THE INTERNATIONAL GEODETIC CONFERENCE AT BUDA PEST.

THE International Geodetic Association held its triennial conference at Buda Pest from September 20 to 28, and I had the honour of serving as the delegate of our Government. By the kindness of the Hungarian Academy the meetings were held in their handsome building, and the arrangements for our reception, which had been made by M. Louis de Bodola, were in every way admirable. Before considering the scientific work of the conference I may mention that the Prime Minister, Dr. Wekerle, invited the members of the "Permanent Commission" to dinner, and that the Archduke Joseph afterwards received all the delegates at the palace. On subsequent days the Burgomeister of Buda Pest gave a dinner in our honour, as also did Count Albert Apponyi, Minister of Public Instruction.

The work of the conference was more interesting than that of any other at which I have been present, and the time was barely sufficient for the adequate discussion of many subjects of importance. In an article of this character it will clearly be impossible to do more than indicate in general terms the subjects which were considered.

The systematic observation of the variation of latitude, which is the special province of Dr. Albrecht, was naturally the subject of much discussion. The existence of a mysterious term in the expression for the position of the pole was discovered some years ago by Prof. Kimura. If this term, which is denoted by the letter z, has a real physical existence, it would indicate that the equator oscillates backwards and forwards, moving parallel to itself. It appeared that observations conducted in the southern hemisphere would quickly determine the reality of the supposed motion. Accordingly, at the conference of Copenhagen in 1903 it was resolved that observations in the southern hemisphere should be instituted, and should be carried out for a period of at least two years. The southern observations of latitude are to be made at Bayswater, West Australia, where Dr. Hessen began his observations on June 6, 1906, and at Oncativo, in the Argentine Republic, where Prof. Carnera began work on May 5. These two stations are in S. latitude 31° 55′ We also heard from Mr. Innes that latitude observations will probably be commenced at Johannesburg (S. latitude 26° 12′) by the end of the present year. With regard to the observations in the northern hemisphere, it was resolved that they should be continued, at least until the year 1909, when the next conference will meet. The northern stations are Pulkova and Leyden, and in N. latitude 39° 8′ Mizusawa, Charjui, Carloforte, Gaithersburg, Cincinnati,[1] and Ukiah, together with Tokyo in latitude 35° 39′. Prof. Helmert gave an interesting account of the present condition of the whole investigation, and he directed attention to certain oscillations or systematic errors of which the physical meaning is as yet altogether obscure. Whatever their meaning may be, their magnitudes are excessively minute.

Another report of importance was one by Dr. Albrecht on the use of wireless telegraphy for the determination of differences of longitude. He concludes that this method may be relied upon to give as good results as those derived from telegraphy through wires.

Dr. Hecker had undertaken, at the expense of the association, a second long sea voyage for the purpose of determining the value of gravity at sea. His first voyage was from Portugal to Brazil, and the second was in the Indian Ocean and across the Pacific. He presented a short preliminary report, in which he stated that the intensity of gravity for the deeper part of the Pacific Ocean is approximately normal, and agrees closely with Helmert's formula of the year 1901. His experience in the first voyage had enabled him to effect considerable improvements in the procedure. The method depends upon the determination of the temperature of boiling water and the simultaneous observation of the height of the barometer. The difficulties in attaining at sea to the requisite degree of accuracy are so numerous that it is matter of surprise that trustworthy results can be obtained. There seems, however, to be now no doubt that we may trust his conclusions. Dr. Hecker exhibited his apparatus with five barometers furnished with the means for obtaining continuous photographic records of the height. One of the greatest difficulties to be contended with is the motion of the ship, for the pitching and rolling make the mercury in the barometer "pump," and the photographic trace of the barometer height is marked with regular notches. Dr. Hecker is to be congratulated on the skill with which he has overcome this and many other difficulties. His conclusions form one of the most noteworthy acquisitions to geodetic knowledge of the last twenty years.

MM. Claude and Driencourt gave an account of the use of their prismatic astrolabe. It gave me the impression that it might be an instrument of much use to geodesists.

The measurement of base lines naturally afforded an important subject of discussion, and M. Guillaume, assistant director of the International Bureau of Weights and Measures at Bréteuil, gave an admirable account of the recent improvements which have been effected in the use of the Jäderin wires. It would appear that the measurement of base lines has now reached such perfection that we cannot look for any great advance in geodetic accuracy in this direction. Errors due to triangulation accumulate rapidly, and the modern practice is to measure short bases about every 200 miles. The Simplon Tunnel has been used by the Swiss geodesists as a base line, and was measured by the Jaderin apparatus. The railway company was good enough to surrender the tunnel to the geodesists for five clear days, and by means of continuous work day and night they were able to complete their task. A special form of tripod for supporting the wires was devised; it rolled along the railway lines, and in this way the labour of transporting the tripods was considerably diminished.

The national reports furnished by the several delegates were in many cases of great interest, but I can only refer to a few of them.

The work of the Swiss in the measurement of a base along the Simplon Tunnel has already been mentioned.

A proposal has been made for the collaboration of the French and Italians whereby the island of Sardinia may be linked to Corsica and to the Italian mainland.

The French delegates gave a final account of the measurement of the great arc of Peru. This work took five years, and eleven officers of the Service Géographique de l'Armée and twenty-eight under-officers and soldiers took part in it. Several of the staff died of exposure and hard work in the Cordillera, and the conference received this intimation standing, in token of respect to their French comrades who lost their lives in the cause of science.

I myself presented reports from Colonel Burrard, R.E., on the work in India, and from Sir David Gill, Colonel Morris, and Mr. Simms, on the geo-

[1] The observations at Cincinnati will, as I understand, be discontinued shortly.

detic survey in South Africa. The conference listened with interest to the account of the various difficulties which had been met with in Africa.

It is well known that the British South African Company, in fulfilment of the wishes of the late Mr. Cecil Rhodes, has up to the present year met all the heavy expense of that part of the survey along the thirtieth meridian of east longitude which runs through Rhodesia, but it has been found necessary for the company to effect various economies, and there was a doubt as to whether it might not prove necessary to suspend the survey for a time. Such a suspension would have proved most unfortunate, since there would have been no junction to the southward between the Rhodesian triangulation then completed as far as Gwelo and the Transvaal triangulation which begins at the Limpopo River. A surveying party under Captain Gordon, R.E., was already in the field in Rhodesia, and it was obvious that it would be much more economical to continue the work at once rather than to defer it until some undetermined time in the future. The expenditure needed for the survey from Gwelo to the Limpopo was estimated at 1600*l.*, and after various negotiations in England the British South African Company offered to advance half that sum, while the Royal Society, the British Association (from a fund raised principally in South Africa for the meeting of 1905 at Cape Town and Johannesburg), the Royal Geographical Society, and Sir Julius Wernher subscribed the other half. These negotiations had to be conducted very hurriedly in order to obviate the break-up of the surveying party, but by means of the telegraph and through the exertions of Sir David Gill all obstacles were overcome, and Captain Gordon began work in June. Since the meeting of the geodetic conference I have heard from Sir David Gill that Captain Gordon is making good progress. Thus in a few months the triangulation will be finished up to and beyond the Zambezi. With respect to Northern Rhodesia, preliminary reconnaissance has been made nearly as far as Lake Tanganyika, and I have reason to hope that, although Sir David Gill is retiring from his position as Astronomer Royal at the Cape of Good Hope, the British South African Company will make arrangements for the completion of the great scientific enterprise for which they have already done so much.

At Lake Tanganyika the continuation of the survey northward will fall to the Imperial German Government. The Academy of Sciences of Berlin has appointed a committee to consider the matter, and although Dr. Helmert was not able to announce that the work would be undertaken immediately, yet I think we may be confident that the northward progress of the survey will be continued in a year or two.

In Egypt Captain Lyons is making preparations for the geodetic survey southward, and I have no doubt that when the conference next meets substantial progress will be reported there also.

In the years 1903 and 1904 the International Congresses of Geology and of Academies passed resolutions in which they asked for the help of the Geodetic Association in respect to accurate levelling and measurements of gravity with a view of throwing light on the internal distribution of masses in the earth and on the rigidity and isostasy of the crust of the earth. It was entrusted to M. Lallemand and to me to draw up preliminary reports on these subjects. M. Lallemand, whilst admitting the importance of the requirements of the geologists, could not maintain that levelling has attained to such a high degree of accuracy as to betray small movements of the land relatively to the sea, but he thought that large changes of level could be detected, and he expressed the opinion that the lines of levelling ought to be repeated at such intervals as two or three times a century. For my part I could not think that it was possible for geodesists to undertake such elaborate measurements of the direction and intensity of gravity as would fully satisfy the requirements of geologists. The repetition of the levelling of a country and systematic observations of gravity entail great expense, and the conference seemed to be unanimously of opinion that they would not be justified at present in urging on their respective Governments any increase of expenditure in these directions. Nevertheless, the wishes of the geologists will not pass unnoticed, for there can be no doubt that in future campaigns with the level and the pendulum more attention will be paid than heretofore to the constitution of the country under survey.

Before referring to the resolution on this topic which was finally adopted by the conference, I must speak of two other communications of great importance. Mr. Tittmann, superintendent of the United States Coast Survey, and Mr. Hayford, inspector of geodetic work, communicated on behalf of the United States a very elaborate discussion of the anomalies of gravity throughout the United States. The conclusions at which they arrived are of great interest to geologists, for it was shown by Mr. Hayford that, at least in the United States, the matter constituting the earth is in hydrostatic equilibrium at a depth of about seventy miles below the surface. In technical language, this is the depth of isostatic compensation. In this connection Baron Eötvös, professor in the University of Buda Pest, explained his application of the torsion balance or Cavendish apparatus for determining local deviations from normality, both in the direction and in the intensity of gravity. His instrument, which we had the pleasure of seeing at the laboratories of the University, is of astonishing sensitiveness, and, so far as we can see at present, its indications are trustworthy. It would seem probable that this instrument might be used to give exactly those indications as to the distribution of internal masses of which the geologists are so desirous. The communication of Baron Eötvös was considered of so much importance that the conference directed special attention to it in the resolution which was adopted as an answer to the International Association of Academies. The Geodetic Association has at present no funds available for continuing researches with the torsion balance, but there is reason to believe that the Hungarian Government will continue to support Baron Eotvos in his researches. It may even become possible by measurements, say on Vesuvius, before and after an eruption, to find where the lava which is ejected from the crater has come from, since the displacement of large masses from beneath the mountain should be betrayed by the indications of the torsion balance.

This meeting of the conference is the last under the existing convention, which expires at the end of the present year, but it was announced that twenty of the Governments which have taken part in the existing convention have already entered into a new one for the forthcoming ten years. There is reason to believe that the Argentine Republic will also join. Indeed, Dr. Porro was at Buda Pest as representative of that Republic, and took part in our discussions.

A telegram has already appeared in the *Times*, and has been repeated in NATURE, stating that I have invited the conference to meet in Cambridge in the year 1909. This is incorrect. It is true that the association has never yet met in England, and I

believe that a meeting here would be of great value for British geodesy, but I told the conference that I had no power to give an invitation, which must come from the Government. I can only now repeat the expression of the hope that the conference may meet in this country in 1909. G. H. DARWIN.

THE FIRST "MANNED" FLYING MACHINE.

OCTOBER 23 of the present year will be remembered as a red-letter day in the history of flying machines, for it was on that day that the first flying machine, constructed on the "heavier than air" principle, successfully raised itself *and its driver* from the ground several feet, and transported itself by means of its own power over a distance of eighty yards.

In this his first successful flight with this machine. M. Santos Dumont is to be sincerely congratulated, for he has accomplished a performance which many workers in different parts of the world have been striving after for many years past and failed. M. Santos Dumont's machine is built on the aëroplane principle, and mounted on two wheels. It is fitted with an eight-cylinder, 60 h.p. motor weighing about 170 lb., and drives an aluminium fan, which makes 1000 to 1500 revolutions a minute. The motor is the work of the Adams Manufacturing Company, England. With its driver the machine weighs about 750 lb.

The aeroplane is shaped like a large T placed horizontally. The short arms of the T are slightly inclined upwards, and are each composed of three compartments, like three box-kites tied together side by side. At the base of the T is a large compartment, also like a box-kite, and by manipulating this about a horizontal axis the upper and lower surfaces act as a powerful rudder. This rudder arrangement is at the front end of the aeroplane, and the operator stands on a platform midway between, and nearly on a level with, the lower surfaces of the two main inclined arms. The driving fan is situated at the rear of the machine, just behind the operator, at the junction of the two main inclined arms.

Now that success has rewarded this daring investigator, it is of interest to take a cursory glance at the steps which ultimately led the way to success.

One naturally, in the first instance, calls to mind the very interesting experiments carried out in 1893 by Herr Otto Lilienthal near Berlin (NATURE, vol. xlix., p. 157), because Santos Dumont's aëroplane is, generally speaking, somewhat after the style of the gliding machines used by him. Lilienthal's experiments were confined to trying to learn soaring, and he employed slightly curved wings having a surface of about 15 square metres. With these inclined planes, and eventually vertical and horizontal rudders, he started from the top of a hill, and after a few steps forward jumped into the air and glided sometimes 250 metres. Lilienthal depended for the success of his apparatus on himself, trusting to his instinct to be able to keep his balance by making the necessary compensating adjustments by moving his own centre of gravity. In later experiments he employed some mechanical aid to assist him in sustaining himself longer in the air. This consisted of a small machine driven by compressed carbonic acid gas, and operating a series of feather-like sails which were capable of flapping. He found that occasional flapping of these wings helped him to cover longer distances.

In 1895 he adopted a new principle, and instead of using one large framework, employed two smaller ones, placed parallel one above the other; this method he found distinctly advantageous (NATURE, vol. liii., p. 300).

About this time Lilienthal's soaring experiments began to be taken up both in this country and in America. Mr. Percy S. Pilcher in England gained considerable experience both in the making and in the handling of these aëroplanes (NATURE, vol. lvi., p. 344). Unfortunately, as in the case of Herr Lilienthal, an accident during his experiments resulted in his death. Pilcher, however, was quite aware of the importance of using some motive power, and some time before his death proposed to employ, and actually began to make, a small and light engine, indicating about 4 h.p., to drive a fan, this being considered by him as more than sufficient for flights of moderate length. With this advance it was hoped that much greater distances could be covered, and a nearer approximation to a flying machine attained.

There is little doubt that if Pilcher had been spared he would soon have constructed and made use of the latest and lightest form of motor, and probably been led to use the double-decked form of aëroplane adopted by Santos Dumont.

By embodying the best ideas of his predecessors and using his own ingenuity to make the aëroplane a practical flying machine, Santos Dumont has advanced the science of aëronautics a very considerable step. The petrol motor has no doubt helped greatly in facilitating this progress, since high-powered engines of comparatively very light weight can be constructed.

In this pioneer work of navigating the air the work of Hiram Maxim and S. P. Langley must not be forgotten. Maxim made numerous attempts to drive his flying machine at such a speed that it would be lifted off the rails on which it ran, but on no occasion could it be said that this was successfully accomplished. Further, it was not known whether it would capsize or not if it was set free. Langley, on the other hand, was undoubtedly the first to demonstrate that a machine heavier than air could be made to travel in the air driven by its own power. The machines he made and launched were all "unmanned," but nevertheless much valuable information was accumulated.

This the latest achievement of Santos Dumont will no doubt give a fresh impetus to the problem of flight, and those who have the money and time have now before them a successful aëroplane that can serve as a starting point.

THE UNIVERSITY MOVEMENT IN WESTERN AUSTRALIA.

A MEETING in support of the movement for founding a university in Western Australia was held on September 7 at Perth, Western Australia. The chair was taken by Dr. J. W. Hackett, and the principal speakers included the chairman, the Right Rev. Dr. Riley, Anglican Bishop of Perth, Dr. Hill, master of Downing College, Cambridge, who is at present lecturing in Western Australia, and the Speaker of the Legislative Assembly, Mr. Quinlan. In 1904, during the Premiership of Mr. Walter James, 4000 acres of land in the vicinity of Perth were set apart by the Legislative Assembly as a permanent endowment for the University of Western Australia when it should come to be formed. The present income from this endowment is practically nil, but its future value is likely to be considerable.

Dr. Hackett in his remarks explained the general