more than 1000 observations up to this. Latterly, this branch of science has made distinct advances in America, where Burnham has made excellent use of the gigantic refractors, which are made by Alvan Clark of Boston. He has discovered a number of important double stars, the components of which cannot be separated at all in older telescopes.¹

In 1878 the French astronomer Flammarion, who is so favourably known from his excellent popular treatises, published his "Catalogue des Étoiles doubles et multiples en Mouvement relatif certain, comprenant toutes les Observations faites sur chaque couple depuis sa découverte, et les résultats conclus de l'Étude des mouvements," a work that is highly valued by double-star investigators, but private observers will do well in consulting also Messrs. Crossley, Gledhill, and Wilson's "Handbook of double-Stars," with its "Supplement."

As remarked above Herschel found that changes had taken place in several systems of double-stars, and in 836 Struve was able to give a list of a hundred systems, where the components appeared to revolve; but on account of the difficulty of the measures, it was not easy to decide whether this was owing to actual motion of the star or in some cases to divergences of the observations. But he proved beyond dispute in about half the cases that the companion had revolved, and Mädler, who was one of the most indefatigable double-star observers, as well as the most prominent calculator, raised this number to several hundreds. His work, "Tabula generalis stellarum duplicium indicationem motus gyrorum exhibentium," was published in 1849, and contains 650 entries, but many of these were mere surmises, and have not been corroborated by subsequent research.

If the observations were absolutely free from errors, it would be an easy task to investigate the path of the companion, but in addition to the imperfection of every observed position, we have as explained above to guard against systematic differences between the different observers. In long series of observations of quickly revolving stars, this gives occasion to endless discussion. We draw, for instance, a powerful aid in discerning systematic errors, from Kepler's law, that the areas described by the radius vector are proportional to the intervals of time; but he would be a bold man, who in the present state of our knowledge, would affirm that all binary stars have been proved to revolve according to this law in elliptic orbits, in the focus of which the main star is situated,² or would condemn all observations that could not be made to fit into such an hypothesis. But though this assumption is a mere hypothesis, and may remain so for a long time to come, we have nothing else to guide us. In fact we cannot calculate an orbit at all except by aid of these laws.³

W. DOBERCK

(To be continued.)

¹ The difficulty of separating close double stars renders them fit tests for the performance of a telescope. Some idea of the quality of a telescope may be gained, when it is stated that it is able to separate objects of a certain class, be it *lucide* or *religuae*, but withal, it is preferable to try its performance on terrestrial test objects. A third sub-class "delicate" double stars, or those in which the companion is so minute compared to the main star, as to require a high degree of optical power to perceive it, has been added by Sir John Herschel, but it deserves to be remarked that the appearance of such objects depends quite as much upon the state of the atmosphere. The companion of Sirius, for instance, has been repeatedly seen in 4-inch refractors under exceptionally favourable circumstances, though in a great latitude. A large aperture is therefore not always an advantage. The situation of the observatory is of much greater importance. Piazzi Smyth has the merit of having for years insisted upon this point. The Lick Observatory, about to be founded on Mount Hamilton, California, will offer unusual advantages. Mr. Burnham has there already discovered some difficult double stars with a minor telescope.

² Both stars revolve, of course, round their common centre of gravity, but it is easy to see that the *relative* position of the two stars is all the same then as if only one revolved. If the changes in the absolute place of one of the stars were known, we would have the means of computing the relative masses; but this has only been possible in a few cases at most.

³ In case of certain triple stars, whose movements do not fit into Keplerian ellipses, we have to represent the motions by aid of epicycles, just in the same way as Ptolemæus represented the motion of the planets in the system named after him.

THE MARIANNE NORTH GALLERY OF PAINTINGS OF "PLANTS AND THEIR HOMES," ROYAL GARDENS, KEW

MANY readers of NATURE are doubtless aware that the large collection of beautiful and instructive pictures of flowers painted in various countries by Miss Marianne North, is now, through the noble generosity of this lady, the property of the nation. The collection is in a handsome building specially erected in Kew Gardens for the purpose, at Miss North's expense, and from designs given by Mr. James Ferguson, F.R.S. Last week the gallery was opened without any ceremony whatever, and henceforward it will be open and free to the public at the same times and hours as the museums and other buildings in the Gardens.

Now that this is an accomplished fact, a few words respecting the history and the principal features of the collection may be useful. Impelled by a love of nature, Miss North has spent many years travelling from country to country, and painting the most striking scenes and objects that came under her observation; and from time to time some of these paintings have been exhibited in London. The more Miss North travelled and painted, the more the desire to travel and paint seems to have grown; the result being a large collection of pictures. Then arose the question, what should be done with them? and happily in this Miss North was influenced by the kindly feeling that she would like other less fortunate persons to see and enjoy what she herself had seen and enjoyed so much. This idea once conceived, the warm-hearted artist and traveller set to work more assiduously than before, in order to carry it into effect, even visiting Australia and New Zealand, for the purpose of painting the vegetation of that region. In a country where the love of flowers is general from the poorest to the richest, such a gift as that now offered to the public will assuredly be fully appreciated.

The collection is designated in the title of the catalogue as paintings of "plants and their homes," and this title is justified by the fact, that in nearly all the pictures, plants have supplied the motive, the other objects represented being accessories. Altogether there are upwards of six hundred pictures, representing vegetation in nearly all temperate and tropical parts of the world except Europe and Africa, unless we regard Teneriffe as belonging to the latter country. A descriptive catalogue, compiled by the writer of this notice, and published at Miss North's expense, contains not only the titles of the pictures, but also short notes concerning the life-history, products, &c., of the plants painted, inserted with the intention of making it as instructive as possible to those who know least of such things. There are representations probably of not less than a thousand species, and these include members of nearly every natural order in the vegetable kingdom. The fruit and other useful plants of the different countries are numerous; and associated with them are many of the most ornamental and most striking wild and cultivated plants. In dealing with trees and shrubs, the artist has usually painted a flower-bearing or fruit-bearing branch, or both, in front, and given the habit of the tree or shrub in a landscape behind. Without being botanical, the paintings of the plants are so thoroughly naturalistic, that a botanist has little difficulty in determining such as are not known to him by sight. In so far as regards its prominent features and peculiar types, the Australian flora is more completely portrayed than any other, about seventy-five pictures being devoted to this region. Miss North visited Queensland, New South Wales, Victoria, Tasmania, South Australia, and West Australia; and from each of these colonies she brought home paintings of a large number of the most striking and characteristic plants. Thus of Eucalyptus there are portraits of *E.*

amygdaliua, calophylla, colossea, cordata, ficifolia, globulus, tetraptera, and several others; of other characteristic Myrtaceæ, the genera *Callistemon*, *Syncarpia*, *Agonis*, *Melaleuca*, *Beaufortia*, and *Leptospermum*; of Leguminosæ, *Acacia*, *Gompholobium*, *Kennedy*, *Clianthus*, *Platylobium*, &c.; of Epacridæ, *Leucopogon*, *Richea*, *Epacris*, *Lissanthe*, and *Styphelia*; of Proteaceæ, *Banksia*, *Grevillea*, *Xylomelum*, *Telopea*, *Hakea*, *Lambertia*, *Macadamia*, *Petrophila*, &c.; of genera belonging to other natural orders, taking them in the order they occur in the pictures: *Phyllocladus*, *Doryphora*, *Casuarina*, *Pimelea*, *Prostanthera*, *Billardiera*, *Exocarpus*, *Anigozanthus*, *Xanthorrhæa*, *Kingia*, *Cephalotus*, *Cheiranthra*, *Xanthosia*, *Leschenaultia*, *Stylidium*, *Johnsonia*, *Trichinium*, *Isotoma*, *Byblis*, *Actinotus*, *Nuytsia*, *Doryanthes*, *Fusanus*, *Come-spermum*, &c., &c. In conclusion I may state that there is a complete index to the catalogue, so that it is possible to ascertain what plants are figured by reference thereto.

W. BOTTING HEMSLEY

AN ELECTRIC RAILWAY

THE following account of the electric railway of Breuil-en-Auge is taken from an article by M. Gaston Tissandier in our contemporary, *La Nature*. The subject of electric railways, which has recently claimed public attention; and the recent construction on a commercial scale of a practical electric railway in the department of

FIG. 1.—The locomotive, with dynamo-electric motor and driving-gear.

Calvados in France derives additional interest from the fact that the motive power is, in this instance, furnished by electric accumulators. We propose to give a general description of the railway, but will first briefly state the object for which the line has been constructed.

The linen-bleaching establishment of M. Paul Duchesne-Fournet is situated at Le Breuil-en-Auge, and is a large concern to which most of the linen fabrics manufactured at Lisieux are sent to be bleached. The complete process of bleaching consists in successively exposing the linen pieces first to the action of chlorine, then to alkaline baths, lastly to the sun's rays. The last operation is of course conducted out of doors by laying out the linen in the open meadows. Each length of linen measures about 100 metres, and the establishment boasts a bleaching ground of 15 hectares (37 acres). The operation of taking up the pieces is laborious, necessitating several workmen.

M. Clovis Dupuy, engineer-in-chief of the works, proposed a mechanical device for picking up the linen pieces by the aid of a railway which carried the requisite

FIG. 2.—The Faure accumulators in the tender.

mechanism. But a railway worked by a steam-engine could not be tolerated in the bleaching field, as the smoke produced by the burning fuel and the ashes projected from the funnel would play havoc with the linen laid out beside the line. M. Dupuy therefore determined to build an electric railway, the construction of which is now finished, and which works very satisfactorily.

The electric railway of Le Breuil-en-Auge passes the end of each of the many plots upon which the linen is laid out, there being a piece of straight line 500 metres in length, and twenty-one branch lines. The total length is 2040 metres. The rails are of the narrow gauge of 0·8 metre (2 feet 7½ inches).

The train is driven by a locomotive shown in Fig. 1, the driving machinery being a Siemens' dynamo-electric machine working as a motor. The currents to drive the motor are supplied from a battery of Faure accumulators