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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public and intended for insertion in this column, must in all cases be accompanied by a large envelope, legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

TRADE RELATIONS WITH SOUTH AMERICA.

The Proprietors of "The Engineer" have pleasure in announcing that they have made arrangements with MR. EASTON GARRETT, A.M.I. Mech. E., "BRANCH OFFICE BUREAU," 526, BOLSA DE COMERCIO, BUENOS AIRES, *to give information and assistance on matters connected with the engineering trades in Argentina to readers of this paper.*

Requests for such information must be addressed to the Manager of "The Engineer," 33, Norfolk-street, Strand, who will forward them to the "Branch Office Bureau," or, in special cases, will take steps for cabling them in private code.

For the assistance of visitors to Buenos Aires, it may be added, Mr. Garrett will be happy to arrange personal interviews.

THE ENGINEER.

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Electrons and the Engineer.

AT first sight it would not perhaps appear that even an important advance in our knowledge of the internal structure of the atom should excite anything but a purely academic interest in the minds of engineers and of practical men generally. This is one of those branches of "pure" science which the ordinary individual regards as entirely "beyond" him; he may echo the opinion which has of late found vigorous expression in some quarters, that such research is "important," but he is content to leave it to a small band of enthusiastic workers whom he is inclined to regard with something between indifference and the semi-contemptuous tolerance which he accords to people who are not "practical." Yet no one gifted with even a small share of insight could have listened to Sir Ernest Rutherford's "Bakerian Lecture" at the Royal Society last Thursday without realising that here was something which not only fundamentally affects all our scientific conceptions, but also something which, sooner or later—and probably sooner rather than later—is bound to affect our practical lives and perhaps to alter the whole aspect of human life and activities. It is true that the epoch-making events which have just been chronicled have occurred only within the narrow walls of a vacuum tube, and that the effects have been confined to a few atoms whose behaviour has been counted one by one. It is much too soon to say why and how these things are likely to affect the practical world as the engineer knows it; yet we have often seen how the most abstruse scientific discovery brings vast results in its train, and it will be more than surprising if a similar sequence of events does not follow in the present instance. In the past such a development has been slow, because only few scientific workers and technical workers were in the field. To-day there are, by comparison, huge numbers of such workers, and progress and development are likely to be rapid. Any surmise as to the possible direction which such development may take can, at the present stage, be nothing more than, at best, intelligent speculation. A survey of the possibilities involved may, none the less, be useful as well as interesting.

To the chemist and the physicist the outstanding feature of Sir Ernest Rutherford's recent work will lie, no doubt, in the fact that he has demonstrated that the transformation of one of the so-called chemical elements into another, with which we have hitherto been acquainted only in the case of the few and entirely exceptional bodies which possess the mysterious properties of radio-activity, can be caused to occur in such ordinary substances as nitrogen and oxygen. When, under suitable conditions, atoms of nitrogen are bombarded by the alpha-particles shot out from radium or its emanations, Rutherford has shown that atoms of hydrogen make their appearance, while a new kind of atom, not hitherto met with in quantities, has been formed by the similar bombardment of oxygen atoms. So far this startling series of transformations has only been carried out on an ultra-microscopic scale, and by the aid of the most powerful of all available agencies—the alpha-rays of radium. But Rutherford's discourse made it quite clear that in his opinion the disintegration of the lighter kinds of atoms at all events might be possible by other more widely available means. The fundamental fact that the atoms of substances not in themselves radio-active can be disintegrated by suitable means has been established very fully and definitely. The carrying out of such an operation on any large scale is, of course, quite another matter; but new fundamental facts extracted from the secrets of Nature are potent things with which it is very necessary to reckon. Let us, then, examine one or two of the possible bearings of this new knowledge on the work of the engineer, whose business it is to utilise the forces of Nature for the benefit of man. We have, first of all, the demonstration that the conception of the atom as a nucleus carrying a positive electric charge, surrounded by and intimately connected with a group of very minute "electrons," is substantially correct, for it has pointed the way to the discovery of how to disintegrate old atoms and to build up new ones. But this conception also serves to show how the atoms, particularly when built up into a crystal, are linked together—a linking which we ordinarily dismiss with the vague term of "cohesion." There seems little doubt that the active agent in "cohesion" is the intensely minute electron, a particle which bears to the atom as a whole something of the same order of relation which the planets bear to the solar system. Atoms, when built together, either into chemical compounds or into crystals, are linked together by their electrons. They may have one or more electrons in common, or the electrons belonging to one atom may fit into vacancies existing in the electron system of a neighbouring atom. Now there is no property of matter which is of more fundamental importance to the engineer than this property of "cohesion"—the hardness of the diamond, the strength of tempered steel, or the softness and ductility of copper alike depend upon this property of matter. Given a deeper and truer insight into the inner mechanism of cohesion, such as this new research appears to offer, and we at once widen the possibilities of the materials available to us. With regard to metals, for instance, modern metallurgy has given us immensely improved steels and alloys, but only the most proximate explanations of why one particular form of matter is so much superior to others. Given the key to the true inwardness of cohesive forces, it is not too much to say that we might well look forward to an era of engineering materials which should surpass the achievements of the present era of "alloy steels" as much as the iron age surpassed the bronze age. We are not yet upon the road to that era, but the first finger-post leading to that road has just been shown to us. From another point of view these recent advances in our knowledge of atomic structure and transformation are, if possible, of still greater interest. The enormous store of energy which lies within the structure of the atoms themselves has come to our notice from observations on radium and on the heat which it steadily generates as a result of its spontaneous disintegration. The lively imagination of Mr. H. G. Wells has familiarised us with the idea that some day it may be possible to utilise this internal energy of the atom for destructive purposes by releasing it at will, and he has painted us a lurid picture of the destruction wrought by such "atomic bombs." More peaceful speculation has suggested that in this great store of energy we shall ultimately find an inexhaustible source of power, not only solving the problem of the exhaustion of coal and oil, but for ever relieving the human race from the burden of physical toil. Those were mere speculation until it could be shown that the stores of atomic energy could be released by human manipulation; but now Sir Ernest Rutherford has shown that, at least, ordinary atoms can be caused to undergo disintegration by external agencies, and we are one tremendous step nearer the realisation, not perhaps of those particular dreams, but of a new world in which we shall possess a degree of control over matter and energy so much greater than that which we possess to-day that it is difficult to foresee the consequences. In his delicate experiments, Rutherford does not speak of having met with any manifestations of the release of large amounts of energy as the result of atomic disruption, but his experiments were not directed to that end. Even if, in the particular cases which he has studied, there is no great gain of energy, it does not by any means follow that such a result may not occur when the path he has opened up is further explored. It may be, indeed, that we shall not find the atomic energy making itself manifest in violent explosions or incandescence, but in quite a different way. In the more speculative part of his lecture Rutherford suggested—in a perfectly calm and breezy manner—

the probability that atoms of either oxygen or nitrogen might be broken up in such a way as to lead to the formation of atoms of carbon. Should such an amazing transformation ever become realisable on a large scale a supply of power of unlimited extent would at once become available. We can, of course, effect a somewhat similar change—of a much more conventional nature however—by the decomposition of carbon dioxide into carbon and oxygen, but there the obstacle lies in the fact that the power or energy required to effect the separation is greater than that which could be again obtained by burning the resulting carbon. It is, of course, possible that in the atomic disintegration also energy will be absorbed, and that therefore, from the point of view of obtaining power, the process may not "pay." On the other hand, the carbon atom is lighter than that of nitrogen or oxygen, and in the case of radio-active bodies at all events we know that the breaking up of a heavier atom into lighter ones is accompanied by a release of energy and not by absorption.

We may therefore well hope that when Sir Ernest Rutherford, or other enthusiasts following up the path which he has pointed out, at last furnish us with the key to the inner mysteries of atomic disintegration, we shall be furnished with the means, not only of producing at will any desired kind of matter, but also—directly or indirectly—with a vast supply of energy or power for moulding it to our needs. These are, of course, for the moment nothing more than dreams of future possibilities; but the definite facts which Rutherford put before the Royal Society last week tend to make that future much less hazy and distant, and those dreams much less unreal than they might have appeared even two years ago.

Railwaymen's Wages.

THAT railwaymen deserve well at the hands of their employers is a statement that not only cannot be denied, but one that requires little support. All railwaymen must not be judged by some of their trade union spokesmen; most of them are painstaking and cautious workmen of long service, who appreciate the financial difficulties of the companies, and are, in a general way, content. But the war brought in new conditions of a disturbing order. Besides the higher cost of living which has to be met, the railwaymen see those of their neighbours who are engaged in other trades receiving much higher wages than they can earn; but, above all, they observe that any loss on the railways is made up by the State. This is a feature in the present relations between the railway companies and their men that must ever be borne in mind when passing judgment on the men's demands. Another disturbing element is the rivalry between the two railway unions—the N.U.R., which has most of the rank and file, and the Associated Society, which takes the enginemen, generally admitted to be the *élite* of the railway service. Over and above these conditions, arising out of the war, there is the fact that at the time hostilities broke out the pay and conditions of service were about, by mutual agreement between the companies and the men's representatives, to be improved. In many grades changes were overdue. The great increase in the size of trains has thrown more work on the driver, fireman, guard and shunter. Engines are bigger and of more varying types, and no driver has now his own locomotive, but may have a different class each journey he makes—a condition affecting the fireman also. There are many appliances and special features on an engine now which need technical knowledge and skill and constant watching. We find the same thing in the signal-box. There electrical apparatus of all kinds has been introduced which, whilst bringing greater safety, needs greater understanding. Signalmen, with the introduction of train control, have to spend more time at the telephone, and have to make returns to and receive instructions from the train controller, so that, as regards train movements, there is more work done in a signal-box than in a station-master's office. Guards, before the introduction of ton-mileage, had already more clerical work to do than was the case fifteen years ago. For all these additional duties—and we are only naming three or four grades of the many in which the responsibilities have been increased—no advance in pay was given.

We mention these facts in order that it may be appreciated why, so soon after the settlement with the enginemen last August, and with the rest of the men as recently as last March, a revision other than to meet the increased cost of living—itself adjusted by an agreed sliding scale—should have been necessary. The award made by the National Wages Board on Friday last recited that the N.U.R. put in a claim for revision on March 20th, and the Associated Society on April 24th. These settlements were unsatisfactory in two respects. One weak point was that the higher-rated man, such as the driver, passenger guard, goods guard and shunter—all men of experience, long service, and, necessarily, more than ordinary ability—received less proportionate increase over the pre-war wage than did the engine cleaner, porter, carriage cleaner, and platelayer. When these settlements were made, the cost of living was 130 per cent. over July, 1914, and yet the drivers had only 122 per cent. increase, the passenger and goods guards 126 per cent., and the gangers in industrial areas 144 per cent. The other unsatisfactory feature of the former settlements was one for which the men had themselves only to thank. It was the introduction of standardisation in which only the variation of a shilling or two was made between a man of the same grade in an industrial area and one in a rural district. The present award says on this subject that the case for an advance is much less strong for the workers in the rural areas than for those in industrial districts, and that a wider difference than at present exists was justified. This opinion is reflected in the Board's award, which varies between 4s. and 7s. 6d. in districts other than rural areas, and between 2s. and 3s. 6d. to men in the latter. But it is not our purpose to review the award, and particularly not as to its relation to the demands. We are more immediately concerned about the growing expenditure of the railways. On page 567 of our last issue we showed that, regardless of the present demands of the men, a further sum of 44½ millions a year is required for the railways. The demands were expected to cost 35 millions. We do not know what increased expenditure the award will bring in its train, but it will, we estimate, be between seven and ten millions, so that, in all, from 52 to 55 millions will have to be provided. If, as was stated by Mr. Arthur Watson, a 20 per cent. increase on the existing passenger fares and another 20 per cent. on the present freight rates becomes necessary to meet the 44½ millions, it would seem as though these two advances will have to be 20 and 25 per cent. respectively to find 55 millions. In this connection the minority views of Mr. Matheson, the general manager of the Caledonian Railway, deserve consideration. He said, *inter alia*, "there should be realisation (1) of the fact that the burdens that have been recently put on railways have already produced a breaking strain, and (2) of the fallacy connected with the charging of higher rates and fares for conveyance than the traffic will bear. The problem attaching to the economic difficulties of the time should be solved by governing the 'shopkeeper' rather than by continually increasing wages." That the majority leaned somewhat towards Mr. Matheson's views may be seen in the concluding observations: "The Board feel justified in recording their view that the absence of any effective system of co-ordinating changes in rates of wages is largely responsible for the fact that wages' settlements tend to be disturbed, not because of inherent defects, but because of changes in the comparative level of wages in different trades brought about without due regard to the position outside the industry immediately affected. The Board desire, with all emphasis, to suggest that every effort should be made to ensure that the movement of wages in the different industries should come effectively under review by a co-ordinating authority, and that in such other directions as may be open steps should be taken to reduce the cost of living or, at least, to prevent any further increase."

The moral, we submit, that is to be drawn from the whole history, during and since the war, of the pay and terms of service of the railwaymen, is that the sooner the companies are put in a position to stand alone, and that they are permitted to manage their own concerns, the better. A fortnight ago we made the same assertion in connection, more particularly, with the necessity that the companies should know what their future is to be. Now this necessity is all the greater. The Board had something to say about what is in our mind. It observed: "The last word in railway development and organisation has not been said, and the future may hold in store substantial rewards for inventiveness and enterprise." How, we ask, can the companies set about making developments so long as they are uncertain what their future is to be? Our railway administrators are capable men who can, as has been proved during the war, and often before, rise to the occasion. A further increased cost of 55 millions has to be met. Give the companies the chance to meet it in their own way. They will not bleed the traders and the public, nor will they allow their men to be discontented. But, on the other hand, so long as the purse of the State may be freely dipped into, so long will there be disturbances. Release the companies from control and matters will certainly be no worse than they are now; there is every chance that they will be better.

Aeronautics and the State.

THE meeting held at the Mansion House on Tuesday last by the Air League of the British Empire served to demonstrate once again the fact that many influential and authoritative people in this country are gravely disquieted over our present national position in aeronautics and the Government's alleged apathy towards the aircraft industry. The situation, as we see it, is admittedly unfortunate. Military and naval aeronautical requirements being now practically negligible, other countries, notably France and Germany, are encouraging the development of civil aviation by means of subsidies and other assistance. From the State's point of view, the expenditure thus incurred is regarded as justified by the fact that the policy adopted keeps the aircraft industry alive, if not in an exactly flourishing condition. The established factories are maintained in existence, the designing staff and skilled workers are kept together, and some assurance is given that progress and development will not come to a complete stop. In addition, by directly encouraging civil aviation, France, Germany and other countries which have adopted the policy of subsidisation intend that as a result there shall always be available for immediate employment militarily a certain number of pilots and machines. In this country, on the other hand, the Government has turned its face against subsidising civil aviation, and confines its assistance largely to the issue of weather forecasts and the circulation of technical information regarding aeronautical developments abroad. It is alleged that as a consequence of this studied neglect on the part of the State, our aircraft industry is becoming moribund, and the proud position of dominance in the air which we held in 1918 has been lost. Our country, it is suggested, is rapidly being placed in a condition which will invite aerial attack and invasion. To prevent this condition from arising, the Air League has pledged itself to do all in its power to maintain or restore our leadership in aeronautics, both on the military and the civil side. It desires to see a large increase in the output of aeroplanes, the subsidising of aerial undertakings, and the restoration of the freedom of the Air Ministry from the control of the War Office.

The position, as we have said, is unfortunate, but whether it is altogether as serious from the national point of view as the speakers at the Air League meeting would have us believe, we have some doubt. We greatly regret the present slump in the aircraft industry, but we cannot shut our eyes to the fact that it was inevitable and that Government neglect, if such be established, can be held responsible for only a very small part of it. Long before the war showed signs of finishing, we ventured to prophecy that matters would develop into the present condition, and were taken severely to task for our temerity. We did not then, and still do not believe that the best or the only way to prevent aerial aggression is to have in our possession an overwhelming numerical superiority of aeroplanes and airships. The whole course of the aerial war showed us very clearly that quality and not mere quantity was the dominant factor in securing ascendency. Time and again preparations to produce certain types of aeroplanes in large numbers had to be countermanded or modified because an enemy design of superior nature had appeared at the front and had rendered our own obsolete before it could be turned out. Had numbers alone counted, our policy would have been to go on w th our quantity production. Instead of doing so, we concentrated upon the construction of a machine one better than the enemy's. That this policy was the correct one is proved by the fact that in the end we established our dominion in the air. The position now that peace is with us is, we admit, not quite the same. With a new war well under way, we would be in at least as good a position to build up a powerful air fleet as we were in 1914. But it seems certain that never again will we have the same leisure allowed us to do so as we had in the recent war. The next conflict of nations—if, unhappily, there should be another—will start straight off with a strenuous aerial campaign. We will not gradually approach the great intensity of aerial operations which marked 1918, but will have to face it almost at once. Our policy, it is clear, is therefore not so much to have in our possession at any and all times a preponderating number of aircraft, but to organise means of producing on a very large scale, when the time arrives, the best and most advanced types of machines. Continuous scientific research work, the continuous training of a nucleus of very expert designers and skilled workers, appears to us to be far more important from the national defence point of view than an air-