there was no country in which the rights of the individual were more fully recognized. The conservatism of the English nation had not permitted the dethronement of rank and title. This was, in the opinion of the lecturer, probably the result of inheritance, not choice. He said, moreover, that the distinction of rank held in check the power of money, and refinement and culture were thereby advanced; but, if the present monarch were to attempt to resume the despotism of some of her predecessors, a storm of revolution would sweep away monarch and throne and peers. For this changed and ameliorated condition of affairs, special credit was due to Sir Robert Peel, Cobden, John Bright, and Mr. Gladstone, the present premier. But the full triumph of democratic principles had not yet been fully realized in England, although it was rapidly approaching. It was worthy of note, that each Parliament introduced more liberal measures, and that the power of the House of Commons was fast superseding that of the House of Lords. England is now not only the home of freedom, but an asylum for the oppressed. Her shores are sought as places of refuge by fugitives of all kinds, who here found justice, and, if innocent, safety.

The moral and physical condition, too, of the present generation, is raised; and this age is conspicuous for its religious freedom, luxury, and the achieve-

[1] Abstract of a lecture delivered Saturday, April 19, in the U.S. national museum, Washington, D.C., by Prof. J. S. NEWBERRY of New York. Revised by the author.

ments of scientific investigation. We of this day scarcely realize that many things which are now considered necessaries of life were absolutely unknown a hundred years ago. These changes have been wrought by the action of cause and effect. How interesting was the inquiry into the causes of this peaceful revolution that had been and still was going on! Some historians had ascribed the changes to certain inherent qualities in man, which must develop as time rolls along. Others referred this progressive state to the continued effects of the Reformation, and considered it as the fruit of a purer and broader religious faith. The lecturer admitted that the emancipation of the mind from narrow dogmas had had its elevating influence, but denied that this would entirely account for the present condition of civilization. Since this age of freedom is also an age of scepticism, he contended that the most potent cause of the eminence of England, and of the spread of democracy, was the production of wealth through the industrial arts, — wealth created and controlled by the untitled classes, who thereby acquire self-respect, self-assertion, and political power. All historians had recognized this truth in part, but had stopped short of the conclusions, which, to the speaker's mind, every unprejudiced man must reach. The development of machinery and the useful arts constituted the most distinctive feature in the aspect of our modern life. This had created cities, provided occupation for the people, and was the means which had supplied the majority of our material wants. And the agent of this development was *coal*.

This conclusion might, perhaps, appear to be a *reductio ad absurdum*, but he thought that the truth of the assertion could be demonstrated. Coal supplied us with light, heat, and motive power, without which our condition would be one of darkness and inactivity. The wheels of industry would be stopped, and the characteristic activities of modern life would be arrested. In a pound of coal was stored sufficient force to raise 11,580,000 pounds one foot; and it had been estimated, that, on an average, 1,500,000 foot-pounds were utilized in the combustion of a pound of coal. Supposing this amount to be equal to the force exerted by one man in a day's labor, then three hundred pounds of coal were equal to the force exerted by one man in a whole year: in other words, a ton of coal yielded a force equal to the labor of six men and a boy for a year; and the force exerted by the average amount of coal produced in England in a year would be equivalent to the labor of two hundred millions of men for the same period. A moment's reflection would convince us of the immense effect produced by this force upon our modern civilization. If, out of the amount of coal annually raised from the English mines, 20,000,000 tons represented the net profit, it would be seen that this profit was equivalent to the labor of 133,000,000 people, working ten hours a day for a year. Was it, then, surprising, that, with such a revenue, England should be the richest nation on the globe, or the most prolific? She had planted colonies in those parts of the earth which were richest in agricultural and mineral resources; to wit, the United States, Canada, Australia, New Zealand, Cape of Good Hope, India, Jamaica, etc.: and these are fast becoming great nationalities. This marvellous success had by some been attributed to psychological rather than material causes; but the true cause, the speaker thought, was the development of machinery and the industrial arts consequent upon her abundant supply of coal. In the thirteenth century, when coal was first substituted for wood, and even a century later, its use was regarded as a nuisance, and actually forbidden by royal enactment, on account of the smoke which it evolved. Indeed, history told us that in 1257 Queen Anne, wife of Henry III., left Nottingham on account of the smoke caused by the burning of coal. By the middle of the sixteenth century, however, coal was in general use, and a considerable quantity was exported to France. In 1621 Dudley had devised a method whereby stone coal could be substituted for charcoal in the manufacture of iron. Then came gradually the introduction of steam-engines in place of horse-power, and iron rails instead of wooden ones, for the transportation of coal from the mines. The years 1702, 1776, 1815, and 1820 were conspicuous for improved changes in connection with steam-locomotion; and in the last-named year wrought-iron was substituted for cast-iron in the manufacture of rails. Fifty years ago Robert Stevenson perfected the locomotive, thus making the railroad the great pathway of traffic and travel. The lecturer then cited statistics which showed that the increase in the produce of iron and steel was proportional to the amount of coal produced. These were, he said, not only factors in the progress already noted, but were its proximate causes. It was worthy of note, that in those great English towns, such as Manchester, Liverpool, Leeds, and Newcastle, where coal was most largely used, the voice of the people was most powerful.

The lecturer then reviewed the possibilities for advancement in the United States, with its coal area of two hundred and fifty thousand square miles. He referred to the almost unlimited deposits of iron, copper, lead, and the precious metals, and to the vast wealth to be drawn from the soil by a thorough system of agriculture. Thus he argued that the United States possessed all the qualifications necessary to make it a greater and happier country than the world had ever seen. The great danger arising from these vast resources was the worship of the wealth they were destined to produce. The general accumulation of wealth by a nation was undoubtedly a blessing; but when held by the few, causing the impoverishment of the many, it could only be regarded as a curse. We might, however, hope, that when the evils of wealth-worship exceeded a certain limit, the people would again rise and correct them, as history teaches us they have done in the past. Among the influences which tended to restrict the effect of wealth on legislation, was the introduction of civil-service reform. The contest between labor and capital was far from adjustment; but the problem was under careful consideration, and in some instances had been practically wrought out to the satis-

faction of all immediately concerned, and to the instruction and guidance of others. The remedy for the excessive love of money would be found in the substitution of other and higher objects of ambition. This could not be expected at this stage of our nation's growth, but it would come with greater maturity. This age, he said, was the seed-time, and not the harvest; nor could the full corn appear until after the intermediate stages of the blade and ear.

THE PRESENT SUN-SPOT MAXIMUM.

AT p. 72 of the second volume of this journal, the observations of the solar spots, made during the previous six years by Professor Todd, now of Amherst college, were collated, and the inference drawn that the present maximum of spots had already passed at the middle of the year 1883. The remarkable solar outbursts, occurring at intervals throughout that year, and the continued manifestation of spot-activity during the present year, have led to renewed discussion of this subject abroad, where very different views are held by the leading authorities in solar physics. Dr. Wolf of Zurich inclines to the belief that we have not yet the data for determining accurately the epoch of maximum; much the highest *monthly* maximum having occurred in April, 1882, while the relative number expressing the spot-prevalence for the year 1883 is easily seen to be greater than that for the year previous. Faye thinks the maximum undoubtedly past, and regards the spottedness during 1883 as "just such secondary maxima as 'might well occur in the progress of a periodic phenomenon which passes rapidly and without hesitation from a minimum to the following maximum, but which passes gently by a series of secondary oscillations from the maximum to the following minimum,' as it is well known the solar spots do." Wolf states, that in 1882 there were no days without spots, while there were four such in 1883. Tacchini of Rome concludes, from the spot-observations of 1882 and 1883, that the solar activity has been on the increase during the latter year: "for, although the difference in the number of spots is very small, the number of groups in 1883 has been very much greater, and the extent of the spots has been truly extraordinary: it has been double that of 1882."

Dr. Spoerer of Potsdam calls attention to a question regarding the numbers, and positions on the solar surface, of the spots observed during the past thirty years. While it has long been recognized that the spots are most numerous, not at the solar equator, but in zones of solar latitude about 15° to 20°, Spoerer's discussion emphasizes the fact, "that, from the time of one minimum until the next, the region of greatest spot-frequency gradually drifts downward from the zone 30° to 25°, to the immediate neighborhood of the equator, and that about the time of maximum its seat lies about 17° or 18°. As the next minimum period is approached, spots more than 15° from the equator gradually become rarer than spots of 35° latitude and upwards were at the time of maximum. But directly the time of minimum is past, spots begin to appear again in those higher latitudes where but very few, perhaps not a single one, had been seen for several years." As justly remarked by the editor of the *Observatory*, this law of sudden transfer of spot-activity from one zone to another is one of the most striking revelations of solar research, and must be accounted for by that theory of spot-periodicity which would be accepted as satisfactory.

Regarding the determination of the present spot-maximum, the same writer observes, that the chief difficulty lies in a variety of opinion regarding what class of data is to be accepted as affording the true index of the state of solar activity. The unusual magnetic perturbations have occurred in coincidence with "the appearance or rapid development of some single spot or group of spots of abnormal extent," and not at the same time with the existence of great numbers of small spots. It would appear, thus, most likely that the total spot-area, rather than spot-numbers, should be taken as the true index.

GUYOT'S VIEW OF CREATION.

Creation; or the biblical cosmogony in the light of modern science. By ARNOLD GUYOT, LL.D. New York, *Scribner's Sons*, 1884. 16+139 p., 9 pl. 16°.

THE great eminence of Professor Guyot in several departments of science is a guaranty that what he writes is worthy of attention. The singular simplicity and clearness of his style make what he writes interesting. But, more than all, the earnestness, the truth-loving sincerity, and deep devoutness of the man, in all he wrote, or said, or did, take captive the reader, or hearer, or companion, and bear him along by the force of sympathy. There has been no teacher in this country who has inspired his classes with deeper personal love, or profounder reverence. To us who knew him well, his very presence was a benediction. It is hardly necessary to say, therefore, how deeply and sincerely we sympathize with the devout spirit which pervades this his latest book, and the noble aim of the author in publishing it. Surely, if we must have reconciliations of this kind between the geological record and the Mosaic cosmogony, this one is the noblest and the most rational which we have yet seen. If any one's declining faith still requires such *tonic*, we most cordially recommend this one; but it has long seemed to us that a *complete change of air* is the better, indeed the only, remedy. We believe that the time is rapidly approaching, if it has not already come, when the whole subject must be looked upon from a different and higher point of view. We have ourselves, in earlier years,