

than I originally intended on the subject, which, as standing first on the muster roll of the Association, and as having been so recently and repeatedly arraigned before the bar of public opinion, is entitled to be heard in its defence (if anywhere) in this place,—having endeavoured to show what it is not, what it is, and what it is probably destined to become, I feel that I must enough and more than enough have trespassed on your forbearance.

J. J. SYLVESTER

The remarks on the use of experimental methods in mathematical investigation led to Dr. Jacobi, the eminent physicist of St. Petersburg, who was present at the delivery of the foregoing address, favouring me with the annexed anecdote relative to his illustrious brother, C. G. J. Jacobi*—

“En causant un jour avec mon frère défunt sur la nécessité de contrôler par des expériences réitérées toute observation, même si elle confirme l'hypothèse, il me raconta avoir découvert un jour une loi très-remarquable de la théorie des nombres, dont il ne douta guère qu'elle fût générale. Cependant par un excès de précaution ou plutôt pour faire le superflu, il voulut substituer un chiffre quelconque réel aux termes généraux, chiffre qu'il choisit au hasard, ou, peut-être, par une espèce de divination, car en effet ce chiffre mit sa formule en défaut; tout autre chiffre qu'il essaya en confirma la généralité. Plus tard il réussit à prouver que le chiffre choisi par lui par hasard, appartenait à un système de chiffres qui faisait la seule exception à la règle.

“Ce fait curieux m'est resté dans la mémoire, mais comme il s'est passé il y a plus d'une trentaine d'années, je ne rappelle plus les détails.

“M. H. JACOBI

“Exeter, 24 Août, 1869.”

THE NEW TELESCOPE AT ETON

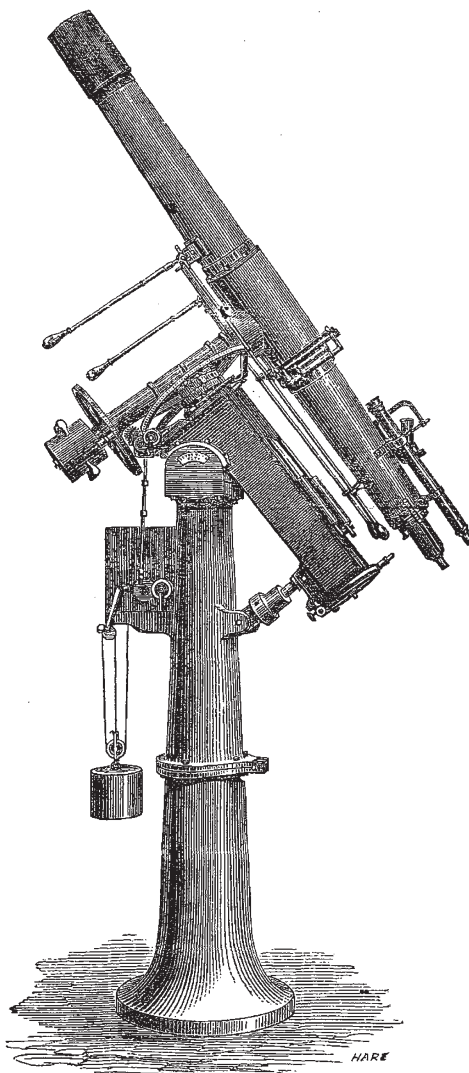
IN furtherance of natural science work at Eton, an excellent telescope has been recently given to the school by the energy and liberality of some of the masters.

The instrument is a refractor, with object glass of 5.9 inches clear aperture, and 88 inches focus, and was made by Messrs. Cooke and Sons, of York, who also supplied the observatory and superintended the erection of the telescope. It is, as will be seen from the engraving, mounted equatorially on the German system, with declination circle reading to 10° of arc, and hour circle reading to 2" of time. The mechanical details do not, with one exception, deviate materially from the pattern usually adopted by Messrs. Cooke, whose name is a guarantee for skill of design and excellence of workmanship. The exception alluded to is in the construction of the driving clock, the speed of which is not regulated, as usual, by a centrifugal governor, or fly, alone, but by a fly supplemented by an ordinary clock escapement. This arrangement is quite new, and is the invention of the late Mr. T. Cooke, the senior partner in the firm. It was described by him in a paper read before the Royal Astronomical Society a short time ago. The details would hardly be intelligible without drawings, but the general mode of action is as follows:—

The barrel is connected with two trains of wheel-work: one (the lowest wheel of which gives motion in the ordinary

* It is said of Jacobi, that he attracted the particular attention and friendship of Böckh, the director of the philological seminary at Berlin, by the zeal and talent he displayed for philology, and only at the end of two years' study at the University, and after a severe mental struggle, was able to make his final choice in favour of mathematics. The relation between these two sciences is not perhaps so remote as may at first sight appear; and indeed it has often struck me that metamorphosis runs like a golden thread through the most diverse branches of modern intellectual culture, and forms a natural link of connection between subjects in their aims so remote as grammar, philology, ethnology, rational mythology, chemistry, botany, comparative anatomy, physiology, physics, algebra, versification, music, all of which, under the modern point of view, may be regarded as having morphology for their common centre. Even singing, I have been told, the advanced German theorists regard as being strictly a development of recitative, and infer therefrom that no essentially new melodic themes can be invented until a social cataclysm, or the civilisation of some at present barbaric races, shall have created fresh necessities of expression, and called into activity new forms of impassioned declamation.

way to the telescope) is terminated by a fly of insufficient power *per se* to reduce the speed within proper limits; the other train is terminated by a half-dead escapement of the usual kind. One of the wheels of the fly-train has a broad rim, on which presses a brake actuated by a wheel in the escapement train. When the escapement is stopped, this brake presses on the wheel with sufficient force to stop the motion of the clock entirely. When the escapement is set to work the brake is released, and the fly-train moves, communicating motion to the telescope. If the speed becomes too great, so as to outrun the escapement, the latter immediately applies increased brake-power, and checks the motion of



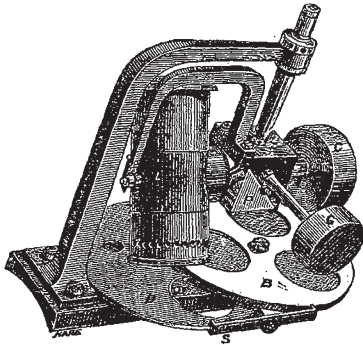
THE ETON EQUATORIAL

the fly; and *vice versa*, if from increased friction or other cause the motion is too slow, so that the fly lags behind the escapement, the brake-spring is relaxed by the latter until the due speed is regained. Thus the two trains are balanced against each other, and since one of the wheels of the escapement-train is, as in some forms of train *remontoires*, supported in a swinging-frame (which frame, in fact, controls the brake-spring), the intermittent motion of the escapement does not reach the telescope. This clock seems to work very smoothly; and not the least advantage of the arrangement is the facility with which

the speed may be altered from sidereal to lunar rate by merely raising the bob of the pendulum through a small space, so as to diminish the time of oscillation.

For special purposes, still greater accuracy might be obtained if the escapement were worked by the observatory clock by means of a small electro-magnet connected with the pendulum of the latter. Conversely, the escapement train might, with slight modifications and the addition of a dial, be made to serve as a journeyman-clock, and show sidereal time with sufficient accuracy to be very useful in finding stars during two or three hours' work.

There is, by the way, another important modification well worthy of notice. When astronomers wish to determine the position of a star, the diameter of a planet, &c., with rigorous accuracy, they employ a micrometer with spider webs, which in the daytime are visible in the field of view. At night, however, they, or the field itself, require to be lit up. This is managed by a lamp outside and a reflector inside the tube, and to make this lamp perform effectively in every position of the telescope is a difficult matter; so difficult, in fact, on the old arrangement, that Messrs. Cooke and Sons, with their wonderful ingenuity, have entirely superseded it in this their latest instrument. Their exquisite contrivance will be seen from the annexed woodcut.



THE COOKE ILLUMINATING APPARATUS.

L is the lamp. P, a prism to reflect the light on to the tube. D, a disc with diaphragms to regulate the quantity of light. B, a disc with glasses to regulate the colour of the light. S, spring catches to clamp these discs. C, counterpoise of lamp. G, Gravity poise.

The telescope is furnished with a sufficient battery of eye-pieces, of powers ranging from 30 to 400, and also with a bifilar micrometer. The position circle is permanently attached to the lower end of the main tube.

The observatory is erected on the roof of the western tower of the New Schools. It is square, and surmounted by a revolving dome. It is obvious that an instrument erected on a tower cannot be wholly free from vibration; but the latter is reduced to a minimum by supporting the telescope on two massive trussed iron girders stretching across the tower. The floor of the observatory is supported quite independently.

Owing to the unfavourable weather of late, the final adjustments of the telescope have not been completed; but it is hoped that before long it will be in a condition for good and accurate work, such as will justify the enlightened liberality which has placed it where it is.

H. G. MADAN

REMARKS ON TERRESTRIAL MAGNETISM

(Being the substance of a paper read at the Royal Astronomical Society, on Friday, Dec. 10)

SOME years since I was led to the belief that earth currents and auroræ are secondary currents produced by rapid, though small, changes in the earth's magnetism.

In this hypothesis the earth was viewed as similar to the soft iron core of a Ruhmkorff's machine, and the upper and rarer strata of the atmosphere and the moist upper surface of the earth as conductors in which secondary currents would be generated whenever any change took place in the magnetism of the core.

This hypothesis is, I think, confirmed by the very interesting and valuable photographic traces of earth currents obtained by Mr. Airy, at Greenwich, in which, during times of great magnetic disturbance, the earth currents are seen to be very strong, and to vary alternately from positive to negative, lying about equally on both sides of the zero.

It has occurred to me that this method of viewing things is capable of extension, and that it ought to be borne in mind that secondary currents are produced, not only in a *stationary conductor* such as that of the Ruhmkorff's machine, where the magnetic core is made to vary, but also in a conductor which moves in the presence of a magnetic core of constant strength.

Have we not in the earth such conductors in constant motion? We have the return trades constantly proceeding at a high elevation from the equator to the poles, the upper strata of which, from their tenuity, may no doubt be considered to be conductors; in their journey they cross the lines of the earth's magnetic force: ought they not, therefore, to be the vehicles of electrical currents? My friend Mr. Lockyer has lately impressed upon me that the zodiacal light may possibly be a terrestrial phenomenon, and, therefore, that it may be connected in some way with the phenomena of terrestrial magnetism. May it not be the return trades rendered luminous through electric currents in the higher regions of the atmosphere, and may there not also be two species of auroræ, the one occurring in stationary conductors, when the earth's magnetism changes, and the other, in moving conductors, when the earth's magnetism is constant?

But again, it must be allowed that these conductors conveying currents must react on the magnetism of the earth, and we might therefore expect that at those periods of the year at which the system of currents, viewed as meteorological phenomena, change most abruptly, the earth's magnetism would also be particularly liable to change. May not this be an explanation of the excess of magnetic storms about the times of the equinox?

But besides these great terrestrial currents, we have the daily convection currents caused by the sun, which, when they reach the upper regions of the earth's atmosphere, we may imagine to be conductors; and as they also pass across lines of magnetic force, we may suppose them to convey currents. May not these, to some extent at least, account for the diurnal variations of terrestrial magnetism? If this be the case we should have a ready explanation of the likeness observed by Mr. Baxendell between the wind curves and those of the declination.

I have hitherto alluded only to atmospheric currents, but there are also oceanic currents, and more especially there is the tidal wave, which occurs twice every lunar day. No doubt the influence of the tidal wave, as a moving conductor, must be very small; but may it not help to account for the lunar-diurnal variation, which is very small likewise?

But if there is an electric current of this kind in the ocean, it ought to be detected by the system of earth current wires which Mr. Airy has at Greenwich, inasmuch as the surface of the earth and the ocean are in electric communication with each other. Mr. Airy has, if I am not mistaken, detected indications of lunar-diurnal inequalities in the results of his observations. On the other hand, he has detected no current with a single daily period that would account for the diurnal variation—a result in accordance with these views, since the currents producing such would be in the upper regions of the atmosphere.

These views are given in order to invite criticism and