all our railways. The power stations need to be placed in the best positions for civil and military needs, and all main and local lines should be properly co-ordinated. At present our railways are being electrified in a piecemeal and desultory way. A comparison is made between manufacturing conditions in this country and in Germany. The conclusions, with some of which we do not agree, are altogether in favour of the German methods. The Committee was impressed by the fact that the balance-sheets of the Allgemeine Elektricitäts Gesellschaft showed a cash balance of more than six million pounds in 1915. Another flourishing firm, the Siemens-Schückert Co., has stated that its large cash balance will shortly be depleted by the manufacture of "peace products" for stock for disposal at the end of the war.

At least, up to the present time, German manufacturing firms have had little to pay in the way of extra taxation or excess profits duty, and so English firms are naturally getting anxious. The Committee recommends that the import of enemy goods should be prohibited for three years after the conclusion of peace. Other recommendations are the imposition of import duties (in other words, Protection), combination between manufacturers, the provision of extended banking facilities, and, most important of all, the promotion of a better understanding between employers and employed and the provision of better housing and working conditions. A supplementary report is promised which will deal, *inter alia*, with education, research, the decimal system, and the consular service. As Sir Charles Parsons and Sir John Snell are on the Committee, their educational proposals will be looked forward to with keen interest.

ITALIAN METEOROLOGY.[1]

A NUMBER of interesting papers dealing with various aspects of meteorology in Italy, including results from a new station in the colony of Gebel Bengasi, have recently been issued by Prof. Eredia, director of the service. The first (1) contains the results of observations made at Nalut during the two years ending May, 1915. The co-ordinates of the station are lat. 31° 53′ N., long. 8° 45′ E., and the height 600 m. The mean temperature is 65·7° F.; that of the warmest month, July, 84·6°, and of January, the coldest month, 44·4°, showing the large variation of more than 40°. The mean daily maxima vary from 98° in July to 52·5° in January. The corresponding mean minima are 70·6° and 36°, so that the amplitude in the day values is 10° in excess of the night values. The mean daily range is 21·5°, and the absolute extremes of temperature are 111° and 23°. Compared with Tripoli, on the coast, the mean temperature is 1·6° lower. In summer (May to August) Nalut is 5° warmer than Tripoli, in winter 10° colder, the extreme differences being +6° in June and −11° in January. The annual rainfall is 194 mm. (7·63 in.), which almost all falls between December and April. The average number of days with rain in the year is nineteen. The rain falls in heavy showers of short duration, which, as a rule, do not exceed thirty minutes. Only on three occasions did the duration of a shower exceed five hours, although one rainstorm lasted two days. The heaviest fall was 1½ in. in two and a half hours, on April 4, 1915. December, 1914, was the wettest month, with 5·16 in., falling on four days during an aggregate of twelve hours, although in the same month of the previous year only 0·03 in. fell. There are 237 cloudless and 36 overcast days annually. The predominant wind is N. at all seasons, accounting for about half of all the observed winds, while winds from the E. and S.E. rarely occur.

The second paper (2) is a discussion of thunderstorm frequency over the north plains of Italy, with special reference to the barometric pressure at the time of the occurrence. Data from ten observatories are examined for the months April to October for the ten years ending 1916, with the general result that thunderstorms are most frequent with pressure under 755 mm. (29·73 in.), while a secondary maximum occurs between 759 mm. and 762 mm. Only in 5 per cent. of the cases was pressure more than 765 mm. The frequency is also discussed with reference to the relative humidity at the time of the thunderstorm. In summer the air was dry (under 60 per cent.) in one-third of the cases, but in early autumn only one thunderstorm in ten occurs with so dry an atmosphere.

The pressure conditions associated with two floods on the River Uadi, at Derna, on the coast of Bengasi, are discussed in (3), from which it is shown that in the flood of November 30, 1913, there was an anticyclone over Western, and a low-pressure area over Central, Europe. The wind at Derna, and, indeed, throughout Bengasi, changed from S. to N., indicating the passage of a depression to the north. In the flood of April 12, 1916, pressure was low to the north of Scotland and high in Portugal, with a subsidiary area of low pressure over Algeria. Details of some other rains associated with flooding in various parts of Tripoli and Bengasi are also given.

The last paper (4) summarises the work of the Italian Meteorological Office since its initiation in 1879. The geophysical branch dates from 1887, and upper-air research from 1902. In October, 1917, there were 181 stations provided with direct-reading and automatic registers, and other 341 stations observing rainfall, temperature, wind, and cloud. Of extra rainfall stations there were 161. Full particulars are given of the special researches carried out by the various sections.

A new edition of useful tables, such as are available in our own "Computers' Handbook," is given in (5), which include tables for the conversion of millimetres into the new pressure units. R. C. M.

[1] (1) Prof. F. Eredia, "Contributo alla Climatologia del Gebel," *Biblioteca Agraria Coloniale*. (2) Prof. F. Eredia, "La Frequenza dei Temporali in Val Padana," *Rend. della R. Acad. dei Lincei*. (3) Prof. F. Eredia, "Le Piene dell' Uadi di Derna" (Ministero delle Colonie). (4) "L'Officio Centrale Italiano di Meteorologia e Geodinamica," Estratto da *La Scienza per Tutti*, No. 1, 1° Gennaio, 1918. (5) Prof. F. Eredia, "Tavole ad Uso degli Osservatorii Meteorologici Italiani."

GEOLOGY OF THE BARBERTON GOLD-MINING DISTRICT.

THE Geological Survey of the Union of South Africa has issued an important memoir on the geology of the Barberton gold-mining district. This district is made up essentially of the Older Granite and the Swaziland System, probably of pre-Cambrian age, and underlying the Transvaal System, the latter being of importance mainly as determining the great escarpment of the Drakensberg; it may be noted that the latter contains auriferous deposits, both reef and alluvial, that have been worked for some thirty-five years. The tectonics of the Barberton district are very complex, intense folding in various regions, such as the Sheba Hills, having been brought about by the intrusion of the great masses of granite. One of the most interesting features of this report lies in the conclusions reached respecting the genesis of the auriferous deposits of the Barberton district. Apart from the alluvials, auriferous deposits of two types are recognised, namely, pyritic quartz reefs and zones of impregnation. The former occur mainly in the granite of the De Kaap valley, and in some of the older rocks, and in many cases the results obtained from their exploitation have been, upon the whole, disappointing. The latter include some of the best-known deposits, such as the famous Sheba Mine; the deposits do not show definite walls, and the auriferous rock does not differ from the surrounding country except by its impregnation with iron pyrites and with gold, often very finely disseminated, so that the workable limits of the deposits can be established only by continual assays. It is pointed out that the zone of contact between the granite and the adjoining stratified rocks is the area within which most of the important gold-bearing deposits are situated, and it is suggested that "gold occurrences are far more likely to be expected within the sphere of influence of the intrusive granite," this forming a belt of country averaging about three miles in width. Furthermore, in prospecting, it should not be forgotten that many of the payable deposits of the Barberton district take the form, not of the well-defined quartz reef, with which most prospectors are familiar, but of "mineralised zones of impregnation, sometimes almost indistinguishable from country rock."

THE SPINNING-TOP IN HARNESS.[1]

THE gyroscopic theory of the lecture and its applications was illustrated by experiments with apparatus designed to show the chief principles of gyroscopic motion on a large scale, so as to be visible to an audience; some bicycle-wheels and a Maxwell dynamical top were used.

The lecture began with a quotation of the initial sentence of Maxwell's own description of his top, as given to the Royal Society of Edinburgh, April, 1857, and the phrase "the perplexities of men who had successfully threaded the mazes of the planetary motions" was interpreted as a sly, malicious dig at Newton and his struggle in the "Principia" with the gyroscopic theory of precession.

Twirled by the left hand, the dynamical top gives the appropriate precession in direction; called precession because the seasons come up in consequence of it twenty minutes earlier each year than otherwise, and twenty minutes a year gives the twenty-six thousand years required for a complete revolution among the stars.

Two large 52-in. bicycle-wheels were employed as spinning-tops on the floor, made originally by Prof. C. V. Boys for his Otto bicycle. A hub was fitted with ball-bearings, carrying a spike and a long stalk. Spun by hand, with the spike resting in a small cup raised about 3 ft. from the floor, the evolutions of the wheel could be watched as they became more violent, and finally extinguished when the rim reached the floor.

When the stalk was grasped and raised horizontal and the wheel spun, the gyroscopic effect was very marked if the wheel was allowed to drop or the stalk was brandished. Letting the spike rest in the hand, the wheel moved round in precession, and Kelvin's rule could be shown off in the alteration of the inclination of the axle.

According to this rule, "Hurry the precession, and the axle rises against gravity." This is observed instinctively in riding a bicycle on the road. To avoid an object the bicycle must be steered towards it in a smaller circle, so as to rise and swerve away. A bicycle cannot run straight.

The stability of the axle was shown by hammering the wheel-rim with a stick, causing it to flinch only slightly, but hurrying the precession.

The mathematical theory was too complicated to be undertaken in the course of an hour's lecture, even when stated in Poinsot's concise manner, "which has brought the subject under the power of a more searching analysis than the calculus, in which ideas take the place of symbols and intelligible propositions supersede equations."

The elliptic function theory arises in all its complexity, and appears as if created to speak the language of gyroscopic theory.

Two special cases of motion were suggested to interest the mathematicians in the audience, where the equations are quasi-algebraical, and may be employed as typical illustrations in the wilderness of general theory:—

(1) Project the axle of the gyroscope horizontally with no spin of the wheel; this gives a spherical pendulum motion, as of the bob of a simple pendulum projected so as to move in a spherical curve, and not in plane oscillation.

(2) Spin the wheel and hold the axle up at an angle above the level, such that when let drop the axle reaches the horizontal and rises again, and so on to a series of cusps.

This motion was illustrated on the gyroscopic apparatus exhibited, an ordinary 28-in. bicycle-wheel and hub screwed to a stalk, a short length of steel rifle-barrel, suspended in altazimuth freedom from a vertical spindle, another bicycle hub, fastened to an iron bracket, bolted to the underside of a wooden sleeper supported on brackets—not a thin lath, as I found them trying in Rome with the specimen I had sent to the Mathematical Congress in 1908. All details to be bought cheap or easily constructed.

The three angles, θ, ψ, ϕ, introduced into the treatment by Euler (1750), were shown in the altazimuth suspension: θ is the angle of the axle with the nadir downward vertical; ψ is the azimuth; while ϕ measures the rubbing angular displacement of the wheel over the axle.

The exact dynamical interpretation of ϕ is rather delicate in its relation to the rotation of the wheel about a moving axle. Thus, starting with the wheel at rest on the axle, we cannot turn it by twirling the axle. But move the axle round in a conical way back to rest at its original start, and we find the wheel has turned round on the axle through an angle ϕ proportional to the conical angle described by the axle. So here is an answer to the challenge of Aristotle: to turn a sphere round that is perfectly smooth, or spitted along a perfectly smooth diametrical axle.

In showing the θ and ψ displacement in altitude and azimuth, the wheel must be held to the axle by the thumb; as, if free, the angle ϕ will come into existence.

Anyone can show this off with a pencil or penholder held between finger and thumb.

The small bicycle-wheel is dismounted by removing the supporting pin, and can then be spun by hand as another top alongside the large wheel, or else superposed, as in Maxwell's experiment of the "top on the top of a top," thus forming two links of a gyrostatic chain, standing up like a *will o' the wisp*, which may be supposed in imagination to reach up to the ceiling, as a mechanical model of the electromagnetic rotary polarisation of light.

Sir William Thomson gave an elaborate mathematical investigation of the vibration and wave propagation, but this can be simplified and brought under elementary treatment by considering the gyrostatic chain as a uniform helical polygon rotating uniformly about the vertical, as I have explained in my Report on Gyroscopic Theory (1914).

Any similar discussion of a double pendulum, as of a bell and clapper, or a chain of links, is simplified in this manner by comparing the oscillation with a

[1] Abstract of a discourse delivered at the Royal Institution on May 3 by Sir George Greenhill, F.R.S.