basis of all classifications. Many attempts of improving it have from time to time been made, but the problem of obtaining a more perfect nomenclature still remains, to a great extent, unsolved. When such an accomplished bibliographer as Dr. Hellmann undertakes the reproduction of a work, we may be sure that he will tell us all that can be known about it, and few persons can read his introductory remarks without learning something. Comparatively few copies appear to have been reprinted from the *Philosophical Magazine*, and Dr. Hellmann points out that the first part of the text was set up afresh, as some of the lines do not exactly agree ; also, that some small omissions were made in the separate copies of 1803 which have been added to this new edition. In 1832 a second edition was issued without plates; but in 1849 L. Howard appears to have drawn a new set of cloud pictures, and these, although not considered to be equal to the first, were included in the third edition, published in 1865. Many other details of great interest are given by Dr. Hellmann, to which we cannot now refer. We may mention that the plates only are actual *facsimiles*, while the type of the text is as nearly as possible like that of the original work.

The additions to the Zoological Society's Gardens during the past week include a Slow Loris (*Nycticebus tardigradus*) from Malacca, presented by Captain Spalding ; two Sooty Mangabeys (*Cercocebus fuliginosus*, ♀ ♀), an African Civet Cat (*Viverra civetta*), two Royal Pythons (*Python regius*) from West Africa, presented by the Rev. Canon J. Taylor Smith ; two Crested Porcupines (*Hystrix cristata*) from South Africa, presented by Mr. Adrian Vander Byl ; a Water Vole (*Arvicola amphibius*) British, presented by Colonel L'Estrange ; a Buzzard *Buteo vulgaris*) British, presented by Colonel C. B. Rashleigh ; a Raven (*Corvus corax*) British, presented by Miss P. L. Graham ; two Pin-tailed Sand Grouse (*Pterocles alchata*, ♂ ♀) South European, a Black Gallinule (*Limnocorax niger*) from East Africa, two —— Moorhens (*Gallinula* sp. inc.) from Madagascar, presented by Mr. H. H. Sharland ; four Swainson's Francolins (*Francolinus swainsoni*), a Delalande's Lizard (*Nucras delalandii*), a Rough-keeled Snake (*Dasypeltis scabra*) from South Africa, presented by Mr. J. E. Matcham ; a Chimpanzee (*Anthropopithecus troglodytes*, ♂) from West Africa, a Lioness (*Felis leo*) from India, deposited ; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a White-backed Trumpeter (*Psophia leucoptera*), a Short-tailed Parrot (*Pachynus brachyurus*) from the Upper Amazons, a Blackish Sternothere (*Sternothærus subniger*) from Madagascar, purchased ; two Barbary Wild Sheep (*Ovis tragelaphus*, ♀ ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Four New Variable Stars.—Prof. E. C. Pickering announces (*Astr. Nach.* 3225) that four new variable stars have been discovered by Mrs. Fleming from the presence of bright hydrogen lines in photographs of their spectra taken in connection with the Henry Draper Memorial. The first of these is a star in the constellation Sculptor, having the co-ordinates R.A. 0h. 10·4m. Decl. – 32° 36′. The range of variability of this star is from magnitude 6·5 or 6·6 to 10·0, and the period 366 days. The second star is Arg.-Oeltz 16121, in Scorpius, its exact position being R.A. 16h. 50·3m. Decl. – 30° 26′. The range of variability is from 7·3 to 11·6 magnitude, and the period is 278 days. The star B.D. + 1°·3417, in the constellation Ophiuchus (R.A. 17h. 14·5m. Decl. + 1° 37′) is the third of the variables discovered, the range in this case being from magnitude 8·5 to 12·5, and the period 348·4 days. The fourth star is B.D. + 4°·4250, in the constellation Aquila (R.A. 19h. 46·5m. Decl. + 4° 13′). Its period is about a year, and at the last maximum on August 12, 1893, its photographic magnitude was 9·5. At a minimum it becomes fainter than the twelfth magnitude.

Speed of Perception of Stars.—When working at the Etna Observatory during a high wind, Prof. Riccò noticed how the pole star and its companion appeared to change their mutual distance at every vibration of the telescope. The phenomenon was not observed on the following night, which was calm, but could be reproduced by shaking the telescope. The pole star appeared in every case to move more rapidly than its companion. This observation has been communicated to the *Società degli Spettroscopisti Italiani*, and connected with Prof. Schaeberle's investigation of the difference of personal equation between bright and faint stars observed in transit. Schaeberle estimated the apparent retardation of faint stars at 0·02 sec. per magnitude. Prof. Riccò proposes to redetermine this by measurements of stellar distances by the micrometer as compared with the transit instrument. That the colour may have a determining influence is shown by the fact that when a spectrum is displaced rapidly at right angles to its length, the more refrangible portions appear to lag behind.

Elements and Ephemeris of Gale's Comet (*b* 1894).—The following elements and ephemeris are given in a supplement to *Astronomische Nachrichten*, No. 3225 :—

T = 1894 April 13·75 G.M.T.

$$\left.\begin{aligned} \omega &= 324^\circ\ 19' \\ \Omega &= 206\ \ 15 \\ i &= 87\ \ 15 \end{aligned}\right\}\text{Mean Eq. } 1894{\cdot}0.$$
$$q = 0{\cdot}9849$$

Ephemeris for Greenwich Midnight.

1894.		R.A.		P.D.
		° ′		° ′
April 26	...	101 38	...	124 23
30	...	115 22	...	109 31

The comet is increasing in brightness, and on April 30 it will be 6·05 times brighter than at the time of discovery.

A Mistaken Cometary Discovery.—From a note by Prof. Krueger in *Astronomische Nachrichten*, No. 3224, it appears that the object seen by Mr. Holmes on April 9, and afterwards announced as a new comet, is really the nebula No. 6503 in the New General Catalogue.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The meeting of the Institution of Mechanical Engineers was held last week in the theatre of the Institution of Civil Engineers, on Thursday and Friday evenings, April 19 and 20. The chair was taken by the President, Prof. Alexander B. W. Kennedy, F.R.S. Two papers were read at the meeting : the first, "On the Grafton High Speed Engine," by Mr. E. W. Anderson ; and the second, "On Fluid Pressure Reversing Gear," by Mr. David Joy. The President's address was, however, the chief feature of the meeting, and to this we shall mainly confine our report, more especially as it would be difficult to give an adequate description of the mechanical devices upon which the two papers were founded without somewhat elaborate illustrations.

After the usual formal proceedings, Prof. Kennedy read his address. It had been expected that in consequence of the leading part the President has recently taken in the development of electrical engineering that the address would deal largely with that subject, and in this respect the result proved to be in accordance with general expectation. The address pointed out that practical electrical problems divided themselves into three main sections, in which electrical energy is used, respectively : firstly, for lighting; secondly, for power; and thirdly, for physico-chemical processes. The third section, which relates to the deposition of metals, the reduction of chemical compounds, &c., was one in which the President had not had experience, but he had no doubt that there was a great future before it. In this section he also included the application of electricity to heating, and said it was to be hoped that there being so many competent workers engaged in the study of this subject, success would soon attend their efforts. The commercial problem of producing the heat sufficiently cheaply to allow of its general use was yet to be overcome. Remembering, however, that something like 95 per cent. of all the energy that goes to incandescent lamps appears only as heat and not as light, there would seem to be an ample opening here for another "thermal storage" process. The use of electrical energy for power, *i.e.* for transformation into mechanical energy, is, the President pointed out, a matter which lies obviously in the closest possible communication with mechanical engineering. He divided this branch of the subject into three sections, namely: (1) Transmission from a distance for whatever purpose; (2) transmission to a number of isolated points pretty near together, as the tools in a factory; (3) transmission for the purpose of traction on railways or tramways. Transmission comes in in every case, because we have as yet no electric prime mover analogous to a steam engine. With regard to transmission of power from a distance, the President said that Prof. Unwin had so fully and ably dealt with the matter recently, that it was unnecessary for him to go over the same ground again. The question of driving tools in a factory by electric motors instead of through counter shafting, is one which has recently come to the front. The carrying out of such work is obviously purely a matter of mechanical engineering. Prof. Kennedy had been at pains to collect information in regard to practical work bearing on this subject. In any given factory running on the ordinary system there is a large continuous waste of power due to the running of the whole shafting, no matter how many or how few machines are at work. The President gave the following figures as the approximate distribution of total work:—

	H.P.
Average useful work	100
Waste in belts and shafting	25
Waste in engine friction, the engine being supposed large enough to give 150 horse-power at tools as a maximum (at about 10 per cent. of maximum horse-power)	20
	145

On the other hand, if all machines in a similar case were driven by separate motors, each having an electrical efficiency of 88 per cent., and these motors worked from a dynamo having an efficiency of 92 per cent. (both of which are high figures for ordinary work at two-thirds of the output), the figures would stand as follows:—

	H.P.
Average useful work	100
Waste in motors and dynamo	24
Waste in leads (say 2 per cent.)	2
Waste in engine friction	20
	146

The two sets of figures it will be seen are practically the same, and the President pointed out that the electrical efficiencies which he had assumed were not likely to be exceeded. It is not, however, the really absolute saving so much as the proportionate saving which should be considered. It is little use to show an engineer that he can make even 20 per cent. saving in one item of expenditure, if that item only represents 3 or 4 per cent. of his costs, and if at the same time he has to expend a considerable amount of capital in making the change. One does not make important and expensive changes, especially changes whose results are by no means very certainly predicted to bring about an estimated saving of one-half of 1 per cent. to 1 per cent. in one's total expenditure. There are, however, other points to be considered, such as the practical convenience of getting rid of the huge mass of shafting gear and belting which fills up the upper half of many engineers' shops, and also that a properly arranged motor may give a much larger range of speed to each tool, than can be readily obtained in the ordinary way. On the other hand, the President pointed out that the cost of dynamo, leads, and motors is very greatly in excess of the cost of shafting in almost every case. It is hardly certain as yet, he said, how the costs of attendance, lubrication, renewals and repairs to the electrical plant, compare with the similar costs in the case of shafts and belting; probably, he said, on the whole they would be less.

The difficulty which besets the electrical engineer, of unequal demand for energy, was dwelt upon in the address. As is sufficiently well known, the demand for lighting energy varies enormously throughout the twenty-four hours, so that a plant which is giving 2500 horse-power for a couple of hours every day, will only be giving an average of 350 horse-power for the whole week, and not even half this for many hours every day and night. If it could be arranged that during the time of light load for lighting purposes, the plant could be used for powe purposes, then electrical energy might be sold at a low price This, however, is not possible, the electrical station must be prepared for any demand, and in case of fog, for instance, lights might be required when the factories were at work; the plant would therefore have to be designed to supply both demands. Electric transmission of power has, however, this advantage over belts and shafting, that when the machinery is not at work there are no losses in the motors; whereas, whilst shafts are being run and belts are at work there is loss through friction.

Prof. Kennedy, in referring to the driving of trains or tramcars by electric power, said that conditions were by no means so favourable as were sometimes supposed. The ordinary engine exerted about 80 per cent. of the gross indicated horse-power in pulling its load along the line. In an electric railway there was a somewhat lighter locomotive to be moved, but against this advantage, and the fact that a stationary engine can have a greater economy than a locomotive, was to be placed the fact that only about 35 per cent. of the indicated horse-power is available for useful work for pulling a train, the loss of course being the number of transformations through which the energy has to pass. In reference to this part of the question the following figures were given:—

	Per cent.
Mechanical efficiency of engine	85
Efficiency of belt driving, if employed	94
Efficiency of dynamos	90
Efficiency of line	85
Efficiency of motors...	85
Efficiency of gearing of motors	75
Total efficiency	39

From this would be deducted the power required for driving the locomotive, leaving 35 per cent. for pulling the train. In spite of this great drawback of loss of power, some conditions rendered electrical traction absolutely necessary. In the public streets there is the great mechanical difficulty of getting the current to the motors on the cars. In America overhead wires are used, and in country laces, the President said, this is possibly the best solution of the problem; but in cities he considered it to be impossible, and that the introduction of electricity for car driving in this country will still wait for a practical underground system to be devised. In the meanwhile, electricity is being hard pressed by its rivals, cable and compressed gas, Prof. Kennedy thinking the latter far the more formidable. It has the advantage of being even more direct than a steam engine, and it can be applied to each individual car even more easily than an electric motor, and it enables the car to run freely on ordinary lines without their reconstruction and without any mains either above or below ground. It has had but a short trial, but what the President had seen of it made him sanguine as to its ultimate possibilities. Prof. Kennedy also referred to the Serpollet boiler and engine, which he wondered had not been introduced for tram work. The Serpollet machinery takes so little space that it might very possibly be put on the car itself, but he supposed some difficulty had been found in the application; at any rate, the proposal had not been made, so far as he knew. We may mention that a number of road carriages, propelled by the Serpollet boiler and engine, have been in use for some time past in Paris.

The address next dwelt at some length on the question of security in running, in efficiency of regulation, and economy of work. In regard to the former the President pointed out the necessity of duplication of plant in order to provide against breakdown of engines or dynamos, and the difficulty of starting boilers with rapidity supposing a sudden call to be made for additional steam. In regard to security in connection with mains, he referred to Mr. Bailey's looped main system. In speaking upon the question of economy, Prof. Kennedy said that in an electric light station the cost of coal averages not far from four-tenths of the total of working expenses. He did not know of any one type of boiler which was better than all others under the conditions of an electric light station; in fact, he said there were five or six types equally good. One thing which tells very much against the economy of electric light stations is that fires must be kept alight and pressures maintained in boilers capable of giving eight or ten times the actual output; added to this is the extent to which in all stations fuel must be expended in getting boilers ready for the heavy load which comes on only once in twenty-four hours. Prof. Kennedy found that the total stand-by losses can be reduced in some cases to 8 per cent. of the total fuel; below this he had not yet succeeded in going, and he thought it was often considerably more than 10 per cent. He was of opinion that the greater waste of fuel occurred beyond the boilers, as it is more easy to get a good evaporation per pound of coal than a small consumption of water per indicated horse-power. Heavy causes of loss are by the condensation in steam pipes and by leakage. These are probably greater in electric light stations than in most other places, because security requires the use of a very elaborate system of steam pipes. Of steam traps Prof. Kennedy has not much that is favourable to say; he refers to them as the "apparatus which we call by courtesy steam traps," and says they require more looking after than the whole of the rest of the machinery put together. He thought also that sufficient attention is not paid to the proper covering of the pipes, including their flanges. He thought the use of super-heated steam might be found very largely to reduce this particular cause of waste. The cost of oil, water, and stores he puts down as averaging about one-fifth the cost of coal alone. Discussing the losses between the indicated horse-power developed and the records of the consumers' metres, the President said that the loss in the engine itself might be taken as about 10 per cent. of the full power of the engine, and remained very nearly constant at all powers so long as the speed was constant. The efficiency of the dynamo at full load might be as much as 95 per cent., so that the ratio of electrical indicated horse-power of a first-class steam-engine and dynamo might be 85 per cent. at full load, whilst at half load it would be about 76 per cent. This was assuming that the engine drove the dynamo direct, and he considered that direct driving with equal running engines was the proper method of proceeding. The losses between the dynamo terminals and the consumers' lamps in a low tension system are simply losses in the leads; in a high tension system they cover the losses in general, which are much smaller in the leads and in the transformers as well. Prof. Kennedy did not consider it desirable, however, to enter into a discussion on the respective merits of the two systems, but stated that as far as the figures to which he had access were concerned, he found that in the case of a low tension system where the maximum proportion of loss in the feeders is allowed to reach 20 per cent. or thereabouts, the actual average loss of energy throughout the whole year amounts to about 10 per cent. This was of course entirely due to ohmic resistance of the feeders themselves and of the network. He had no corresponding figures for the alternating current system, but he had reason to believe the total losses both in mains and transformers in the high tension system are not less than 25 per cent. the energy generated, but he thought it certain that this figure will be very considerably reduced in cases where banked transformers are employed with low tension distributing mains. In any case, however, he hardly thought that it could be expected that the total losses would ever be so low as with the low tension system.

In conclusion Prof. Kennedy referred to the ease and accuracy with which electrical measurements may be made with continuous currents, a fact which he thought had helped very much in the extremely rapid progress made during the last few years in matters electrical. In the case of the Westminster Electric Supply Corporation, the unaccounted for quantity as between the energy developed at the dynamo terminals and the readings of the metres of consumers has been reduced to 1·8 per cent. Unfortunately alternating current measurements are much more difficult and troublesome, and Prof. Kennedy thought that the fact had, to a certain extent, hindered their adoption. There were, however, he considered alternating current watt-metres practically free from error due to circuit induction and capable of giving results with quite sufficient accuracy under the actual conditions of station practice. He believed that very great improvements in the economy of alternating current working will date in every case from the time when the station commences to make accurate determinations of the true energy generated and the way in which it has been expended.

At the conclusion of the address a vote of thanks was proposed by Sir Frederick Bramwell, as the Senior Past President, and seconded by Dr. William Anderson, the Junior Past President. It was carried by acclamation, and responded to by Prof. Kennedy in a short speech.

The next business was the reading of a paper by Mr. Edward W. Anderson, of Erith, in which was described the Grafton high speed steam-engine. The design of this novel engine was illustrated by many large cartoons hung upon the wall of the theatre. As we have said, without the aid of illustrations we can only hope to give a general idea of the design of this engine. It consists, firstly, of a foundation casting, the engine being of the vertical type. Upon this casting is erected a second, forming a standard and also a cover for the whole mechanism, the engine being of the enclosed type and the crank shaft running in an oil bath, upon the system common with single-acting engines of this type. The upper casting has a cylinder formed in it by means of two loose liners, one placed in from each end till the liners nearly meet; the space thus left between them forms the admission port, and, as its width is the circumference of the cylinder bore, its length is only required to be very small in order to get a large area of opening. Communication with the steam pipe is effected through an external annular channel in the casting directly surrounding the space between the two liners or admission port. At a little distance from the steam port the upper liner has a circle of holes drilled through it, which holes open into a similar external annular channel connected with the exhaust branch. The liners are open at both their ends, forming a cylinder, without covers, in which two cast-iron pistons reciprocate. The lower of these is an ordinary trunk piston and has a connecting-rod attached working upon the centre throw of the crank shaft below. The upper piston serves both for a piston and for a valve. It is essentially a short cylinder having a strong diaphragm across the middle of its length, and just below the diaphragm a circle of holes is cut through the rim of the piston, and these holes communicate, therefore, with the space between the two pistons. The diaphragm in the upper piston has a hemispherical recess; this receives the steel ball attached to the crosshead. The latter spans the cylinder and acts on the two outer throws of the crank shaft by means of a return connecting rod attached to each end. The advantages claimed for this engine are:—That the waste spaces to be filled by steam are reduced to a minimum, as the steam is cut off close to the bore of the cylinder, and the long steam passages between the cylinder and the slide valve are done away with; the weight of the piston and that of the piston-valve, instead of being wholly unbalanced, act in the same line and for the most part in opposite directions so as nearly to balance each other, the result being that the unbalanced moment is small. The valve, instead of having a moving part that is idle as regards the transmission of power, performs the same function as an ordinary piston in rotating the crank shaft. The friction of the valve is also no greater than that of an ordinary piston valve of the same dimensions and stroke. The engine described was single-acting and non-compound, but the author said there was no reason why a combination of engines ranged side by side should not be made to work compound if desired. An experiment carried out on a 12-inch engine, working with an initial pressure of 100 lbs. per square inch at 603½ revolutions per minute, indicating a mean of 36·77 horse-power, gave a consumption of 28·2 lbs. of feed water per indicated horse-power per hour.

A discussion followed the reading of the paper. The general opinion appeared to be that the invention was one of great ingenuity, but no fresh points of importance were brought forward.

Mr. Joy, in his paper, dealt with the hydraulic reversing gear, which he described in his paper read before the recent meeting of the Institution of Naval Architects, and which we referred to in our report of that meeting in our issue of March 22.

The summer meeting will be held in Manchester during the first week in August.

WHAT ARE ZOOLOGICAL REGIONS?[1]

THE subject which I now propose to discuss, is the purport and use, and therefore the essential nature, of what are termed zoological regions. This seems necessary because, although such regions have been more or less generally adopted for more than thirty years, there has of late grown up a conception as to their nature and purport which seems to me to be altogether erroneous, and which, if generally adopted, is calcu-

[1] A paper read at the 500th meeting of the Cambridge Natural Science Club, March 12, by Dr. A. R. Wallace, F.R.S.