Address of the President, Sir Ernest Rutherford, O.M., at the Anniversary Meeting, December 1, 1930.

At this, our Annual Meeting, we are naturally conscious of the severe losses in our ranks in the course of the year. We have to deplore the removal by death of some of the best known and most valued Fellows, including Lord Balfour and Sir William McCormick, elected under Statute 12, Professor Le Bel, Foreign Member, and twelve Fellows of the Society.

The death of the Earl of Balfour at the age of 82 removed from our midst a public figure of the first magnitude. Although Balfour's activities covered a wide field, and although through a great part of his career he carried heavy responsibilities in guiding the affairs of the Nation, science was always with him a topic of primary interest. If he cannot be said to have made original contributions to scientific knowledge himself, there can be no doubt that his championship of the cause of science was of the greatest indirect benefit. As First Lord of the Treasury in 1900, he did much to help forward the scheme for the National Physical Laboratory, in which his brother-in-law, Lord Rayleigh was interesting himself. He was constantly called upon to preside, or to speak, at meetings for the furtherance of scientific objects, or the commemoration of the great scientific careers of the past, and seldom failed to add distinction to such occasions. He may indeed be regarded as a chief interpreter of science to the English public during his generation. He was President of the British Association at Cambridge in 1904. He was elected to the Royal Society under Statute 12, as early as 1888, at the age of 40 years. He served on the Council in 1907–08 and again in 1912–14. But, perhaps, his chief work for science was in his later years, after the most active part of his political career was over. In two successive terms of office as Lord President of the Council, he was the Minister responsible for the Department of Scientific and Industrial Research, and for the Medical Research Council. Of the latter body he acted as chairman until the onset of his illness. He watched the scientific interests under these departments with close personal attention, and did much to establish them on a permanent basis. Finally, to him was due the Committee of Civil Research,
complementary to his older creation of the Committee of Imperial Defence. He was Chancellor of the Universities of Cambridge and Edinburgh, and President of the British Academy. His is a place which will not easily be filled.

Sir William McCormick, who died suddenly in his seventy-first year, had a very varied career of service to the Universities and to the State in many capacities. At one time Professor of English in University College, Dundee, he became the first Secretary of the Carnegie Trust for the Universities of Scotland. He was for many years Chairman of the University Grants Committee where his personal influence and advocacy were largely instrumental in obtaining the increased grants for the Universities in the difficult post-war period. He was the first Chairman of the Advisory Council of the Department of Scientific and Industrial Research which was set up in 1916 under the pressure of the war to organise the application of science to industry. The success of this Department, which is known to you all, was in no small part due to his financial acumen and organising ability. Although not trained as a scientific man, he had a wide interest in science and sympathy with the scientific outlook and worked loyally with his band of scientific advisors—originally all Fellows of our Society. The Society was glad to recognise the value of his services to Science by electing him a Fellow under the special statute. His charm of manner and breadth of outlook endeared him to all his friends, and he will be greatly missed.

The death of Admiral Sir Henry Jackson at the age of 75, has caused deep regret in both naval and scientific circles. When in the Navy, in 1891, he began experiments to test the utility of Hertzian waves as a means of communication between ships at sea, and was largely instrumental in the rapid development of this method of signalling in the Navy. As early as 1902, in a paper to our "Proceedings," he drew attention not only to a failing of signals but also to their reappearance as the distance between the signalling and receiving ships increased. During the war, he was appointed as First Sea Lord in 1915 when Lord Fisher left the Admiralty. On his retirement from active service, he was appointed, in 1920, Chairman of the Radio Research Board, instituted by the Department of Scientific and Industrial Research. In this capacity he did admirable work in encouraging researches on the fundamental problems of radio-transmission. He was elected to our Fellowship in 1901 and was awarded the Hughes Medal in 1926. His charm of manner, simplicity of nature and devotion to duty endeared him to all those with whom he came in contact.
In Percy Alexander MacMahon the mathematical world has lost a distinguished and enthusiastic worker of marked individuality, as well as a most attractive personality. An algebraist of great resource and insight, he was early attracted by the theory of invariants (in the most extended sense) and symmetric functions, and his discoveries in connection with the differential operators in these theories gained at once the warm appreciation of the great exponents, Cayley and Sylvester. By a natural sequence he was led on to intricate problems of Combinations and Probability, to which his researches had already opened a line of attack. His work on these subjects was afterwards collected in the two volumes published under the title "Combinatory Analysis," by the Cambridge Press. An interesting by-product of his later years was the theory of repeating patterns, with which he occasionally amused an audience, and which afforded an outlet for his strong sense of humour. He died on Christmas Day 1929, at the age of 75.

Dr. Sebastian Ziani de Ferranti who died in January last was the great pioneer of electricity supply at high pressure. He was of Italian descent from one of the Doges of Venice, but was educated and lived all his life in England. At the age of eighteen, he patented the Ferranti alternator and a few years later, while still a young man, designed a system of supply from Deptford which was transmitted at 10,000 volts. Little was then known about these high pressures and no instruments for measuring them were in existence. Ferranti consulted Lord Kelvin on some abstruse points in mathematical physics during the course of his work. In 1892, he severed his connection with supply and started the firm of Ferranti, Ltd., which manufactured many of the machines and devices he had perfected. He was careful to make machines which would be safe for the workman to handle and loved to invent devices which lightened domestic drudgery. Ferranti was a great engineer and lived to see his ideas developed and huge high pressure networks constructed in almost every country. Were it not for him the world would be perceptibly poorer to-day. He was a man of great modesty but much personal charm.

The premature death of Professor Hugh Longbourne Callendar has removed from our ranks an experimental physicist of great ability and insight. Elected Fellow of Trinity College, Cambridge, in 1886, he first devoted himself to the development of platinum thermometry as a means of very accurate measurement of differences of temperature. In 1893 he became Professor of Physics in McGill University, Montreal, and was largely responsible for the admirable equipment of the then new Macdonald Physics Laboratory. While in Montreal he began his researches on continuous
electrical calorimetry and had a wide influence in promoting interest in research in that University. After a short term of service in University College, London, in 1902, he was appointed Professor of Physics in the Imperial College of Science and Technology and filled this chair up to the time of his death. An unusually careful and accurate experimenter with marked interest in engineering applications, he devoted himself to accurate measurements of many important quantities in heat, and in this respect was a worthy successor of Regnault. One of his last pieces of work was the preparation and publication of accurate steam tables which have proved of great utility to industry. A man of wide training and all-round capacity, his death has left a gap in the scientific world which is difficult to fill.

Edwin Tulley Newton, who died in his ninetieth year, was for many years a leader in the study of fossils in Great Britain. Interested in natural history, he attracted the notice of Huxley and became his assistant. In 1882 he was appointed palaeontologist to the Geological Survey and held this post until his retirement in 1905. Some of his most fundamental contributions to vertebrate palaeontology are contained in three memoirs published in our "Transactions." He was elected to our Fellowship in 1893 and was awarded the Lyell Medal by the Geological Society.

Mr. Alan Archibald Campbell Swinton was a member of our Council at the time of his death. Trained as an electrical engineer he took an active part in the development of the electrical industry both as consulting engineer and as a director of many companies. A man of wide scientific interests he was one of the first to obtain X-ray photographs in this country, and was much interested and helpful in the early development of experiments on radio-communication. Of wide reading and sympathies, he was well known to scientific men and was a familiar figure in scientific gatherings. He was most interested in the work of the Society and served on a number of its committees as well as on the Council. The Society is much indebted to him for a generous gift of £1,000 in 1926 to form the nucleus of a General Purposes Fund.

Kenneth Joseph Previté Orton passed away on March 16 last in his fifty-ninth year. After his student days at Cambridge, Heidelberg and London, he joined the chemical staff of the Medical School at St. Bartholomew's Hospital, and in 1903 became Professor of Chemistry in the University College of North Wales at Bangor. Orton carried out original work on the mechanism of organic chemical reactions and developed more particularly the study of the chlorination of aromatic compounds; he was one of the first systematically to apply
physico-chemical methods to the study of organic reactions. Orton was a vigorous and refreshing personality with many interests lying far outside his particular branch of chemistry; he was an experienced field geologist and ornithologist. He devoted himself with enthusiasm to the development of the University of Wales and his early death leaves all who are interested in Welsh education under a keen sense of loss.

John Oliver Arnold, who died on March 27 last, at the age of 71, was closely identified with the progress of the metallurgy of steel. Appointed while a young man to the Professorship of Metallurgy in the Sheffield Technical School, he saw the growth of that institution into the Applied Science Department of a University, and established a connection with the steel industry which has had lasting effects. It is largely due to his efforts that scientific control has been so generally adopted in metallurgical works, whilst his own researches did much to forward the application of metallographic methods, originally due to his fellow townsman, Sorby.

The death of Joseph Achille Le Bel on August 6 last, takes from among us one of the veterans of French chemical science. In 1874, simultaneously with, but independently of, van’t Hoff, Le Bel enunciated the doctrine of the asymmetric carbon atom and thereby laid the foundation of modern stereochemistry; it would be difficult to over-state the part which this fundamental theoretical conception has played in the development of structural organic chemistry. Le Bel, who was born in Alsace in 1847, received our Davy Medal in 1893, and was elected a Foreign Member of the Society in 1911. In 1925 he made a gift of money to the Society with the request "that you subsidise research rather than subsidise students, for I think we have plenty and to spare of savants who have fattened on examinations, but not enough of the people who employ their time in solving problems of interest. Hitherto the Royal Society seems to me to have used its money well. I hope that it will continue."

Herbert Hall Turner, who died suddenly at a meeting of the International Union of Geodesy and Geophysics, was Savilian Professor of Astronomy at Oxford. In 1893, when photography was beginning to be applied to the determination of positions of stars, he introduced the methods of reduction which have been employed with little modification ever since. He devoted himself very energetically to the project of the International Astrographic Catalogue, and having completed his own (Oxford) section in good time, rendered assistance to other observatories which were behindhand. He was also interested in variable stars and seismology, both of which subjects gave scope for his favourite
theme—harmonic analysis and the search for periodicities. He performed still greater service to astronomy by the infinite pains he took to assist and encourage the amateurs and the younger men and to keep in touch with those working in isolated observatories in the Dominions and elsewhere. A very ready speaker, a genial chairman and leader in any kind of activity, he will be greatly missed at astronomical meetings and conferences.

**Harold Baily Dixon** entered Oxford with a classical scholarship in 1871, but soon turned his attention to science under the influence of Dr. A. Vernon Harcourt; in 1876 he commenced those experimental studies on gaseous explosion with which he was occupied until the morning of his death. During his early work he showed, contrary to the conclusions arrived at by Bunsen, that the explosion of gaseous mixtures is governed by Berthollet's "law of mass action"; he also discovered that carefully dried mixtures of carbonic oxide and oxygen cannot be ignited by an electric spark, and so opened up a new and fertile field of investigation which is still under exploration. Dixon carried out a large amount of difficult but very precise work on the high speed of travel of the explosive wave in gaseous mixtures and was the first to make careful measurements of the ignition temperature of such mixtures. In 1886 he was appointed to succeed Sir Henry Roscoe as Professor of Chemistry in Owens College, Manchester, a position which he held until 1922, when he was elected Honorary Professor in the University of Manchester. Although Dixon was intensely occupied throughout his life with scientific work of fundamental importance and far-reaching consequences, he devoted himself with enthusiasm to furthering the academic, social and athletic activities of his University. In this, his administrative gifts, his brilliance and felicity as an exponent, and his power of arousing enthusiasm in his students, made him again a commanding figure. As one of the foremost authorities on gaseous explosion, Dixon was frequently called upon to assist in Government enquiries into coal-mine disasters. He was elected to the Society in 1886 and was awarded a Royal Medal in 1913; he delivered the Bakerian lecture on "The Rate of Explosion in Gases" in 1893. On September 18 last he passed away suddenly in his seventy-ninth year, whilst retaining unimpaired until the end those mental gifts which so many of us have been privileged to admire.

**William Diller Matthew**, Professor of Palaeontology in the University of California, was born in Canada, and though domiciled during the whole of his scientific career in the United States of America, retained the nationality of his birth. For thirty years he was associated with Dr. Henry Fairfield Osborn, in the charge of the great collection of fossil vertebrates in the American Museum.
of Natural History, New York, to which collection Matthew's own discoveries in the Western States greatly contributed. In 1927 he accepted the chair in California, with the expectation of a long period yet before him for further work on the fossils of far Western America. His investigations and writings have played a large part in the development of knowledge of the extinct vertebrates and theories concerning their evolution, and the science of palaeontology has suffered a heavy loss by his death at the early age of 59 years.

Dr. John William Evans, who was admitted a Fellow of the Society in 1919, was a geologist of wide and varied experience. He had carried out important geological investigations in Southern and Western India, and in South America, besides occupying himself with many problems in theoretical geology. Of late years he had given much attention to the application of geographical methods to the study of the earth's crust.

I shall now pass to a discussion of some matters of general interest to the Society. In the Report of the Council for last year, it was announced that the Committee, which was appointed by the International Research Council to revise the statutes now in force, had adopted all the suggestions which the Council of the Royal Society had made. Since then the Committee's Report has been considered by the Executive Committee of the Research Council which has adopted it after making a few modifications and has recommended these revised statutes to the General Assembly for approval at its meeting in July, 1931. The changes introduced are all in the direction of giving to the Unions greater freedom in arranging their own affairs, the Council performing the function of a co-ordinating body. The Unions will be members of the International Council and will have representation in the General Assembly at its triennial meetings. The new Statutes are such as should facilitate that international co-operation in science which it is the aim of the organisation to promote.

At these anniversary meetings the President has frequently taken the opportunity of putting before the Society some recent and important development of science within the scope of his own personal interest. To-day, on this last occasion of my addressing the Society from this chair, I have felt rather disposed to look back over the whole term of my Presidency, and into that of my immediate predecessor, and to put on record some of my impressions of the work of the Society and of the way in which it is responding to the new opportunities for the promotion of science which have come to it in this present period.
I propose, then, to review briefly some aspects of the history of our Society since the end of the war, and to point out the way in which the responsibilities and work of the Society have increased during this period. While in the course of its long history, the Society has received numerous bequests for scientific and general purposes, shortly after the end of the war the funds at its disposal were greatly increased by the receipt of four major benefactions. I refer to the bequests of Miss Lucy A. Foulerton in 1919, of the late Dr. Rudolph Messel, F.R.S., in 1921, of the late Dr. Ludwig Mond, F.R.S., in 1923, and the notable benefaction of our valued friend Sir Alfred Yarrow, F.R.S., in 1923. Miss Foulerton's bequest was made specifically for the promotion of research in the Medical Sciences, while the terms of those by Dr. Messel and Dr. Mond and of the gift from Sir Alfred Yarrow allowed the Society a wider discretion to utilise the interest on the resulting funds for the general object of our Society, namely, the "improving of natural knowledge." Taking these benefactions as a whole, they provide resources for the promotion of research in practically the whole range of the natural sciences which our Society represents.

Under the Presidency of Sir Charles Sherrington, the Council considered with great care the best method of employing these new resources and decided to apply a large part of the incomes of the Foulerton and Yarrow funds in the first instance for the institution of Research Professorships. The first holder of such a Royal Society Professorship was the late Prof. E. H. Starling, appointed Foulerton Professor in 1922. A second Foulerton Professorship was created in 1926, Prof. A. V. Hill being appointed. On the death of Prof. Starling, a Foulerton Professorship was awarded to Dr. E. D. Adrian in 1929. In 1923, Prof. A. Fowler and Mr. G. I. Taylor and in 1924, Prof. O. W. Richardson were appointed Yarrow Professors of the Royal Society.

The Council further adopted regulations for the Messel and the Mond funds, subject to periodical review, which provided for the eventual use of these funds for the support of further professorships as the need and opportunity might arise. Wisely, as I think, they and their successors were content to watch for a time the general effect on scientific progress of the Foulerton and Yarrow appointments, holding meanwhile in reserve the similar opportunities which the Messel and Mond funds would enable them to offer. My close personal contact with him and his work enables me with special pleasure and warm approval to announce that this year the Council have appointed Dr. Peter Kapitza, F.R.S., Fellow of Trinity College, Cambridge, to a "Messel" Professorship of the Royal Society. I
shall have occasion later in my address to refer to the important researches on which Dr. Kapitza has been engaged in recent years, and to the arrangements made with the University of Cambridge for the provision and upkeep of a laboratory suitable for his investigations.

In my address to the Society in 1928 I reviewed briefly the work of the Royal Society Professors up to that date. As I then pointed out, we have been fortunate in securing the services of a group of men of marked research ability. There has been an output of work of high quality and importance, and I am sure we can all agree that this new experiment of endowing research professorships has proved an unqualified success. In all cases, the holders of our professorships have been heartily welcomed by the Universities and Institutions with which they were associated, and they continue to carry out their investigations under excellent conditions. I think there can be no doubt that the appointments so far made have not only added materially to the strength of the research side of the universities concerned, but have led to a marked increase of the research power of the nation.

While our Professors have been allowed a wide discretion in the work they perform, and in many cases direct the work of research schools, and give advanced courses of lectures, there is undoubtedly a general opinion that, at the present time, it would not be wise to increase unduly the number of our Research Professors. There is always the danger that any substantial increase in the number in the near future might lead, in a sense, to the segregation of some of the more vigorous elements in the research life of our Universities from that intimate contact with students and inspiration of their work which, in the case of many investigators of the highest rank, is an essential part of their contribution to the advancement of Science. In instituting these Professorships, the Society has been engaged in a novel experiment and, successful though the result has been, it is still desirable that we should proceed with caution and reconsider our policy from time to time as our growing experience suggests.

In addition to the six professorships which are supported from the trust funds obtained since the war, the Society now offers for the encouragement of younger research workers eight Studentships and Fellowships, namely, the Sorby, and Smithson Fellowships and the Foulerton, the Mackinnon, two Moseley, the Tyndall, and the Lawrence Studentships. The second Moseley Studentship has been established during the year in consequence of the augmentation of the Moseley fund by a bequest from the late Mrs. Sollas.
These Fellowships and Studentships are all financed from funds left to the Society for the specific purpose of their creation. In my address last year, I referred to the institution of a new Research Fellowship, financed from the bequest left by the late Mr. E. W. Smithson. The first appointment to this Fellowship has now been made and I shall say a few words later on the work of the new Fellow.

Taking into consideration the provision now made for the support of research, to mention only some of the major sources, by grants from the large Government funds administered by the Department of Scientific and Industrial Research and the Medical Research Council, by the studentships offered by the 1851 Commissioners, and by the Fellowships for research in the Medical Sciences created by the Beit Memorial Trustees, it is clear that financial support is now available from a number of different sources, for young research workers of promise in this country.

As I have pointed out, the funds held in trust by the Society for the furtherance of research in various branches of science have been very greatly increased during the past ten years and now amount to more than £600,000. The major increase occurred within the short period of five years from 1919 onwards, and the Council, fully conscious of its responsibility on behalf of the Society, in providing for the use of these great resources for the advancement of science, proceeded as I have indicated, with proper caution. After the appointment of the five first research professors, and the creation of the studentships for which certain bequests were specifically made, the Council had still a substantial margin of income from some of the larger funds, and this has been invested, while plans for its use to the best purpose were being matured. In this way about £72,000 has been added to capital, while in each year a considerable sum is still being received in dividends which has not yet been definitely allocated to any special research. Another reason for an initially cautious policy in expending these trust funds, was the difficulty of foreseeing the financial commitments of the Society due to its already existing activities. For example, the rapid increase of the volume of the Society's publication after the War, and the disproportionate rise in its cost, involved an increasing call on the funds available for this purpose. The Council at that time considered that one of the greatest services which they could render to Science, with the funds at their disposal, was to facilitate the publication of the results of research at a cost rendering them accessible to the widest range of scientific workers. The Council to-day have not moved from this opinion, but they have been able better to survey the Society's policy in relation to that of the scientific world in
general, and to estimate more clearly the probable needs of the future. It now seems unlikely that there will be any substantial increase in the amount of publication during the next few years. Moreover, the Council during the present year have given careful consideration to the cost of publication and have decided on an increase in the price of the Society’s ‘Proceedings’ and ‘Transactions’ to external subscribers. Though the price is still low in comparison with that of other scientific publications and in relation to the increased cost of production, the change should result in the release of a substantial sum which can be allocated for other purposes.

It would, therefore, seem that the time has arrived when we may with prudence consider how some at any rate of the accumulated income from our trust funds may be best expended in promoting some form of scientific research.

Experience has shown that the encouragement of research by minor grants for special apparatus and material is in reasonable measure provided for by the Government Grant, supplemented from the Society’s own research funds. The grants to individual investigators from such sources are usually small but suffice to assist materially important researches of a limited scope.

The situation, however, is very different when we consider large scale investigations of a pioneering character, which may require considerable financial support extending over a period of years in order to provide the necessary apparatus and technical assistance to bring the investigation to a definite conclusion. Few of our Universities or other Scientific Institutions are sufficiently well endowed to support large scale researches of this kind, even when the research appears of marked promise and when the idea and the man are forthcoming. In considering the best method of utilising the balance of the Society’s present resources, the Council decided that it could best help the advance of science by assisting major researches of this character, and after careful consideration, were impressed with the fundamental importance of the researches at present being carried on by Dr. P. Kapitza, at Cambridge, and the need for continuing this work on a more permanent basis.

It may be helpful at this stage to give a brief history of the origin and development of the work on which Dr. Kapitza has been engaged for the past eight years. Trained as an electrical engineer, he was lecturer in Physics in the Petrograd Polytechnical Institute during 1918–1921. In 1921, he came to England and commenced research work in the Cavendish Laboratory, Cambridge. In 1922, he began experiments to test the possibility of
obtaining intense magnetic fields by sending very strong currents through a
coil for such a short interval that the heating effect in the coil is restricted to
a permissible value. With the assistance of a grant from the Department of
Scientific and Industrial Research, special accumulators were contructed to
give the necessary intense currents for a short interval of about 1/50 of a second.
In this way, fields up to 200,000 gauss were obtained, and it was found
practicable to carry out experiments by this method, for example on the Zeeman
effect and on the deflexion of α-particles. In order to carry these experiments
still further, it was necessary to have a method of obtaining currents still
larger and more under control. For this purpose, a generator of special design
was constructed which gives, on short circuit, a current of about 70,000 amperes.
The heavy current from the generator is passed for about one-hundredth of a
second through a coil and is then broken by means of a specially designed auto­
matic break. The Department of Scientific and Industrial Research gave a
very substantial grant for the construction of this apparatus, while Sir William
Pope kindly provided a temporary laboratory to instal the plant and to carry
out the experiments. In 1926, the laboratory was opened formally by the
late Lord Balfour, then Lord President of the Council, who had throughout
taken an active interest in promoting these large scale experiments. This
pioneering investigation, which was carried out in connection with the Caven­
dish Laboratory, was only made possible by the generous and bold support of
the Department of Scientific and Industrial Research, which, up to the present,
has defrayed the complete cost of the apparatus and of the subsequent
investigations.

One of the chief difficulties in these experiments has been to construct a
coil strong enough to withstand the enormous disrupting forces which arise
when a large current is passed through the coil. A number of coils have been
constructed which give magnetic fields of between 300,000 and 400,000 gauss
over a volume of about 3 c.c. There appears to be no inherent difficulty why
fields of the order of 1 million gauss should not be obtained, when called for,
by this method. As the current through the coil only lasts for about 1/100
second, oscillograph methods are used to determine the strength of the current
and magnetic field and to follow the changes in the properties of the material
under investigation. There is no special difficulty in conducting experiments
with these momentary fields. In fact, a single photograph, obtained in 1/100
of a second, may give a complete quantitative record of the magnetic effects
produced in a material over a wide range of magnetic field.

The application of these new methods of producing intense magnetic fields
opens up a wide field of research where all magnetic properties can be examined in fields 10 to 30 times greater than those hitherto available by the use of electromagnets.

As soon as the apparatus was in working order, experiments were begun by Dr. Kapitza to investigate the change of resistance of crystals of bismuth in these intense magnetic fields from atmospheric temperature to that of liquid air. This was followed by an extensive investigation of the behaviour of a large number of metals under corresponding conditions. In general, it was found that the change of resistance was at first approximately proportional to the square of the magnetic field, but above a certain critical field, which varied from metal to metal, the change of resistance tended to become linear. On the basis of these new results, he has suggested a new way of looking at the phenomena which underlie the electrical conductivity of metals and its variation with temperature. Preliminary experiments have also been made on the action of these strong fields on the paramagnetism and diamagnetism of certain substances, while a new and sensitive apparatus has been constructed to study magnetostriction effects. An account of the apparatus and the experimental methods, together with the results of some of these investigations, has been published in our 'Proceedings.'

Magnetic phenomena are shown in their simplest form at very low temperatures when the complications due to the motion of the atoms and molecules are largely avoided. In order to obtain temperatures still lower than that of liquid air, a liquid hydrogen plant has been installed during the present year, and is now in working order. Preliminary arrangements have been made to instal a liquid helium plant when this is required for the investigations.

The grant given by the Department of Scientific and Industrial Research for carrying out these researches expires in a few years, while the laboratory temporarily lent for the purpose of these experiments is now required by the Chemical Department. The Department of Scientific and Industrial Research, by its broadminded and far-seeing action, has done a great service to science in thus supporting, through their initial stages, investigations having no obvious or immediate application in practice or industry. Their support for an indefinite further period, however, could hardly be part of the Department's policy. On the other hand, it appeared to the Society's Council, that investigations of this kind, in which new fields of knowledge are being opened up by new methods, had a peculiarly strong claim for support from those funds which they were holding ready for the furtherance of fundamental researches in pure science.
After full consideration, therefore, the Council, in addition to appointing Dr. Kapitza to a Messel Professorship, agreed to offer the University of Cambridge the sum of £15,000 for the building of a suitable laboratory within the next three years, provided the University was prepared to offer an appropriate site and to defray the running expenses of the new laboratory. Negotiations have taken place with the University of Cambridge and, though the matter has not been formally sanctioned by the University, the Council of the Society has received assurances which make them confident that the offer will be accepted and that the University will provide the necessary funds to carry out the work. If the University of Cambridge concurs with these proposals, the Royal Society will thus have been instrumental in founding a new and up-to-date laboratory, primarily designed for carrying out researches in intense magnetic fields, but at the same time providing the essentials of a modern Cryogenic Laboratory for the study of magnetic and other effects at the lowest attainable temperatures.

It is proposed that a Committee should be appointed, which would be responsible for the direction of the work of the Laboratory. The name of the laboratory has not yet been settled, but it would clearly be appropriate if it indicated the connection with the Royal Society and with the late Dr. Ludwig Mond whose bequest furnished the income from which the cost of the laboratory will be defrayed. It should be noted that among the purposes indicated in the will of Dr. Mond for the use of his bequest was "erecting new laboratories."

It will be remembered that, thirty years ago, this country was pre-eminent in the study of effects produced on matter by the low temperature produced with the aid of liquid hydrogen. It will be recalled that the late Sir James Dewar, with the technical assistance of Mr. Lennox, first produced liquid hydrogen in quantity in the Laboratories of the Royal Institution in 1898, and in 1899 the first solid hydrogen was obtained. It was as early as 1893 that Dewar devised the vacuum flask which has proved to be of such fundamental importance in the technique of low temperatures and has so greatly simplified the handling of liquid gases. It is of interest to note that it was decided in 1902 to construct a liquid hydrogen plant, of capacity of about 5 litres of liquid hydrogen per hour, as a British Government exhibit to the St. Louis Exposition in 1904. This plant was placed in the competent hands of Mr (now Sir) Joseph Petavel and I well remember the interest of his demonstrations of the properties of liquid hydrogen at that Exhibition. Some time later, a small liquid hydrogen plant was installed by Dr. Travers, of University
College, in the Laboratory of the late Sir William Ramsay. In the meantime, an efficient Cryogenic Laboratory had been established at Leyden, under the direction of the late Professor Kamerlingh Onnes, For.Mem.R.S. All of you are aware of his success in liquefying helium and of the wide range and importance of the investigations carried out on the effects of low temperatures on the properties of matter. It was only a few years ago that Prof. Keesom, who followed Onnes in the charge of this Laboratory, was successful in producing solid helium.

A few years ago, owing to the energy and enthusiasm of Professor J. C. McLennan, F.R.S., liquid hydrogen and helium plants were installed in the University of Toronto, and have proved their utility in a number of important researches. In recent years modern equipment for the liquefaction of hydrogen and helium has been installed in the Reichanstalt, Berlin, by Dr. Meissner, and very valuable results have been already obtained. Dr. Franz Simon, of the University of Berlin, obtains the temperature of liquid helium by an ingenious method involving the use of liquid hydrogen and the absorption of helium gas by charcoal.

I am sure it will be gratifying to the Society to know that we may soon expect to have an up-to-date Cryogenic Laboratory on a small scale in this country, and thus to take part again in the exploration of this important field of enquiry.

I should emphasise the point that the Council in deciding to incur the liability of the expense of this new laboratory have utilised the income alone of certain trust funds, while the capital of each remains intact. There is still a substantial amount of income from these Trust Funds to be allotted, in accordance with the general aim adopted and kept in view by the Society’s Council, for the furtherance of fundamental research in pure science. The policy which they may be expected to maintain in the future, is to keep watch over the whole field of scientific activity, in readiness to give help where there is promise of an important advance, and where the right man for its conduct is available. The Council look with confidence for help and support from the whole body of Fellows in the important responsibilities which they have accepted and have still to undertake on behalf of the Society.

I believe that it is in helping such important schemes of research that the Society can best utilise any research funds which it already possesses or which may become available in the near future. It not infrequently happens that a promising line of research or the development of a new method may be held up or abandoned because of the difficulty of obtaining adequate financial
support. In some important directions, advance can only be made with the help of technical assistance in the construction and use of special apparatus, in some cases on an almost-engineering scale.

By its constitution, the Society is especially well fitted to advise and support investigations of this kind with a minimum of that bureaucratic control which is generally so distasteful to the original investigator. While with our modest funds, we can only hope to support a few of such undertakings, I am sure that if more funds were needed for such an important purpose they would soon be forthcoming. This extension of the activities of the Society, whereby it is taking an active and essential part in advising and assisting in the development of fundamental science in this country, cannot fail to have a vitalising effect not only on scientific workers in general, but on the Society itself. Along such general lines, it is not difficult to foresee that the Society will exert an ever increasing influence on the progress of science and thus promote still further the original intentions of its founders.

I referred earlier in my address to the institution by the Society of the Smithson Research Fellowship. The Society was fortunate in obtaining applications for this Fellowship from a number of distinguished investigators in different branches of Natural Science. The Selection Committee, consisting of representatives of our Society and of the University of Cambridge, did not find it an easy task to make a selection from among such an able group of investigators.

The first award of the Smithson Fellowship has been made to Dr. P. D. F. Murray. After a distinguished undergraduate career in the University of Sydney, Dr. Murray spent two years in research work in the Department of Comparative Anatomy at Oxford, and since 1926, has been lecturer in Zoology at the University of Sydney. Nearly all his work has been in the field of experimental embryology, and he has investigated with conspicuous success, the factors which determine the differentiation and shaping of the limbs and other parts of the body, mostly by the method of transplanting small portions of early embryos on to the chorio-allantoic membrane, where their development proceeds, apart from the influence of the other tissues of the embryo. By this procedure and by the method of tissue culture, Dr. Murray proposes to examine the cellular differentiation of the developing chick, which underlies the coarser morphology. He will work in the first instance at the Strangeways Research Laboratory in Cambridge.

Mr. A. H. White, for so many years in charge of the Library of the Society,
has retired this year on pension. Many of our Fellows and particularly our senior Fellows, are well aware of his devoted work in the interests of the Society for such a long period, and of his unrivalled knowledge of the Society's books and history. In recognition of these services, on his retirement, Mr. White has been given the title of Consulting Librarian to the Society. He has been succeeded in his office by Mr. R. Winckworth.

Before I pass on to the presentation of medals, my last official act before the termination of my Presidency, I should like to express my gratitude to the officers and Council of the Society for the consideration and kindness they have uniformly shown me. My path has been made easy by the very efficient help that I have received both from the present officers and those who have retired during my term of office. I would like also to express my thanks to Mr. Towle and the other members of the staff for their unvarying help and kindness. I can assure my distinguished successor from my own experience that he will find his work made pleasant by their ministrations. It has been a great honour for me to preside at your counsels and gatherings, and I can assure you that I have been happy to serve the Society to the best of my powers. I thank you all for this great opportunity and privilege of service.

The Copley Medal is awarded to Sir William Bragg.

To the rapid advance of Experimental Physics in the last thirty years, Sir William Bragg has made conspicuous contributions by his pioneering researches in Radioactivity, X-rays, and Crystallography. When Professor in the University of Adelaide, he was the first to realise, in 1904, the characteristic difference to be expected in the nature of the absorption of the massive \( \alpha \)-particle and the light \( \beta \)-particles expelled from radioactive substances. His experimental researches brought out clearly the rectilinear path of the \( \alpha \)-particles and their limited range of travel. In collaboration with his students, he examined in detail the variation of the ionisation of the \( \alpha \)-particle along its path and its absorption by different kinds of matter. In his researches in X-rays and \( \gamma \)-rays, he was impressed by the difficulty that these high frequency radiations behaved like projected corpuscles—a difficulty which has only been in part resolved to-day. Following the discovery by Laue of the diffraction of X-rays by crystals, he was the first to develop a method for showing that ordinary X-radiation gave bright lines superimposed on a continuous spectrum. This reflection method of studying the spectrum of X-rays has proved of great importance to the development of knowledge. In the hands of Moseley, it supplied a means of showing that the
atoms have all a similar structure and that their properties are defined by a whole number. In the hands of Sir William Bragg and his son, Professor W. L. Bragg, it has provided a powerful tool for unravelling the structure of crystals. In this important development, which has added widely to our knowledge, Sir William Bragg has taken an active part, not only by his own researches, but by the direction of an important school of research on this subject at the Royal Institution. His work throughout is characterised not only by simplicity and elegance but by a clear grasp and exposition of the essential principles involved.

The Rumford Medal is awarded to Professor Peter Debye.

To Professor Debye are due many important advances in the field of heat and radiation. He introduced and developed a theory of the specific heats of solids which is of fundamental importance. By it, for the first time, the main phenomena relating to specific heats and their variation with temperature were quantitatively explained. He made important contributions to the theory of the scattering and reflection of X-rays. Independently of Compton, he put forward the quantum theory of the change of frequency due to the scattering of X-rays—the Compton effect. He was one of the inventors of the powdered crystal method of X-ray crystal analysis. By his introduction of the idea of spatial quantization and by his investigations relating to the electric and magnetic properties of molecules he did much to advance our understanding of radiation and molecular phenomena. In collaboration with Hückel, Debye has developed a theory to account for the properties of strong electrolytes which has many important applications.

A Royal Medal is awarded to Professor Owen Willans Richardson, F.R.S.

In his earlier work, Richardson had laid the foundation of Thermionics—a subject of the greatest theoretical and practical importance. He was the first to study in detail the escape of electrons from hot bodies in a vacuum and to give the correct interpretation of the phenomena. His investigations, continued over many years, led him to originate many of the fundamental ideas connected with the emission of electrons from hot bodies which are now universally accepted. His work on photo-electric emission was also of fundamental importance, and in it many of the now generally accepted ideas relating to interaction between radiation and matter were suggested. Among many important contributions in other fields was the prediction and calculation of the gyro-magnetic effect—the rotational torque accompany the
magnetisation of a rod. During the last ten years he has continued to make many important contributions towards the clearing up of difficulties in the subjects of his earlier investigations. In addition, he has done important work on electron emission associated with chemical action. He and his students have contributed largely towards filling up the gap between the ultra-violet and X-ray spectra. His main work in recent years has related to the hydrogen molecule, and has afforded a detailed test of the new quantum mechanics when applied to one of the simplest structures for which the old quantum mechanics breaks down. Richardson has throughout his work shown a most unusual combination of experimental skill and ingenuity with theoretical knowledge and insight.

A Royal Medal is awarded to Professor John Edward Marr, F.R.S.

At a time when few believed it possible Professor Marr discerned a delicate time-scale in the Lower Palæozoic Rocks, chiefly in the Lake District and North Wales, and applied it to elucidating the development of life and earth-structure. After testing his results in Scandinavia and in Bohemia he was able to make further use of them in setting in order corresponding rocks in South Wales. He has worked out the structure, origin and development of the mountains, lakes and rivers in Lakeland and elsewhere in the North of England, pioneer work which has been eagerly followed up by his pupils and successors. His work in association with Dr. Harker on the metamorphism brought about by the great mass of granite of Shap Fell on the rocks into which it was injected has become classic, and has inspired the rapid advance now being made in kindred studies. Of recent years he has contributed largely to knowledge of the Cambridge district, and particularly of the Pleistocene Deposits and their relation to Early Man there and in East Anglia generally. For some thirty years he gave invaluable assistance to Professor Hughes at Cambridge before succeeding him in the Chair. His labours during over forty-five years have been the chief instrument in establishing and maintaining the position in training and research now held by the Cambridge School of Geology.

The Davy Medal is awarded to Professor Robert Robinson, F.R.S.

By his investigations of the chemistry of the alkaloids, he has made notable additions to the knowledge of the structure of these complex substances, and by experiment extended by theoretical discussion he has strikingly indicated possible mechanisms of their formation in nature. His brilliant synthetical
work in connection with the colouring matters of flowers has greatly promoted the study of a group of substances of outstanding interest. His theoretical studies of the mechanism of organic reactions, in particular substitution in aromatic compounds, have led to results of great value in that they enable a very wide range of reactions to be considered from a common point of view.

The Darwin Medal is awarded to Professor Johannes Schmidt.

The Darwin Medal is given in reward of work of acknowledged distinction in the field in which Charles Darwin himself laboured. When it is remembered that the store of knowledge which Darwin accumulated on board the "Beagle" in her voyage round the world was the foundation of all his later thought and of his outlook on biological problems, the conditions of the award are without doubt fulfilled in the person of Dr. Johannes Schmidt, at the same time a distinguished oceanographer, and a recognised research worker in genetics of animals and plants. The number and extent of the voyages in small research vessels which Dr. Schmidt has accomplished with success, his large and varied collections of the pelagic fauna and flora, and the remarkable series of observations, made under his direction, on the physical and chemical phenomena of the sea, give him an undisputed place in the first rank of those scientific explorers whose labours have built up our knowledge of the oceans of the world. His researches on the life-history of the freshwater eel and the discovery of its breeding places far out in the Atlantic have proved of such general interest that they are almost as well known and appreciated by the general public as they are accepted and valued by his fellow-biologists, although in reality these researches constitute a comparatively small part of his real contributions to the science of the sea. It has already been said that, in addition to his work of marine exploration, Dr. Schmidt has devoted great attention to the fundamental problems of the science of genetics. His breeding experiments on the tropical freshwater fish, *Lebistes*, carried out in the Carlsberg Physiological Laboratory at Copenhagen, of which he is a director, are of much interest, whilst his investigations on the local races of the viviparous blenny (*Zoarces viviparus* L.) are of outstanding importance and originality.

The Hughes Medal is awarded to Sir Venkata Raman, F.R.S.

Sir Venkata Raman is one of the leading authorities on optics, in particular on the phenomenon of the scattering of light. In this connection, about three years ago he discovered that the light's colour could be changed by scattering.
This had been predicted theoretically some time before, but in spite of search the change had not been found. The “Raman Effect” must rank among the best three or four discoveries in experimental physics of the last decade. It has proved, and will prove, an instrument of great power in the study of the theory of solids. In addition to important contributions in many fields of knowledge, he has developed an active school of research in Physical Science in the University of Calcutta.

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The Isolation by Cataphoresis of Two Different Oxyhaemoglobins from the Blood of some Animals.

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Many observers have found specific differences in the properties of haemoglobins from different species (Barcroft, 1928). These differences are due—as Barcroft states—to the globins, whereas the hematin is probably the same in all haemoglobins (Barcroft, 1928).

Another important question was raised by Bohr (1892). This author advanced the hypothesis that more than one haemoglobin may be present in the same animal. Bohr’s hypothesis was also supported by Hoppe-Seyler’s investigations (Hoppe-Seyler). Crystallographic observations on haemoglobins by Reichert and Brown (1909) showed that it is possible to obtain different crystals of oxyhaemoglobin from the same blood. The oxyhaemoglobin crystals are dimorphous or polymorphous in many species of animals. A. K. Boor, criticising the findings of Reichert and Brown, states (Boor, 1930) that the conditions of crystallisation were not uniform. According to Boor, various organic impurities might have influenced the crystal habit, as well as the crystal system and form. Boor prepared oxyhaemoglobin by mixing washed red corpuscles with aluminium cream, followed by filtration in a refrigerator. The crystals were formed from the pure filtrate by adding a suitable amount of ethyl alcohol and maintaining a temperature of 0° C. or lower. Only one kind of crystal of horse oxyhaemoglobin and of horse carbon monoxide haemoglobin is reported, while dog oxyhaemoglobin was found to be represented