## Developments of Wireless Communication.

IN the course of his address to the Royal Society of Arts on November 17, Mr. A. A. Campbell Swinton, chairman of the council of the society, gave a remarkable experimental demonstration of some of the most recent developments in wireless telegraphy. Utilising only a small aerial on the roof, where the conditions were far from favourable, he commenced by picking up some messages of a general news nature which were being sent out by the 7000-metre continuous-wave station of the Admiralty at Horsea, near Portsmouth, about sixty miles from London. These messages were first received by means of a group of thermionic valves, and the clear-cut, distinct Morse signals were rendered audible to the large audience by a telephone receiver with a trumpet attachment.

A printing equipment of the pattern originally developed by Mr. F. G. Creed for line telegraphy, but now most successfully adapted to wireless working, was then put into action under the supervision of Mr. Creed himself, and the receiver was soon seen to be punching a paper strip in accordance with the Morse signals received. The strip was then put into the printer, and appeared on another strip automatically translated into ordinary type. A portion of the printed strip was projected upon the screen, and was seen to contain an extract from a speech by Mr. Bonar Law, with but few errors due to jamming or atmospherics. Between the experiments Mr. Campbell Swinton found time to explain briefly the way in which groups of thermionic valves connected in a particular way can be employed to detect and to amplify the received oscillations, and, by the addition of an auxiliary oscillation, to produce signals at a frequency audible in a telephone, by the method of beats. He also recapitulated the leading principles of the extraordinarily ingenious Creed receiving and printing instruments by which the signals are recorded in the Morse code and afterwards translated into ordinary type by means which we hope to deal with a little more fully later. The most impressive demonstration was the reception and printing of a special message sent from the Eiffel Tower by the kindness of Gen. Ferrié on the same apparatus, but with even more success than in the case of the Horsea messages.

Passing to wireless telephony, Mr. Campbell Swinton attributed the earliest accomplishment of real wireless telephonic communication to Prof. Poulsen, of Copenhagen, and showed diagrams of the latest arrangement used by the Royal Air Force. In conclusion, a special five-valve receiver, made for the purpose by Mr. H. W. Sullivan, was put into action, and the audience was entertained with some spoken remarks, whistling, and gramophone music from a short-wave installation in another part of London. Mr. Campbell Swinton predicts great developments in the field of wireless telephony, and looks forward to the time when a speaker at a political meeting will be able to make himself heard all over the world, or it will be possible for the King to address his subjects throughout his Empire simultaneously.

## Engineering at the British Association.

SIXTEEN papers were read before Section G; these covered a wide field, but, with the exception of Prof. Howe's paper on radio-telegraphy, electrical engineering was entirely unrepresented. Several of the papers were of great importance in that they dealt with fundamental properties of materials and of internal-combustion phenomena. Prof. F. C. Lea read a paper on the effect of temperature on some of the properties of materials. Many materials, such as aluminium alloys, have highly desirable properties when cold, but undergo such changes at the temperatures met with in engine cylinders as to make them quite unsuitable. Fireproof buildings must be designed to have the requisite strength at temperatures likely to be experienced during a fire. The tensile strength and hardness of a large number of materials have been determined at various temperatures obtained by means of electric furnaces, details of which were given. In all the alloys tested the tensile strength and the hardness decrease as the temperature is raised, the decrease being very rapid between 200° and 400° C., which is a range likely to cover both the examples mentioned above. Concrete was among the materials tested on account of its importance in view of the behaviour of ferro-concrete buildings in case of fire.

Col. Crompton discussed the nature of the action leading to the blunting of the edges of cutting-tools. Without accurate knowledge of the nature of this phenomenon one cannot scientifically re-design cutting-tools when making them of the recently developed high-speed steels containing, in addition to carbon, such metals as tungsten, cobalt, molybdenum, nickel, and vanadium. These steels can be hardened like carbon steel, but, unlike it, they retain their hardness at the high temperatures caused by taking heavy cuts at high speed. They are also stronger to resist fracture, and can thus be made with a more acute angle. This angle varies from 90° in shears and punches down to 15° in the blades of safety razors. The smaller the angle the less is the force required to drive the edge into the material, but the weaker is the edge to resist breakage. If examined under a microscope the edge is seen to be blunted by the crumbling away of the material of which the tool is made. This crumbling is hastened by the shaving wearing a groove in the upper face of the tool, thus reducing the angle of the edge. The author was of opinion that all the ordinary tool angles could be reduced 25 per cent. when using high-speed steels.

It is not often that a paper is read before Section G by an author who speaks, not as an engineer, but as a critical user of the engineer's products. Mr. S. F. Edge's paper on farm tractors made one realise the importance of such communications. Mr. Edge evidently spoke from a wide experience of tractors of many types, and discussed them not only from the engineering and agricultural points of view, but also from that of their psychological effect on the labour question. He warned makers against sacrificing quality to cheapness, and expressed his belief in the future of the tractor industry if makers will give the farmers the best machines alike in design, material, and workmanship.

Mr. H. R. Ricardo's paper on a high-speed internal-combustion engine for research dealt with experiments carried out with an engine specially designed for fuel research at the request of the Asiatic Petroleum Co. Nothing had been spared to make the experiments trustworthy and exhaustive and of both scientific and commercial value. The author described the design and construction of the engine in detail, together with the arrangements for measuring the fuel supply, etc. With this engine one will be able

to determine the efficiency of various fuels and the best conditions for the use of any fuel, and also to compare the performance with the calculated figures based on thermodynamic theory.

Prof. W. H. Watkinson described a dynamical method for raising gases to a high temperature without the use of high pressures, which consists in drawing the gas into a cylinder through a partly opened valve, so that the pressure in the cylinder is only a quarter, say, of that outside, and then compressing the gas up to the external pressure with consequent rise in temperature. By a cascade arrangement of several such pumps the temperature could be raised sufficiently high to ignite the gas in an internal-combustion engine.

Dr. C. Batho read a paper on the partition of the load in riveted joints, in which he explained that he treated the riveted joint as a statically indeterminate structure, and applied the principle of least work in order to determine the distribution of the load between the rivets. The details of the method have already been published in the Journal of the Franklin Institute (U.S.A.) for November, 1916. The author quoted some experimental results obtained with an extensometer which supported his theoretical treatment.

Prof. J. T. MacGregor-Morris described and demonstrated his portable direct-reading anemometer for the measurement of ventilation in coal-mines. This instrument, which is made by the Cambridge and Paul Instrument Co., consists of an ebonite handle carrying a cage containing four fine nickel wires, two of which are exposed and two shielded from the air. These wires form the four arms of a Wheatstone bridge, and the galvanometer is connected by means of a flexible wire passing through the ebonite handle. The galvanometer is first used as a voltmeter to adjust the applied voltage to the correct value for the observed temperature of the air. It is then used to indicate the out-of-balance bridge current, which depends upon, and is used as an indicator of, the velocity of the air-stream.

Messrs. H. T. Tizard and D. R. Pye read a paper on specific heat and dissociation in internal-combustion engines. Although very little advance has been made in recent years in the thermodynamical theory of internal-combustion engines, there have been great practical advances, and the actual efficiency of a modern high-speed engine is higher than the theoretical efficiency calculated on the old specific heat figures of Clerk and Lange. The temperature reached is about 2500° C., but the specific heats of the gases concerned were not known accurately above 1500° C., and the extent to which dissociation of $CO_2$ and $H_2O$ takes place was also unknown. Data on these subjects are now available, having been obtained in Nernst's laboratory in Berlin. The authors apply these data to the engine and obtain results which are confirmed by experiment as regards variation of power and efficiency with strength of mixture, with compression ratio, and with different types of fuel. Closely allied with the foregoing was the paper by Sir J. B. Henderson and Prof. Hassé with the attractive title "The Indicator Diagram of a Gun." The diagram is not obtained experimentally, but by calculating the pressure from the temperature, which can be determined only when the specific heat and dissociation are known. The temperature of the explosion is of the order of 3140° C. absolute, and it is calculated that of the energy liberated from 92 to 95 per cent. is converted into kinetic energy in the projectile. A gun is a type of internal-combustion engine, and very similar difficulties arise in investigating the two problems.

A very important but difficult subject is the action in steam-nozzles, and a paper by Prof. A. L. Mellanby and Mr. W. Kerr recorded a great amount of careful experimental work carried out at the Glasgow Technical College, the data from which were analysed and discussed in the paper. Pneumatic elevators for the unloading of grain were invented in England, but, as in many other things, it was in Germany that later study and development took place. Prof. Cramp, who had studied Continental practice before the war and commenced a research on the factors determining the efficiency of such apparatus, was afterwards given a grant by the Department of Scientific and Industrial Research to enable him to continue the work. His paper gave an account of the experiments made by him at Manchester University. To design apparatus intelligently one must be able to calculate the weight of grain which can be lifted a given height through nozzles and pipes of a given shape and size by a given vacuum and a given power. Whereas mechanical elevators can be made to work with 75 per cent. efficiency, the pneumatic type cannot reach a higher theoretical value than 40 per cent., and in practice falls far short of this. In spite of this pneumatic elevators are used because of their labour-saving qualities and freedom from dust.

The most striking and imaginative paper read before the Section was that of Wing-Comdr. Cave-Brown-Cave on airships for slow-speed heavy transport and their application to civil engineering. The author discussed the use of airships with one or more trailing air-barges for the transport of men and material over virgin country through which a railway was being constructed or in which it was necessary to carry on prospecting. In his opinion the present stage of development of airships and of the methods of handling them is such that their use for such purposes is quite practicable and offers great advantages.

Prof. G. W. O. Howe discussed the efficiency of aerials and the power required for long-distance radiotelegraphy. Of the power supplied to an aerial, the fraction which is radiated decreases with increase of wave-length, but, on the other hand, the longer waves are transmitted around the earth with less attenuation than shorter ones. On the latter point, however, there are but scant empirical data; on the usually accepted assumptions the author calculated the power required to produce a given strength of electric field at various distances with different wave-lengths. Using the optimum wave-length in each case, the power required for a range of three or four thousand miles varies as the sixth to the eighth power of the distance. Prof. Howe mentioned that recent experiments between America and Italy indicated the necessity of much smaller powers than those given in the paper. In conclusion, the author pointed out the need for extended research on this subject to enable a network of stations to be designed intelligently.

In the concluding paper Dr. J. S. Owens gave a very interesting description of the removal by drilling and blasting of 11,000 tons of rock-reefs from the bed of a river. No divers were employed, but holes were drilled from a floating barge, using a 5-in. steam drill. "Sausages" of dynamite were fed into the holes through a pipe and fired electrically in groups of about eight holes. The cost was a mere fraction of what it would have been if divers had been employed.