part of Glen Nevis seen from our position was clear of cloud and mist, but in a brief space of time, not exceeding five seconds, a dense mist suddenly filled the whole breadth of the glen, the upper limit of the cloud-fog being only a little lower than the level of our position. These facts point to ascensional movements in the atmosphere over Ben Nevis, which in all probability are caused by the temperature of the surface of the mountain being higher than that of the enveloping atmosphere at the same heights. These ascensional movements are disturbing influences on the winds prevailing on the Ben, but especially at the top, the result being that it is frequently difficult, if not impossible, to say what the true direction of the wind is, as it is found to blow from all points of the compass within the space of a few minutes.

In the accompanying sketch (Fig. 2) Mr. Wragge has given a faithful representation of the surface of the plateau of the summit. This plateau consists of about ninety acres, the difference of level between any two points of which does not exceed ten feet. It is throughout strewn to a depth of about four feet, with blocks of felstone lavas and volcanic agglomerates, nearly all tilted up to such a degree that the only mode of progression is over the sharp edges of the stones. These blocks are different from the rock of the mountain itself, the nearest rock resembling them being found in Glencoe, twelve miles distant. No soil is anywhere visible, the heavy rains doubtless having long ago washed it all down hill; indeed, except in small detached patches, the mountain is wholly bare of soil for the last 1500 feet of the ascent.

That the striking bareness of Ben Nevis is due to the excessive rains having washed away the soil, and not to the climate, is shown by the remarkably well-grown specimens of *Cerastium alpinum*, *C. trigynium*, *Saxifraga stellaris*, and *Alchemilla alpina*, which were found at heights closely approaching 4000 feet in situations which protected the soil from being carried away by the rains. In a small patch only 240 feet from the summit, I gathered a small grown specimen of *Saxifraga stellaris* in flower, and in the same patch there was growing a Carex, which however showed no flower. Excepting the above flowers and *Sagina saxatilis*, *Carex rigida*, *Luzula spicata*, and a single specimen of *Sibbaldia procumbens*, I did not notice any other flowering plants which a botanist would take the trouble to put into his vasculum. The scanty flora of Ben Nevis as regards the rarer species is thus in striking contrast to the rich floras of Ben Lawers and many others of our Scottish mountains, a circumstance which may perhaps possess some geological significance.

ALEXANDER BUCHAN

THE ELECTRIC TRAMWAY

ONE of the most interesting sights in connection with the Exhibition at Paris is the electrical tramway; it is a practical evidence of the great future in store for electricity as a motive power. From an article in *La Nature* we give some of the leading features of this recent application of electricity. In the case of a tramway the question is a complicated one, for the rails cannot be isolated, and they therefore cannot be used as

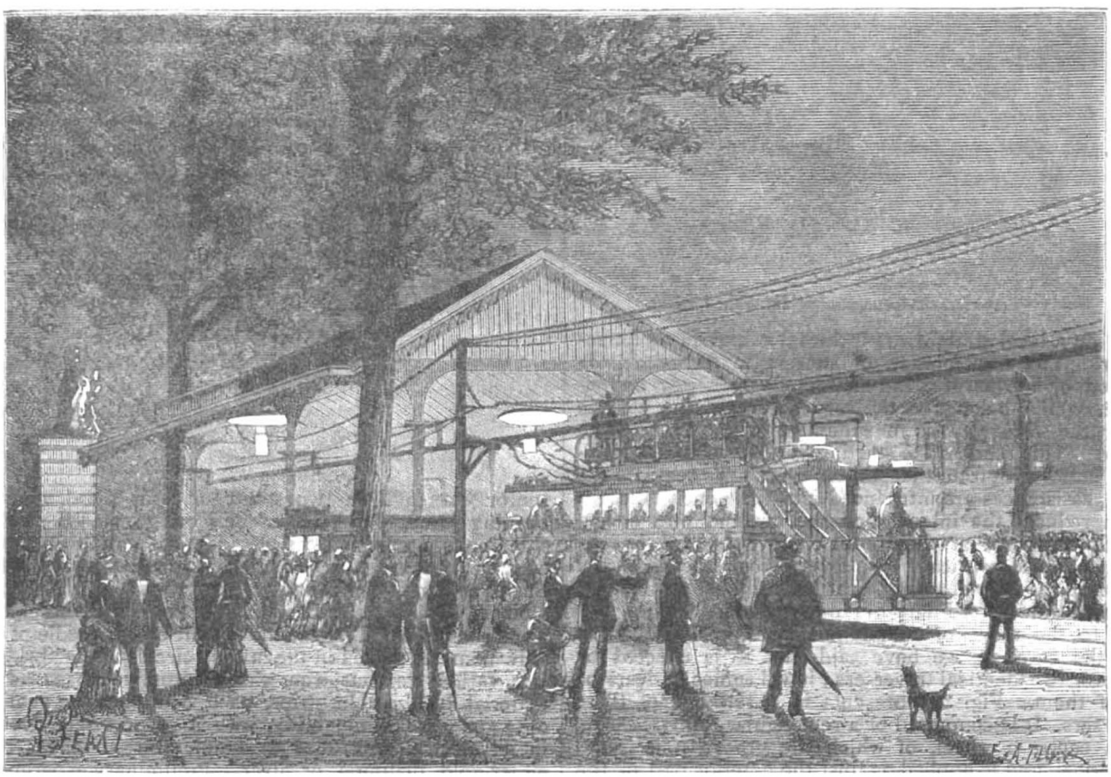


FIG. 1.—Siemens' Electric Tramway; Departure Station at the Place de la Concorde.

conductors. How then, in these conditions, is the motor of the carriage connected with the fixed generator placed in the Exhibition at the Palais de l Industrie? This is the problem which MM. Boistel and Sappey, the engineers of Messrs. Siemens, have completely solved, after several fruitless attempts, which almost always precede successes of this kind. In the preliminary experiments made at the workshop in the Rue Picot, they made use, as conductors, of a brass tube electrically connected with the carriage by a traverser, the function of which we shall explain; the wheels and rails will serve as the return wire. This system worked well at the *workshop*. In practice a special difficulty was encountered. The dirt sticking to the rails and felloes of the wheels formed a sort of crust so insulating as to prevent adequate communication with the earth. The increase of resistance produced by this interposition of finely conducting bodies was often sufficient to arrest the vehicle. The remedy was happily beside the evil, and a second conductor was established parallel with the first, in communication with the second pole of the generator, on which runs a second traverser, identical with the former. These two cars follow on their respective tubes the movements of the vehicle, and ensure a good and constant communication between the electrical generator and the motor. Fig. 1 represents the carriage and the station at the Place de la Concorde. At the height of the knife-board are seen the two conducting tubes supported at certain distances by posts, and in the intervals by iron wires, like the floor of a suspension bridge. The carriage is exactly the same as the ordinary tramway car. The motor is placed underneath the feet of the inside passengers; it is a Siemens dynamo-electric machine, with horizontal inductors similar to that which produces the current in the Palais de l'Industrie. The distance traversed is about 500 metres, and is accomplished in one minute. The work expended reaches 8 horse-power in the curved

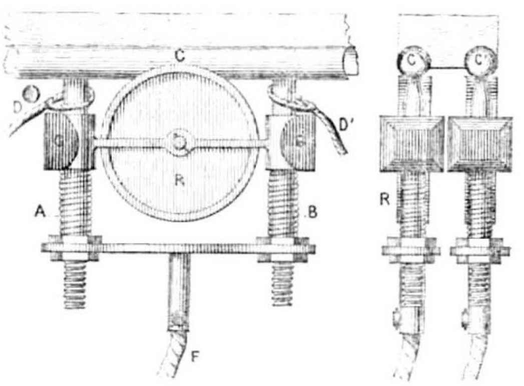


FIG. 2.—Traversers conducting the current to the carriage.

part; on a level straight run it does not exceed 3½ horse-power. The transmission of motion to the wheels is effected by means of a fall-chain. By a happy coincidence, which belongs to the very nature of the electric motor, the *static effort* is maximum when the motor is in repose. This renders the starting very easy, and no difficulty is met with from this point of view. To regulate the speed, resistances are introduced into the general circuit, which reduces the intensity of the current, and consequently the work of the motor; this operation is very simply effected by means of a lever placed at each end of the carriage. For stopping, the current is broken, and at the same time an ordinary brake is applied.

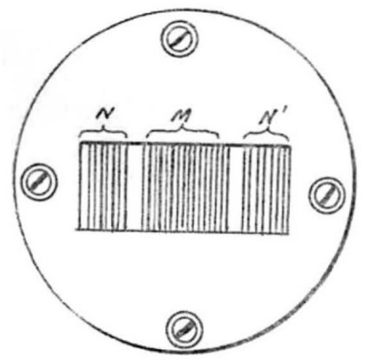
As to the mode of communication of the conductors with the carriage, we have said that it is effected by means of two identical traversers; it will suffice to describe one of them. Fig. 2 represents in detail one of these traversers. It is composed of a rectangular frame, bearing in its centre a wheel, of which the groove R is semi-cylindrical, and is applied against the exterior part of the conductor C, formed of a brass tube 22 millimetres in diameter and slit on its lower part along all its length to a breadth of about 1 millimetre. In this tube slides a cylindrical core of 12 centimetres in length, on which are fixed, at its extremities, two vertical shafts, A, B, which support the wheel or roller. Two springs supported on these vertical shafts press the wheel against the tube, and maintain an elastic contact between the tube and the wheel. The carriage may then be moved; the wheel runs against the tube, the core glides in the interior, without the communication ceasing to be, if not perfect, at least quite sufficient for the purpose. Only at times a few sparks are seen at the moment when the carriage passes the coupling of the tubes; these sparks are due to small instantaneous ruptures of the current which do not affect the regular working of the system. The experiment shows that the wear and tear scarcely affects the tube, and bears almost entirely on the core placed in the tube; but nothing is easier than to replace a core. The current reaches the machine by the copper conductor F. The traction of the carriage is effected by the cords D or D', according to the direction.

The electric railway of the Palais de l'Industrie presents the first practical solution of an electric traction in the case of a tramway. Of course it is easy to see how this application of electricity is capable of the greatest development, and that by modification of details the principle might be applied to railways.

THE BOLOMETER

AN instrument a thousand times more sensitive to radiant heat than the thermopile, and capable of indicating a change of temperature as minute as 1-100,000th of a single Centigrade degree, deserves the attention of the physicist. When to these qualifications it can be added that the new instrument is far more prompt in its action, and more reliable than the thermopile for the *quantitative* measure of radiation, then, indeed, no apology is needed for a detailed description. The instrument is termed by its discoverer, Prof. S. P. Langley, the *bolometer*, or *actinic balance*. The earliest design of the in-

FIG. 1.



ventor was to have two strips of thin metal, virtually forming arms of a Wheatstone's bridge, placed side by side in as nearly as possible identical conditions as to environment, one only of them being exposed to radiation. Such radiation would slightly warm the strip and therefore alter its electric resistance, and the amount of this change would be indicated by the movement of the needle of the galvanometer placed in the middle circuit of the "bridge." For various reasons iron was eventually chosen as the material for the thin strips, as it combines the qualities of tenacity and laminability, with a greater sensitiveness in its electric resistance to temperature changes than either gold, platinum, or silver. Preliminary experiments made with a simple strip of iron in comparison with several delicate thermopiles showed the advantage of the new method of investigation. A large Elliott thermopile of sixty-three pairs, a very sensitive thermopile of sixteen small pairs, and a delicate linear thermopile of seven pairs of elements were selected. The iron strip taken was 7 millims. long, ·177 millims. broad, and 0·004 millims