5. The numerous attendants of the old steam engines and boilers have mostly been transferred to other work, only a few of them are required at the central station, and one or two men can easily look after all the electric motors used in the various parts of the works.

Elsewhere equally favourable results have been obtained by the introduction of electrical distribution of power, and in this respect I beg to refer you to a paper read before the German Institution of Civil Engineers by Mr. E. Hartmann in April of last year, and to a paper read by Mr. Castermans before the Society of Engineers in Liège, in August last, in which he compares in detail various methods of transmission of power, of which the electrical one was adopted for a new small arms factory.

We may therefore take it for granted that the advantages alluded to above have not resulted from local circumstances at Woolwich, but that they can be realised anywhere by the adoption of the electric current for distributing power from a central station.

At first sight this result appears to be of interest only to the manufacturer; but the development of this idea may lead to far-reaching consequences, when we consider that cheap power is one of the most important requisites for cheap production.

While power was generated by steam engines the cost of producing one-horse-power varied a good deal in the different parts, and the various owners could not have obtained their power on equal terms, those possessing the largest steam engines having a distinct advantage. This inequality is done away with altogether when the power is distributed by electricity, as the current can be supplied for large or small powers at the same rate per Board of Trade unit. It is therefore clear that the establishment of central stations for the generation of electricity on a large scale will bring about the possibility of small works competing with large works in quite a number of trades where cheap power is the first consideration.

Another circumstance favouring small works is the diminution of capital outlay brought about by the employment of electric motors. Not only are the motors cheaper than boilers and steam engines of corresponding power would be, but the outlay for belting and shafts is saved, and the structure of the building need not be as substantial as is necessary where belts and shafting have to be supported by it. A commencement has already been made in this direction by the starting of electric light stations, where the owners do all in their power to encourage the use of the current in motors, in order to keep the machinery at their central station more uniformly at work. The introduction of electricity as motive power will apparently present a strong contrast to the effect steam has had on the development of industries for the reasons already stated; and in addition there are many cases where the erection of boilers and steam engines, or even of gas engines, would be inadmissible on account of want of space or of the nuisances that are inseparable from them. Motive power will therefore be available in a number of instances where up to the present time no mechanical power could be used, but the work had to be done by manual labour or not at all.

You may have noticed that I have confined my remarks hitherto to the case of distributing electricity over a limited area, but that I have not yet discussed the question of transmitting power to a great distance.

Theoretically we have been told over and over again that the motive power of the future will be supplied by waterfalls, and that their power can be made available over large areas by means of electric currents. As a prominent example the installation is constantly mentioned by which the power of a turbine at Lauffen was transmitted over a distance of 110 statute miles to the Frankfurt Exhibition with an efficiency of 75 per cent. No doubt this result is very gratifying from a purely scientific point of view, but unfortunately in practical life only commercially successful applications of science will have a lasting influence, and in this respect the Lauffen installation left much to be desired. On the one hand science tells us that the section of the conductor can be diminished as the pressure of electricity is increased, and it appears to be only necessary to construct apparatus for generating electricity at a sufficiently high pressure so as to reduce the cost of a long conductor to reasonable limits. On the other hand, experience shows that at these high potentials the insulation of the electric current becomes a most difficult problem, and for practical purposes difficulty means an increased outlay of money.

MAGNETICAL AND METEOROLOGICAL OBSERVATIONS MADE AT THE GOVERNMENT OBSERVATORY, BOMBAY, 1890, WITH AN APPENDIX.

THIS volume, we are informed, is the thirtieth of the series of "Bombay Magnetical and Meteorological Observations," extending the previous record from 1845 to 1889, up to 1890. At this well-organized observatory, under the direction of Mr. Charles Chambers, continuous registration of the different magnetical and meteorological elements is maintained by means of automatic recording instruments, of which there are five sets, the magnetographs (three), the barograph, the thermograph, the pluviograph, and the anemograph, all being photographic records excepting that of the anemograph, which is mechanical. In addition eye observations are also made, including the usual meteorological observations of weather and other phenomena. Daily values for 1890 are given of atmospheric pressure, temperature of the air, rainfall, wind and cloud, with some further discussion of the anemometric results; five day means of meteorological elements are also given. In the magnetic section is found observations of absolute horizontal force, magnetic declination and dip, at short intervals throughout the year. And in the appendix is contained a collection of the monthly values of declination and horizontal force from 1868 to 1890, accompanied by a discussion of the secular changes of these elements. In regard to declination the results show the eastern magnetic declination to have increased during the early years of the series, arriving at a maximum at about the middle of the period, and decreasing in the later years. Taking the annual values of declination to be represented by the formula $\delta = at^2 + bt + c$, it is found that the maximum easterly declination occurred in 1880, with value 0° 57′ 17″. This actual observation of the turning-point at this place, in the long cycle of change, is very interesting. The horizontal force values are similarly discussed, but in this case the values are generally progressive. There is no discussion of diurnal inequalities, but these were elaborately treated in a previous volume. Magnetic observatories in tropical and southern regions are valuable. Many exist in Europe with others scattered over different parts of the northern hemisphere, generally publishing with regularity their results, but there is a want of similar establishments in southern regions. There are magnetic observatories at Batavia, Mauritius, and Melbourne, but we do not get from them all that might be desired. England possesses no regularly maintained southern establishment of this kind. A magnetic observatory existed many years ago at the Cape of Good Hope, which, long since destroyed, we believe, by fire, was never again reorganized, which was unfortunate. The attention of the Magnetic Committee of the British Association was several years ago drawn to the question of re-establishing the Cape Magnetic Observatory, and in the Report of the Committee for the year 1891 it is stated that a representation had been made to the Admiralty as to the desirability of so doing. An efficient magnetic observatory in such a position, with regular publication of the results, would provide information of great value for the discussion of various questions in magnetic phenomena that now arise. It would be well also if the study of earth currents were taken up at some of the magnetic observatories in different parts of the world by continuous photographic registration thereof, for the better elucidation of the physical relation that may exist between magnetic and earth current variations, in regard to which our knowledge seems at present to be so imperfect.

BACTERIA AND BEER.

THE examination of water for micro-organisms since the publication by Koch in 1881 of his beautiful process of gelatine-plate cultures has come more and more into general use, as the public has gradually become cognisant of its value for hygienic and practical purposes. But whilst affording much valuable information on many subjects, Hansen has pointed out, as far back as 1888, that as applied to the examination of waters for brewing purposes it cannot be considered wholly satisfactory. Working on lines suggested by Hansen, Holm has recently published a paper, "Analyses biologiques et zymotechniques de l'eau destinée aux brasseries" (*Compte-rendu des travaux du laboratoire de Carlsberg*, vol. iii., Copenhagen, 1892), in which he describes a large number of investigations on brewing-waters examined by Hansen's method, and in which the relative merit for brewing

purposes of Koch's and Hansen's processes is also discussed. It is obvious that the organisms to be feared in a brewery are those which will flourish in wort or beer, and that the mere knowledge of the number of bacteria in any given water as revealed by gelatine plate cultures is but of little use. Hence Hansen and his pupils reject for such examinations gelatine-peptone, substituting sterilised wort and beer as a culture material. An interesting table is given showing the different bacteriological results obtained in the use of gelatine-peptone, gelatine to which wort had been added, wort alone, and beer. For example, whereas a particular brewing-water yielded by gelatine-peptone about 8000 colonies per c.c., the majority of which were bacteria; gelatine mixed with wort gave about 14, all being moulds; in wort 5·4 were found, consisting of bacteria and moulds, whilst sterilised beer gave only 0·8 for the c.c., and only moulds. Holm points out that to estimate the value of a water for brewing purposes a note should also be made of the rate at which the organisms develop in the wort or beer, for should signs of growth only declare themselves after four or five days in the laboratory under favourable conditions of temperature and in the absence of competing forms, it is not unnatural to expect that their vitality, under the more rigorous conditions imposed during brewing operations, would be so far impaired that their development, if taking place at all, would only be accomplished with great difficulty. Although instances occurred in which even after the lapse of seven days growths first made their appearance, yet in the majority of cases the incubation of the wort-flasks for one week was sufficient. Holm is of opinion that the use of other culture materials besides wort is unnecessary, as all the organisms which successfully develop in beer can also grow in wort. Moreover, it was found that in the process of sterilisation to which the beer was submitted a considerable proportion of its alcohol was lost, thus diminishing its natural bactericidal properties. A beer containing 5 to 6 per cent. of alcohol, after sterilisation, had this reduced to 2·8 per cent., although it even then proved a very unfavourable medium for the development of ordinary water bacteria. As a practical outcome of his experiments Holm emphasises the necessity of a careful selection of the site for the erection of the water-reservoir attached to a brewery. The reservoirs of the old brewery at Carlsberg are placed in the immediate vicinity of the storehouses for grain and malt, consequently in this water a far larger number of moulds were met with than in the water examined from differently situated reservoirs supplying the laboratory and another brewery. But although moulds usually predominate, yet they are not so much to be feared as the bacteria, more especially those which are found in the fermentation chamber, for although they are unable to assert themselves to any considerable extent in the beer preserved in the store cellar, yet when it is drawn off and thus aërated, and the temperature raised by its transference to bottles or small casks, these organisms can develop with an astonishing rapidity, and produce great mischief.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Shore, of St. John's College, late Examiner in Physiology, has been elected a member of the Special Board for Medicine; Dr. A. Macalister, F.R.S., St. John's, has been appointed an elector to the Professorship of Chemistry; Dr. Ferrers, F.R.S., Master of Gonville and Caius, an elector to the Plumian Professorship of Astronomy; Prof. Newton, F.R.S., Magdalene, an elector to the Professorship of Anatomy; Dr. Phear, Master of Emmanuel, an elector to the Professorship of Botany; Dr. R. D. Roberts, Clare, an elector to the Woodwardian Professorship of Geology; Mr. P. T. Main, St. John's, an elector to the Jacksonian Professorship of Chemistry, &c.; Mr. R. T. Glazebrook, F.R.S., Trinity, an elector to the Professorship of Mineralogy; Mr. F. Darwin, F.R.S., Reader in Botany, an elector to the Professorship of Zoology and Comparative Anatomy; Mr. W. D. Niven, F.R.S., Trinity, an elector to the Cavendish Professorship of Physics; Dr. Phear, an elector to the Professorship of Mechanism; Prof. Liveing, F.R.S., St. John's, an elector to the Downing Professorship of Medicine; Dr. P. H. Pye-Smith, F.R.S., an elector to the Professorship of Physiology; and Sir G. M. Humphry, F.R.S., an elector to the Professorship of Pathology.

SCIENTIFIC SERIALS.

American Journal of Science, February.—Isothermals, isopiestics, and isometrics relative to viscosity, by C. Barus. The substance experimented upon was marine glue, and its viscosity at different pressures and temperatures was measured by a transpiration method, the substance being forced through steel tubes 10 cm. long and 0·5 to 1 cm. in diameter under pressures as high as 2000 atmospheres. It was found that in proportion as the viscosity of a body increases with fall of temperature, its isothermal rate of increase with pressure also increases. Speaking approximately, the rate at which viscosity increases with pressure at any temperature is proportional to the initial viscosity at that temperature, and, conversely, the rate of decrease with temperature is proportional to the actual temperature and independent of the pressure. An interesting result is that in high pressure phenomena at least 200 atmospheres must be allowed per degree Centigrade, in order that there may be no change of viscosity.—"Potential," a Bernoullian term, by Geo. F. Becker.—Datolite from Loughboro, Ontario, by L. V. Pirsson.—A new machine for cutting and grinding thin sections of rocks and minerals, by G. H. Williams.—Stannite and some of the alteration products from the Black Hills, S.D., by W. P. Headden.—Occurrence of hematite and martite iron ores in Mexico, by R. T. Hill, with notes on the associated igneous rocks, by W. Cross.—Cæsium lead and potassium-lead halides, by N. L. Wells.—Ceratops beds of Converse County, Wyoming, by J. B. Hatcher.—Use of planes and knife-edges in pendulums for gravity measurements, by T. C. Mendenhall. The employment of a pendulum to which the plane is attached instead of the knife-edge presents several advantages. The plane may be accurately adjusted at right angles to the rod by simple optical methods. A pendulum carrying a plane instead of a knife-edge is vastly less liable to injury, and the knife-edge being no longer an integral part of the vibrating mass can be reground or replaced at will. The length of the pendulum is more capable of accurate determination, since the error introduced by the yielding of the edge under pressure is eliminated. The disadvantage due to the uncertain position of the axis of oscillation can be mechanically got rid of by a proper construction of the raising and lowering apparatus, and experiment shows that the period in the course of twelve sets of swings of an hour each does not vary by as much as one part in a million. The best angle for the knife-edge was found to be about 130°, the material used being agate.—Preliminary note on the colours of cloudy condensation, by C. Barus. If saturated steam is allowed to pass suddenly from a higher to a lower temperature in uniformly temperatured, uniformly dusty air, a succession of colours is seen by transmitted white light which, taken in inverse order, are absolutely identical with the colours of Newton's rings of the first two orders.—Lines of structure in the Winnebago Co. meteorites and in other meteorites, by H. A. Newton (reprinted in this issue).—Preliminary note of a new meteorite from Japan, by Henry A. Ward.—Restoration of Anchisaurus, by O. C. Marsh (see Note, p. 349).

American Journal of Mathematics, vol. xiv. No. 4 (Baltimore, 1892).—The main object of the note on the use of supplementary curves in isogonal transformation, by R. A. Harris (pp. 291–300), is to show how the problem of representing one plane conformably upon another, using any real function of the variable, may be made to depend upon the problem of constructing supplementary curves from given tracings of the corresponding principal curves. It is well illustrated by four carefully drawn figures. In her memoir (pp. 301–325) on the higher singularities of plane curves, Miss C. A. Scott goes over ground to some extent previously occupied by Profs. Cayley and H. J. S. Smith in writing on the same subject (*cf.* also papers by Brill and Nöther in the *Math. Annalen*, vols. ix. xvi. xxiii.). Nöther's results are presented in analytical form, "involving no dependence on geometrical ideas even when geometrical terms are used." The author brings out his results more clearly by making use of Dr. Hirst's method of quadric inversion. The text is accompanied by twenty-seven drawings of curves. Mr. W. H. Metzler, writing on the roots of matrices (pp. 326–377), employs a modification of Dr. Forsyth's method of proving Cayley's "identical equation" ("Messr. of Mathematics," vol. xiii.) to prove Sylvester's law of latency and Sylvester's theorems. He also investigates the existence of roots of matrices for different indices, and in particular the roots of nilpotent matrices. A