hood opened up an altogether new horizon. Of the theoretical investigations of which it has been the starting point I will speak presently. On the practical side it was at once utilized in the construction of the so-called magneto-electric machines, by which a continuous electric current was generated by the rotation of a suitably arranged electro-magnet in the neighbourhood of a permanent magnet. On a small scale these applications, though interesting, were not of any great use, even to the pure physicist, but of late years they have received an enormous development. Great improvement have been made by Gramme and Siemens in the construction and disposition of the revolving electro-magnet, resulting—among other things—in the improved steadiness and uniformity of the current; whilst the happy idea, conceived independently by Wheatstone and Siemens, of replacing the fixed permanent magnets by electro-magnets, excited by means of the current furnished by the machine itself, has vastly increased the power. The dynamo-electric machine, as it is called, when driven by a steam or gas engine is by far the most economical and convenient source of powerful electric currents, and has effectually superseded the troublesome and expensive voltaic battery for all purposes where such currents are required—as for instance in electro-metallurgy and electric-lighting. There is a prospect of usefulness for it, too, in another direction—in the electric transmission of power. When we have a source of power which we wish to utilize at a distance it may sometimes be worth while to make the source generate in the first instance, by means of a dynamo, a current which is conveyed by wires to the spot where the power is wanted and there made to drive an electro-motor. Of couse there is an inevitable loss of power in the process, but where the original source would otherwise run to waste this consideration loses some of its force. In other cases, too, the facility with which the electric connections can be made, as contrasted with the cumbrous arrangements necessary for the transmission of motion by ordinary mechanism, may cause the preference to be given to the electrical method. I cannot do more than refer to such matters as electric railways and telpherage, for the full development of which we may have long to wait. It would be unreasonable to expect that electrical machinery should, any more than the steam-engine or the locomotive, leap to maturity in a year or two. There is, however, one beautiful instance of the electric transmission of power which cannot be passed over, viz., where the "power" is that of aerial vibrations. Ten years ago the spectacle of a man gravely talking to a box on the wall would have been viewed with amazement. The admiration of the spectator, even though a competent physicist, would not have been diminished on learning the simplicity of the means by which, in Bell's original arrangement, the conversion of the energy of sound waves into that of electric currents, and the subsequent reconversion, were effected. The scientific principles on which the telephone is based, viz., the discoveries of Ampère and Faraday to which I have referred, and the analysis of musical quality by Helmholtz, had indeed long been known. Any physicist to whom the plan of Bell's apparatus might have been submitted would certainly have granted that the "receiver" would give out vibrations which would be almost an exact copy, as to pitch and quality, of those communicated to the "transmitter" at the other end. But if the thing had not actually been tried, he would almost as certainly have added that the vibrations so given out would be far too feeble to be heard. In fact, the extraordinary minuteness, from a mechanical point of view, of the stimuli which are capable of exciting the nerves of hearing has only lately come to be appreciated. Lord Rayleigh has shown that in a particular case a sound was audible when the amplitude of the air-vibrations in the neighbourhood of the ear was less than the ten-millionth of a centimetre (one twenty-five-millionth of an inch). From this we can calculate that the amount of energy represented by the combustion of an ounce of coal would, if properly applied, be sufficient to maintain a perfectly audible sound in a telephone for a million years. With Faraday the list of capital discoveries in electro-magnetism practically closes. Of the splendour of the material results which have already flowed from these investigations there can be no question, nor is there any prospect of the stream being soon exhausted. But I will not dwell further on this side of the subject, which runs, indeed, no risk of being overlooked. Rather would I turn to another aspect of the matter, and point out that these material results, great as they are, are based upon the researches of men who were not looking for immediate practical benefits, but were engaged in in the single-minded search for truth. Ampère and Faraday were assuredly not in quest of the telegraph, or the electric light, or the telephone. If they had been, we may be confident that neither the theoretical discoveries nor the practical results would have crowned their labours. Science is a goddess who must be worshipped with no calculating devotion.

"*Wer um die Göttin freit, suche in ihr nicht das weib.*"

The splendour of the gifts which she lavishes on humanity are in proportion to the purity of the intention with which she is served. I will not discuss whether or how far science would be a legitimate object of pursuit apart from any prospect of material benefit from it. It would be idle to argue about a purely imaginary condition of things. There is no research, however abstract, of which we can say that it is destined to be for ever barren of practical fruit. The instances in which investigations of the most recondite character have been the source of most valuable results in practice are innumerable. To the vulgar mind nothing could be more trivial than the occupation of Galileo when counting the oscillations of a chandelier in the Cathedral of Pisa and comparing them with the beats of his pulse. Yet this was the first step in a path which has led, among many other things, to the chronometer, on whose accuracy are daily staked life and wealth incalculable. To take a smaller, but more recent matter, the incandescent lamps of Swan and others depend for their durability on the perfection of the vacuum in which the filament of carbon is placed. The improvements in the airpump which have rendered a sufficiently perfect vacuum possible and easy of attainment are due to men who were engaged in researches of the most abstract kind on the phenomena of the electric discharge in rarefied gases. Every scientific investigator must feel satisfaction in the thought that his work may, possibly at a long-distant date, and in some indirect manner which it is impossible to foresee, contribute to increase the conveniences or mitigate the woes of mankind. But the fact remains that the real driving power of science, the secret of the fascination which it has exercised on some of the most powerful intellects in all ages, is not the purpose "*commodis humanis inservire*," as Bacon has it, but rather the desire to penetrate more deeply into the secrets of Nature — to trace the connection of her varied manifestations, and to bring to light the framework of law and order which underlies the whole. There is no wish to lessen the tribute of admiration paid to those men of eminent practical genius who have been so successful in bending the powers of nature to the service of man. With no one is this admiration more genuine than with the students of pure science, who indeed have special reasons of their own to be grateful to the practical man for the new and more powerful weapons put into their hands and the new problems suggested. For instance, the telephone has already proved a useful instrument of physical research, whilst the refined methods of electrical measurement which the physicist now has at his disposal have been called into existence in a great measure by the requirements of submarine telegraphy. But the practical genius is in no danger of having his praises unsung. His name is heard in the market-place. Let us not forget that some of his greatest achievements have been built on the labours of men whose fame

"not in broad rumour lies,"

who in the study and the laboratory have from generation to generation patiently toiled to unravel the laws of Nature, and whose enthusiasm in the search for knowledge has been sustained by the intrinsic grandeur of the problems with which they have had to deal. I pass on to notice the profound theoretical speculations which have been suggested by the discoveries of Ampère and Faraday. The complicated facts of electromagnetism were reduced to law by the discoverers and their immediate successors (amongst whom we must mention F. Neumann) with a completeness and precision which recall the great achievement of Newton. But just as Newton felt that his law of gravitation could not be looked upon as an ultimate fact in nature, so in the present subject men's minds have tried to penetrate more deeply into the heart of the matter, and to guess at the nature of that mysterious agent —electricity—which is at the bottom of these varied phenomena. An attack on this problem has been made on two very different lines, by Weber and others in Germany on the one hand, and by Faraday and Maxwell in England. The ideas of Weber are a development of the old notion of two electric fluids. Weber looks upon the wire connecting the poles of a voltaic cell as the seat of a veritable current, or rather of a double current, of the two fluids flowing equally in opposite directions, the particles of the fluids being supposed to act directly on one another at a distance according to a somewhat complicated law. This law is so different from anything of which we have experience in the case of ordinary matter that it has not met with favour from British men of science, although the beautiful manner in which, if its truth be once granted, it leads to the explanation of all ordinary electro-magnetic phenomena has gained for it enthusiastic advocates in the land of its birth. Faraday and Maxwell on the other hand, attribute the phenomena of the electric current to something going on in the space surrounding the wire as well as in the wire itself. In an altogether different branch of science, viz., in physical optics, we are led to believe in the existence of a subtle omnipresent medium, the so-called luminiferous aether, although the structure of this medium and the precise nature of the luminous vibrations remain, as far as optics are concerned, open questions. Faraday suggested that this medium may have other functions besides that of conveying radiations, and that it may constitute the mechanism through whose agency one electric current is able to act on another at a distance. A relation between the two classes of phenomena was in fact established by his beautiful discovery of the action of magnetism on light. He found that a ray of what is called polarized light, travelling in glass along a line of magnetic force, has its direction of vibration gradually turned round as it advances. The experiment has recently been successfully performed in the case where the ray travels in air, and the magnetic force is simply that due to the earth. It has been argued very powerfully by Thomson that this phenomenon proves the existence of a motion of rotation going on in a medium subject to magnetic force, that the medium contains in fact a countless assemblage of minute vortices spinning everywhere about the direction of the magnetic force as axis. The ideas of Faraday have received a magnificent development at the hands of Maxwell in his classical treatise on electricity. Maxwell has shown that all the known phenomena of electro-magnetism, as well as the attractions and repulsions of statical electricity on which I have not touched, are consistent with the hypothesis that they are not direct actions at a distance, but are due to the action of some medium. It is not necessary to attribute to this medium properties different in kind from those which we meet with in ordinary matter, or, indeed, to make any very special hypothesis as to its ultimate structure. This theory leads further to the result that electrical disturbances will be propagated through the medium in the form of waves, with a velocity which can be calculated indirectly from experimental facts of a purely electrical nature. The velocity so found agrees with the velocity of light, as found by various astronomical and terrestrial methods, quite as closely as these different determinations agree among themselves. The theory, thus strikingly supported, that light is an electro-magnetic phenomenon, or rather that light and ordinary electro-magnetic actions are the same agency made manifest in different ways, seems destined to play a great part in scientific history. It has already received at the hands of Maxwell and his followers important developments, but these, as well as many other points of interest in Maxwell's researches, I am compelled *spatiis inclusus exiguis* to pass over.

I must bring this review to a close. It cannot be said that we are as yet near a definite solution of the problem of the nature of electricity. The researches of Maxwell have proved that the phenomena of electro-magnetism *may* be due to the operation of some kind of matter of a more subtle character perhaps than any of which we have direct knowledge by the senses, but endowed substantially with the same properties. But these phenomena form, after all, only a part of the science of electricity. If we reflect on the chemical and thermal properties of the electric current, and on the beautiful but complicated phenomena of the electric discharge in gases, it becomes plain that any substantial addition to our knowledge of the nature of electricity will involve the solution of other profound problems as well. We shall require to know something of the ultimate structure of matter, of its relation to the aether, of the nature of chemical combination. On some of these questions we have, perhaps, some feeble light, but little in comparison with what is needed. The goal may be distant, but we cannot doubt that the mere efforts to attain it will be amply rewarded by the treasures picked up by the way.

The proceedings then closed.

The Register.

ADELAIDE: THURSDAY, DEC. 18, 1884.

THE UNIVERSITY COMMENCEMENT.

The address delivered yesterday at the Commencement by the Chancellor of the University deals with a variety of interesting topics. His Honor gave a brief but lucid *résumé* of the principal events of the year, and sketched the most important changes and improvements which will characterize next year's work. Chief in the former category stand the endowment of Chairs of Music and Chemistry and the establishment of a School of Medicine. After detailing the part taken by His Excellency the Governor in the endowment of a Chair of Music, the Chancellor proceeded to pay a graceful compliment to Sir Thomas Elder, who, for the first time, was present at the chief ceremony of the institution for which he has done so much. No one ever deserved such a compliment more fully than Sir Thomas, and it must be a gratification to him to find that his fellow-colonists are not ungrateful for the benefits which he has bestowed upon them. Mr. Angas, too, is a consistent friend of the University, and the Chair of Chemistry as well as the Engineering Scholarship, which goes by his name, are solid proofs of his friendship.

As regards the future the Chancellor drew an encouraging picture. The University is to have more Professors. The list of officers will certainly look most imposing when, in addition to the six Professors and Lecturers now engaged, we shall have also Professors of Music, Chemistry, and Anatomy, and Lecturers in Physiology and Materia Medica. It is to be presumed that the Council goes on the supposition that supply creates demand, and that more undergraduates will flock in because there are more professors. At present, however, there is little sign of any such desirable consummation. The number of students this year was 143, as against 157 in 1883. Of these 143 only forty-six are reading for a degree, and nearly all of the forty-six desire to graduate in Laws. The number of degrees conferred at the Commencement yesterday was nine, three in the Arts course and six in the Laws. In the Science School the only successful candidate for a degree at the late examination was a lady. It is in the training of those who are proceeding to degrees that a University displays its usefulness, and a University which has only a small class of art students runs a great risk of being regarded as an institution whose sole object is to examine for such degrees as will qualify for a profession. It may be, as the Chancellor hinted, that our community is of too practical a turn of mind to care much for the pursuit of knowledge for its own sake. But this argument, if carried to its due length, would tell most strongly against the University itself. If it be the fact that we in a very real sense only work to live, why have we a University at all? Might it not be said that it would have been high time for us to enjoy the advantages of a higher education when we have learnt to