quiet ascent of air, in a slanting direction if there were any wind. Such ascending currents may be of small area, not much larger than the circles described by birds when soaring. It seems possible that the object of describing circles may be to keep within the ascending current, though it is true they sometimes describe circles when the ascending current is up a slope and not limited to a small area. If a plain much heated by the sun border on the sea, ascending currents will soon start a sea-breeze, and the cold air from the sea will soon restore the stability of the atmosphere. In summer the sea-breeze blows over the Canterbury Plains four or five days a week, beginning between 8 a.m. and noon. When delayed till near noon, the soil and lower strata of air are much heated, and as the previous nights are cool, the conditions for causing the unstable state are present. I long ago remarked that the best time to look out for soaring birds is at the commencement of the sea-breeze when it is late. Soaring is much oftener seen here in summer than in winter, and is, I believe, more common, and the species of soaring birds more numerous, and the birds larger, in hot than in cold climates—that is, in climates where the unstable state of the atmosphere is oftenest caused by the sun's heat.

Mr. Peal says: "That there are no uprushes of air I have fairly good proof in the small tufts of cotton from the *Bombyx malabaricum* which cross the field of my telescope when examining the Noga Hills at ten, twenty, or thirty miles; these are always beautifully horizontal at elevations of from 200 to 2000 feet, coming from the plains and hills to the north-east of us." The presence of light bodies at great heights seems to show that there *are* upward currents: no doubt uprushes of air at a large angle with the horizontal, and of considerable area, might be detected by a careful observer from the movements of small floating bodies, but upward slanting currents of small area might easily escape observation.

It is obvious that upward currents over a plain, caused either by variations in the velocity of the wind or by the unstable state of the atmosphere, must be almost insensible near the ground, and could not attain their full strength under a considerable height. This accounts for the fact that over plains birds do not begin to soar at less than about 200 feet. If soaring were possible in a uniform horizontal current, they would save themselves the muscular effort of rising 200 feet and over by the active use of the wings, and would begin to soar immediately on leaving the ground, as they do in currents blowing up a slope.

I have often observed gulls with extended motionless wings following a steamer in the same relative position for several minutes. In every case it was clear that they used the current diverted upwards by the hull. Before the upward energy of this current is exhausted, a fast steamer has gone a good many yards, so that a bird is supported at some distance astern. Also an upward current of considerable strength would flow off the mizen sail of a ship s ailing near the wind and leaning over.

Christchurch, N.Z. A. C. BAINES.

Rain-making in Florida in the Fifties.

THE article on "Rain-making in Texas" (NATURE, p. 473) recalled to my memory a passage of Dr. Th. Reye's book ("Wirbelstürme, Tornados, &c.," Hanover, 1872), in which (at p. 12 and following) the author in question translates quotations from J. P. Espy's "Second and Third Report on Meteorology, 1851, auf Befehl des Senates der Union gedrukt" (Reye's note at his p. 235; quoting also fourth Report, 1857). The facts related were observed by the surveying officers George and Alexander Mackay. They (in Florida) had at their disposal great quantities of rushes (saw-grass), which they set in flame, and the huge conflagrations were invariably followed by rain.

September 22. G. P.

A Dog Story.

THE following dog story may interest your readers.

As I went to the train one morning, I saw a brown retriever dog coming full speed with a letter in his mouth. He went straight to the mural letter box. The postman had just cleared the box, and was about 20 or 30 yards off when the dog arrived. Seeing him, the sagacious animal went after him, and had the letter transferred to the bag. He then walked home quietly.

Putney, September 23. JOHN BELL.

SOME NOTES ON THE FRANKFORT INTERNATIONAL ELECTRICAL EXHIBITION.[1]

II.

A Page of Modern History.

ELECTRIC transmission of power to great distances bids fair in the near future to change the whole commerce of the world, and yet the history of its development is all comprised within the last fourteen years. In a long paper read in the early part of 1877 before the Institution of Civil Engineers, "On the Transmission of Power to a Distance," the author, Prof. Henry Robinson (now the engineer to various electrical companies), does not even suggest the possibility of employing electricity for this purpose. So that in the discussion Sir William Siemens remarked, "He might also refer to another method of transmitting power to a distance, which did not seem to have occurred to the author, perhaps because it was of recent date, viz. by electric conductors."

A week later, Sir W. Siemens, in his Presidential address to the Iron and Steel Institute, throws out the idea of utilizing the power wasted in the Falls of Niagara; and after referring to the use of high-pressure water mains and quick-working steel ropes for transmitting power over one or two miles, he says, "Time will probably reveal to us effectual means of carrying power to great distances, but I cannot refrain from alluding to one which is, in my opinion, worthy of consideration—namely, the electrical conductor." And he adds, "A copper rod three inches in diameter would be capable of transmitting 1000 horse-power at a distance of, say, thirty miles."

The use of the electric current for the transmission of power over considerable distances was, therefore, fully present in the mind of Sir William Siemens in 1877, but not apparently the employment of the high potential differences which are absolutely necessary to make such a transmission commercially possible. For a copper rod of three inches diameter, such as he speaks of, has a cross-section of nearly seven square inches, and could carry some 5000 or 6000 amperes without undue heating. Therefore, even when the problem of transmitting 1000 horse-power over thirty miles was in question, he did not contemplate, apparently, using a pressure of more than about 100 volts.

At the commencement of the following year, 1878, in his Presidential address to the Society of Telegraph Engineers, he refers to his previous statement, and adds, "Experiments have since been made with a view to ascertain the percentage of power that may be utilized at a distance." The result obtained, he says, is that "over 40 per cent. of power expended at the distant place may be recovered"; but Sir William adds, in reference to the 60 per cent. loss, "This amount of loss seems considerable, and would be still greater if the conductor through which the power were transmitted were of great length."

The length of the conductor employed in the above experiment is not given, but its approximate length, as well as what is understood by "great length," may be gathered from the context; for Sir William goes on to consider the problem "of distributing the power of a steam-engine of, say, 100 horse-power to twenty stations within a circle of a mile diameter"; and although the distance to which it is proposed to transmit the power is only one mile, he assumes that the loss is what was found in the above experiment, viz. 60 per cent. He further adds, "The size of the conductor necessary to convey the effect produced at each station need not exceed half an inch in external diameter." Clearly, then, as the power proposed to be transmitted by the half-inch conductor to each station one mile distant was only 5 horse, there was no idea of using

[1] Continued from p. 497.

a potential difference in the transmission higher than that maintained between the terminals of a lamp.

Two wrong notions misled people in those days—the one, that the maximum efficiency of a perfect electromotor could be only 50 per cent.; the other, quoting the remarks of Sir W. Siemens in the discussion of the paper read by Messrs. Higgs and Brittle at the Institution of Civil Engineers somewhat later in the same year 1878, "In order to get the best effect out of a dynamo-electric machine there should be an external resistance not exceeding the resistance of the wire in the machine. Hitherto it had been found not economical to increase the resistance in the machine to more than one ohm; otherwise there was a loss of current through the heating of the coil. If, therefore, there was a machine with one ohm resistance, there ought to be a conductor transmitting the power either to the light or the electro-magnetic engine not exceeding one ohm." He then goes on to consider that as the conductor is lengthened its cross-section must be increased in proportion to keep the resistance constant at one ohm; and he arrives at a result quite new at the time, viz. that if the number of dynamos *in parallel* were increased in proportion to the length and cross-section of the line, "it was no dearer to transmit electromotive force to the greater than to the smaller distance."

Sir William Thomson grasps at once the novelty and importance of this idea, and renders it even more important by proposing to put all the dynamos *in series* at one end of the line, and all the lamps in series at the other. But it would still appear that even 40 per cent. efficiency for transmision over a considerable distance could only be attained when "there were a sufficient number of lamps" to make it necessary to use *many* dynamos in parallel in accordance with Siemens's proposal, or, *many* dynamos in series in accordance with Thomson's modification of Siemens's proposal.

In 1879, the electric transmission of power was still such a *terra incognita* that the largest firm of electrical engineers in Europe could not be induced to tender for transmitting power over ten miles in India.

At the British Association lecture in the autumn of 1879, Prof. Ayrton exposed the fallacy of assuming that 50 per cent. was the maximum efficiency theoretically obtainable with an electromotor. He further proposed that, instead of employing many dynamos at one end of the line and many lamps at the other, there should be used a single dynamo and a single motor, with much wire on each; that the high potential of the line necessary for economical transmission of power should be maintained by running both dynamo and motor much faster than hitherto; and that both dynamo and motor should be separately excited. Although not wholly free from the prevailing idea of that day—that electric transmission of power over long distances would only be commercially possible when a very large amount of power had to be transmitted—he says, after discussing the subject, "So now we may conclude that the most efficient way to transfer energy electrically is to use a generator producing a high electromotive force and a motor producing a return high electromotive force; and by so doing the waste of power in the transmission ought, I consider, to be able to be diminished with our best existing dynamo-electric machines to about 30 per cent."

This was perhaps the first time that it had been even suggested that the efficiency in electric transmission of power could be more than 50 per cent.

Further, the lecturer proposed to use in all cases this high E.M.F. motor, whether the received power were required for motive purposes, for light, or for electro-plating; and, as experimentally shown in the lecture, to generate the current locally in the two latter cases by using the motor to drive a suitable dynamo, thus giving the first illustration of the employment of an electric transformer in the actual transmission of power to a distance.

Two years later, viz. in 1881, the old mistaken notion, that it was only 50 per cent. of the power given to a dynamo that could be returned by the motor, was again propounded during a discussion at the Society of Arts; and the Chairman, Sir W. Siemens, when correcting the speaker's error, added, "Experiments of undoubted accuracy had shown that you could obtain 60 or 70 per cent."

In this year two very important propositions were put forward—the one, by Sir W. Thomson, at the semi-centenary meeting of the British Association, that, in the electric transmission of power, the small current of high potential difference should be employed at the receiving end of the line to charge a large number of accumulators in series, the accumulators being subsequently discharged in parallel for supplying light or power to a town; the other, by MM. Deprez and Carpentier, to use one alternate current transformer at the sending end to raise the electric pressure, and another transformer at the receiving end to lower it down again, the arrangement being symbolically shown in Fig. 1.

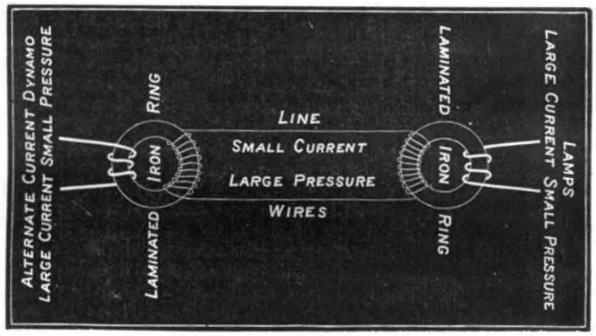

Fig. 1.—Deprez and Carpentier's Plan of Double Transformation.

The great advantage of this combination is, that the pressure along the line may be very high, and the line therefore composed of only thin wire, whereas the pressure between the leads from the generating dynamo at the transmitting end, as well as the pressure between the lamp mains at the receiving end of the line, may be as low as if the dynamo and lamps were close together.

In the experiments, however, made in the following year, 1882, to transmit power from Miesbach to Munich, along thirty-five miles of iron telegraph wire 0·18 inch in diameter, the current going by one wire and returning by another, M. Deprez did not employ his double transforming arrangement described above, probably because alternate current motors were then quite untried practically. But, instead, he used a direct current dynamo generating a potential difference of some 1500 volts, the current from which set in motion a direct current motor, wound to stand a similar high pressure, placed at the other end of the telegraph line.

The experiments were attended with various breakdowns of the dynamo, which was probably constructed on the usual string-and-glue fashion of those days; and finally, after repairs had been effected, the power given out by the motor at Munich was only a fraction of 1 horse, with a commercial efficiency of about one-third.

It was, therefore, decided to repeat the experiments the next year, 1883, with machines constructed more solidly, and for the convenience of the jury the dynamo and motor were placed close together in the workshops of the Northern Railway near Paris, one terminal of each being connected by a short wire, and the other terminals by a telegraph wire 0·157 inch thick going from Paris to Bourget and back again, a distance of 18,133 yards. The power used in driving the dynamo was towards the end of this second set of experiments about $10\frac{1}{3}$ horse, and the power given out by the motor about $3\frac{1}{3}$ horse, the potential difference at the dynamo terminals being some 1850 volts.

The arrangement of the machines was very bitterly criticized: some pronounced the result a great success; others that the whole thing was a fraud, that the power did not go from the dynamo at Paris to Bourget and back again, but that, owing to leakage from one of the telegraph lines to the other, the actual distance over which the power was transmitted was far less than the distance stated.

The next experiments were made with the same machines rewound and improved in insulation. They were now employed to transmit power over $8\frac{3}{4}$ miles, from Vizille to Grenoble, a pair of silicium bronze wires 0·079 inch in diameter being used to connect the dynamo and motor. A difference of potential of about 3000 volts was employed, and 7 horse-power was given off by the motor with a commercial efficiency of 62 per cent.

This experiment of transmitting power from Vizille to Grenoble in 1883 was distinctly successful, and constituted a great advance on anything in electric transmission that had been attempted before. It is interesting, for example, to compare it with the transmission from Hirschau to Munich by Mr. Schuckert in 1882, and which was regarded as very striking at the time it was carried out.

Transmission of Power.

	1882. Hirschau to Munich.		1883. Vizille to Grenoble.
Distance in miles ...	$3\frac{1}{2}$	...	$8\frac{3}{4}$
Diameter of conducting wire in inches ...	0·18	...	0·079
Horse-power delivered by electromotor ...	5·8	...	7
Commercial efficiency of the transmission ...	36	...	62
Potential difference at terminals of dynamo in volts	700	...	3000

Comparing, then, the Vizille transmission of 1883 with the Hirschau transmission of 1882, we see that the distance was twice as great, the cross-section of the wire less than one-quarter, the power somewhat greater, and the efficiency nearly twice as great; this great improvement being effected by using a pressure of 3000 instead of 700 volts.

But with 3000 volts the limit of constructing the commutator of an ordinary direct current dynamo or motor is reached—a fact which was not appreciated by M. Deprez. For when it was decided somewhat later to try and transmit 200 horse-power through 35 miles of copper wire 0·2 inch in diameter, stretched on telegraph poles between Creil and Paris, by using a pressure of 6000 or more volts, the same system of *direct* current dynamo and motor, that had been employed by M. Deprez in his previous transmissions, was resorted to. The result was that the 200 horse-power had to be reduced to 100, and the dynamo and motor were burnt up time after time.

Eventually, after the expenditure of a very large sum of money, spent in several rewindings of the machines, &c., M. Deprez succeeded in 1886 in obtaining from the shaft of the motor at Paris 52 horse-power, this being 45 per cent. of the power spent in driving the dynamo at Creil. The power delivered at Paris was distributed by coupling a low potential difference dynamo to this motor, and using the current developed by this dynamo for driving various smaller motors, so that the power actually delivered to the pumps, &c., was somewhat less than the 52 horse stated above.

In the use of a dynamo and motor each with a high resistance armature and a low resistance field magnet, the fields being produced by separate excitation, and in the employment of a motor-dynamo for utilizing the received power, M. Deprez expressed his approval of the very plan proposed by Profs. Ayrton and Perry in 1879 for "sending by even quite a fine wire a small current," and so obtaining "an economic arrangement for the transmission of power."

This experiment, although very costly, had considerable interest, in showing that as much as 52 horse-power could be actually delivered at the end of thirty-five miles of copper wire 0·2 inch thick, and that a pressure of 6000 volts could be practically employed with a lead covered insulated conductor. But probably the most important lesson learned from it was, that when the distance over which power had to be transmitted was so great that a pressure of 6000 volts became necessary to obtain economy in the conducting wire, an alternating and not a direct current ought to be used.

While these various experiments of M. Deprez with direct currents were being carried out, the transmission of power by means of alternating currents had been progressing in the face of considerable opposition. The exhibition at the Aquarium, Westminster, in the spring of 1883, will probably be chiefly remembered from its being there that Messrs. Gaulard and Gibbs showed what they called a "secondary generator," which was simply an improved form of Ruhmkorff induction coil, without the ordinary vibrating make and break. A current from an alternating dynamo was sent round one of the coils, and to the terminals of the other were attached lamps, the brightness of which could be varied by pulling out the iron core of the induction coil more or less, as is done with medical coils to alter the strength of the shocking current.

Nobody thought much of the "secondary generator"; it seemed to have no very special use; the iron core felt very hot, so that there would be a new waste of power introduced into electric lighting by the use of secondary generators. Besides, the electricians saw that Messrs. Gaulard and Gibbs were employing methods and apparatus for measuring the power which must give totally erroneous results when used with alternating currents; and so, forgetful of the fact that invention is frequently quite ignorant of the language of the text-book, they decided that there was nothing in it.

But Messrs. Gaulard and Gibbs believed in their secondary generator, whatever electricians and the technical press might say; they put them at the Notting Hill Gate, Edgware Road, Gower Street, King's Cross, and Aldgate stations of the Metropolitan Railway, joined the fine wire coils of all the generators *in series* with one another, and sent a small alternating current through the whole circuit from a dynamo placed at Edgware Road. Lamps of different kinds attached to the thick wire coils of each of the generators at the five railway stations burned steadily and brightly; an alternate current motor, even, which was put at one of the stations, revolved rapidly: but what a great waste of power there must be in all this unnecessary transformation, said the learned.

Well, in the spring of the next year, 1884, Dr. J. Hopkinson tested the efficiency of these secondary generators on the Metropolitan Railway, and, to the surprise of nearly everyone, it came out close on 90 per cent.

In the autumn of the same year, in connection with the Exhibition at Turin, power was transmitted to Lanzo, twenty-five miles away, by means of a bare overhead wire rather less than one-quarter of an inch in thickness, and, by means of Gaulard and Gibbs's secondary generators, the power was distributed at Lanzo and elsewhere along the route, for lighting incandescent and arc lamps. The jury reported that the efficiency of the transformers was 89 per cent., the whole distribution strikingly successful, and a prize of 10,000 francs was awarded to Messrs. Gaulard and Gibbs by the Italian Government.

No electromotors, however, appear to have been driven by the transmitted power, for, even in 1884, alternating current electromotors were still comparatively untried.

Tests of a secondary generator were next undertaken in 1885 by Prof. Galileo Ferraris, of Turin, who found the efficiency at full load to be no less than 97 per cent.,—a value even higher than that previously published. This investigation is the more memorable, in that it led Prof. Ferraris to take up the mathematical and experimental investigation of alternating currents, resulting in the discovery and construction of the self-starting alternate current motor in 1885, and to extensions of considerable practical importance in our knowledge of the action of secondary generators, now called *transformers*. And so one of the chief lions this year at the Frankfort Exhibition was Prof. Ferraris. W. E. A.

(*To be continued.*)

THE GIRAFFE AND ITS ALLIES.

ALTHOUGH coming within that well-defined group of ruminants known as the Pecora, the Giraffe (the sole existing representative of the genus *Giraffa*) stands markedly alone among the mammals of the present epoch; although, on the whole, its nearest living relations appear to be the deer (*Cervidæ*). Moreover, not only is the giraffe now isolated from all other ruminants in respect of its structure, but it is also exclusively confined to that part of the African continent which constitutes the Ethiopian region of distributionists. When, however, we turn to the records of past epochs of the earth's history, we find that both the structural and distributional isolation of the giraffe are but features of the present condition of things. Thus, in regard to its distribution, we find that in the Pliocene epoch giraffes were abundant in Greece, Persia, India, and China; and we may therefore fairly assume that they were once spread over the greater part of the Palæarctic and Oriental regions. Then, again, with regard to their allies, the researches of palæontologists have been gradually bringing to light remains of several large extinct ruminants from various regions, which are more or less nearly related to the giraffe, but whose affinities appear to be so complex and so difficult to decipher, that not only do they remove the stigma of isolation from that animal, but even render it well-nigh impossible to give a definition of the group of more or less giraffe-like animals, by which it may be distinguished on the one hand from the deer (*Cervidæ*), and on the other from the antelopes (*Bovidæ*). Since an interesting account of a new extinct Giraffoid from the Pliocene deposits of Maragha in Persia has been recently given by Messrs. Rodler and Weithofer in the *Denkschriften* of the Vienna Academy, the present time is a suitable one to offer a brief *résumé* of the present state of our knowledge of this group of animals, and the different views which have been entertained as to the affinities of some of its members.

Among the chief structural peculiarities of the giraffe, the most noticeable is its great height, which is mainly produced by the excessive length of the neck and limbs. The fore-limbs are, moreover, longer than the hind ones, as is well shown by the circumstance that the radius, or main bone of the fore-leg, is longer than the tibia in the hind-leg; whereas, in other living ruminants the reverse condition obtains. The skull is more like that of the deer than of any other existing ruminants, this being shown by its general contour, and also by the presence of the large unossified space below the eye, which completely separates the lachrymal from the nasal bone; a condition but very rarely met with in the *Bovidæ*, although found in the skull of the water-buck. Then, again, the skull resembles that of the deer in the great elongation of the portion situated behind the eyes, *i.e.* the parietal region. The bony processes arising from the skull between the occiput and the eyes, and clothed in the living animal with skin, are not strictly comparable either with the antlers of the deer or the horn cores of the antelopes; in the young condition they are separate from the bones of the skull, with which, however, they unite as age advances. The whole of the frontal and nasal region is much swollen and inflated by the development of air-cells between the inner and outer layers of bone; and at the junction of the frontal and nasal bones there is a large oval hillock-like protuberance in the middle line, which is sometimes termed a third horn. This excessive inflation of the region of the face makes the appearance of this part of the skull very different from that of the deer, in which it is much flattened. The grinding or molar teeth of the giraffe are remarkable for the peculiar roughness of their external coating of enamel, and also for their broad and low crowns, which in the upper jaw lack the internal additional column occuring in those of most deer and many antelopes. These teeth are, however, more like those of the deer than those of other ruminants, although they can be distinguished at a glance from all others except the larger ones of the under-mentioned fossil forms.

Since a good deal depends on the similarity between the structure of the molar teeth of the giraffe and those of the extinct ruminants in question, it may be well to observe that the characters of the molar teeth among all the ruminants are of great importance in classification. Thus, these teeth in all the deer, although varying to a certain extent in the relative height of their crowns, present the same general structure, those of the upper jaw being comparatively short and broad, with a large internal additional column. Then, again, in the *Bovidæ* we may notice that each of the several groups into which the antelopes are divided, as well as the goats and sheep and the oxen, are severally distinguished by the characters of their molar teeth, and that, although the teeth of one group may approximate more or less closely to that of another, we do not find any instances where one member of a group possesses teeth of a totally different type from those of the other representatives of the same group. These facts strongly indicate that, when we meet with fossil ruminants having molar teeth of the very peculiar type met with in the giraffe, we shall be justified in considering that there must be a certain amount of relationship between the owners of such teeth.

Another marked peculiarity of the giraffe is that the humerus has a double groove for the biceps muscle, instead of the single one found in ordinary ruminants. In regard to its soft parts, the giraffe resembles the deer in the usual absence of the gall-bladder, although its reproductive organs are constructed more on the Bovine type.

With these preliminary remarks on some of the structural peculiarities of the giraffe, we may proceed to the consideration of its fossil allies. The genus which probably comes nearest to the giraffe is the imperfectly known *Vishnutherium*, founded upon part of a lower jaw from the Pliocene of Burma, but to which have been referred some upper molars and bones from the corresponding beds of the Punjab. This animal must have been considerably larger than the giraffe, and the upper molars are remarkable for the great flatness of the outer surfaces of their external columns, in which respect they come nearer to the corresponding teeth of the elk than do those of any other members of the group. The posterior cannon-bone, or metatarsus, assigned to this genus, although relatively much shorter than that of the giraffe, is more elongated and giraffe-like than the corresponding bone of any other fossil genus in which this part of the skeleton has been described. The cervical vertebræ are also more elongated and giraffe-like than those of any of the under-mentioned genera. It will of course be immaterial if these bones prove to belong to a genus distinct from *Vishnutherium*; their interest lying in the