moderate care the reader will understand the points illustrated nearly as well as if he saw the experiments themselves. In great part Mr. Ball has devised these experiments himself, and thus in the well-worked field of elementary mechanics he has introduced much that is original in treatment, and in some parts—particularly in his lecture on friction—there will be found something

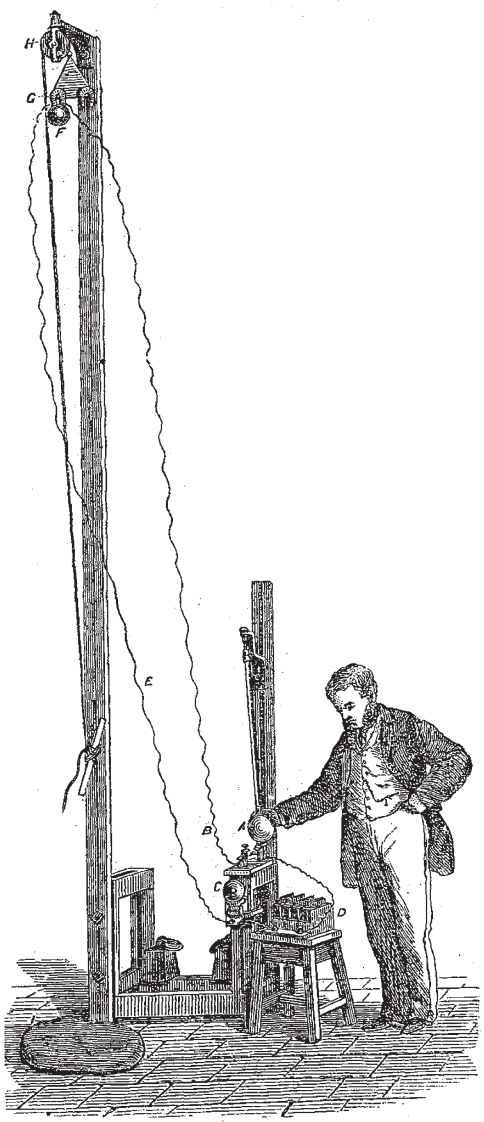


FIG. 3.

more. On the whole the work is one that will amply repay perusal, both by teacher and student, and is a most valuable supplement to works on the theory of mechanics. Nor must we take leave of the volume without adding that its general appearance—due to paper, printing, and illustrations—is truly beautiful, and, in fact, we cannot call to mind any English book of the same class which will bear comparison with it in these respects.

J. F. TWISDEN

## ON THE BEST FORM OF COMPOUND PRISM FOR THE SPECTRUM MICROSCOPE

IN studying the spectra of coloured solutions and solid substances by means of the spectrum microscope, it is most important to employ prisms having a suitable amount of dispersion. It would be a very great mistake to suppose that the result is better with a very wide dispersion. This, of course, makes the spectrum larger, but very greatly impairs the definition of the absorption-bands. Everyone who has had experience with an ordinary microscope must be well aware that a particular magnifying power is best for each particular class of object or kind of structure, and that in some cases nearly all the important characters would be lost by employing too high a power; but at the same time too low a power would be equally disadvantageous in other respects. This analogy holds good in the case of the dispersion of prisms. The power ought to be regulated by the character of the absorption-bands. If they are dark, narrow, well-defined, and lie close together, as in the case of partially opaque crystalline blow-pipe beads of borax containing deposited crystals of oxide of lanthanum with oxide of didymium, a somewhat powerful dispersion is not only admissible, but quite necessary to separate some of the bands. If, however, they are broad and faint like those seen in the spectra of many of the colouring matters found in animals and plants, a powerful dispersion spreads them over such a wide space, and makes the shading off so gradual, that the eye can scarcely appreciate the extra amount of absorption; whereas, when a lower dispersive power is used, a well-marked absorption-band can easily be seen. This is more especially the case with impure mixtures. I have found that when it was requisite to examine a mixed, somewhat turbid, coloured solution to detect, if possible, the presence of some substance which, when alone, gave a spectrum with distinct absorption-bands, no trace could be recognised by means of a prism of high dispersive power; but it could be detected without any difficulty with a lower. In carrying on practical investigations it is far more important to be able to succeed in such a case than to exhibit on a large and more imposing scale the spectra of a few substances which give dark and well-defined bands. There can be no doubt that it is a great advantage to have a number of prisms of different dispersive power, so that in all cases the most suitable may be used; but at the same time some observers might not wish to have more than one, and thus it becomes important to decide what amount of dispersion is the best for the generality of objects—is sufficiently great to divide narrow, closely-placed bands, and yet not so great as to prevent our seeing broad and fainter. No magnifying power whatever is applied to the spectrum itself in the instrument now under consideration.

As described in some of my former papers,* the compound, direct-vision prisms first made for me by Mr. Browning were composed of two rectangular prisms of not very dense flint glass, and three of crown glass, one being rectangular, and the others of an angle of about 75°. This combination gives a dispersive power, which shows faint bands very well; but is not enough to divide the narrow and close bands seen in the spectra of a few substances. Mr. Browning then made prisms of similar construction, only that very dense flint glass was employed; This combination gives about double the former dispersion, which divides narrow and close bands admirably, but sometimes shows broad and fainter bands so very badly that they can scarcely be recognised. It thus appeared to me that, if only one compound prism be supplied with the instrument, the best dispersive power would be intermediate between these two extremes. At the same time much would depend on the particular purpose to which the instrument was applied, and also, to some extent, on the individual differences between different observers.

Mr. Browning has described† the plan that he proposes for the measurement of the position of absorption-bands by means of a bright line, seen by reflection from the surface of the prism, moved backwards and forwards

* *Popular Science Review*, vol. v., 1866, pp. 66—77; Brit. As. Report, 1865 (pt. 2), p. 11.

† *Monthly Microscopical Journal*, vol. iii. p. 68.

by a micrometric screw with a graduated head. My objection to the original construction was that the bright line was photographed on a small piece of glass, and the background was so far from being black as to much impair the spectra of substances that will not transmit a bright light. I suggested that in place of this glass plate a small piece of tin-foil should be used, having a very minute hole in it. This shows far brighter than the line in the photograph, and the back-ground is quite black; and thus the bright dot can easily be seen even when in the brightest part of the spectrum, and there is no extraneous light to impair the faintest absorption-bands The only important objection to this method of measuring their position is, that a very slight movement in the apparatus, due to the loose fitting of moveable parts, alters the readings, and that the value of the measurements, as read off by the micrometer, depends on so many variable particulars, that nearly every instrument might have a different scale. The chief objection to my interference scales * is the difficulty of making all agree absolutely, but when accurately made they have not the above-named disadvantages. I therefore still adhere to that plan, but at the same time I have found the bright dot arrangement very useful, not only as an indicator in showing spectra to others, but also as a fixed point in comparing different spectra, or in counting the bands of the interference scale. Possibly without such help some observers might find this difficult, and would prefer in all cases to measure the position of bands by means of the graduations on the circular head of the micrometer, and therefore I was anxious to devise a prism that would have a dispersive power intermediate between the two extremes already mentioned, and at the same time have the upper face inclined at an angle of 45° to the axis, so that the bright dot micrometer might be employed conveniently. To accomplish this, Mr. Browning made for me a prism composed of two rectangulars of crown glass, one rectangular of very dense flint, and one of less dense, cut at such an angle as to give direct vision. This combination gives what I consider to be as good a medium dispersion as could be wished, and at the same time enables us to measure the position of the bands with the bright-dot micrometer as accurately as is requisite in nearly all practical applications. Subsequent trials have shown that the same advantages may be secured in a more satisfactory manner by replacing the less dense flint glass prism by two, one of flint and the other of crown, of such angles as give direct vision for the whole combination of five. The dispersion is very nearly the same as that of two prisms of ordinary flint glass of 60° angle.

I have been thus careful in explaining the advantages and disadvantages of various arrangements, because the successful use of the spectrum-microscope depends so much on such particulars, and because so many who have not had experience in the practical working of the instrument seem anxious to see a wide spectrum, and overlook the practical importance of being able to recognise obscure absorption-bands. My own experience of this question agrees with that of most of my friends who have worked with the instrument, and yet I am quite prepared to believe that a different amount of dispersion might better suit some observers, and to admit the truth of the German saying, "Eines schickt sich nicht für alle."

H. C. SORBY

## NOTES

RIPE in years and in honours, his work done and his fame world-wide, amid the regrets of all ranks of his countrymen, Sir Roderick Murchison has gone to his rest. It is nearly a year since he was seized with an illness which disabled him from further active work. Yet in the interval he has shown all his old interest in the affairs of which he has so long been the heart and soul, keeping up his intercourse with the world of science by reading, and with many of his associates by personal interviews at his own residence, and by correspondence. To the last his wonderful memory remained true, even to trifling details of place and date. Within the last few weeks, however, the disease made sad progress, and though he continued to enjoy frequent carriage exercise, his physical strength became less able to withstand any malign effects which the chills of autumn bring with them. On Thursday last he was seized with bronchitis, and gradually sank under the attack, till he died at half-past eight on Sunday evening, the 22nd inst. We shall offer next week a fuller reference to Sir Roderick's life-work and scientific influence. For the present, and ere the earth closes over all of him that is mortal, let us only say that in him Science has lost a hard-working and distinguished cultivator, as well as an influential patron, and that to a narrower circle of mourners his loss is also one of a kindly large-hearted friendship.

WE have to record the death, on Saturday last, at the age of seventy-nine, of Mr. Charles Babbage, the eminent mathematician and mechanician. The most important events of his life, as well as some of the eccentricities of his character, are familiar to the public through his autobiographical volume, "Passages in the Life of a Philosopher." Born in 1792, he entered Trinity College, Cambridge, in 1810, and was transferred to St. Peter's the following year. At his B.A. degree he did not take honours in mathematics, not having specially pursued that subject of study as a student, and was understood to have been disappointed at not being elected a fellow. In 1828 he was however elected Lucasian Professor of Mathematics at Cambridge, a position once held by Sir Isaac Newton. He published no less than eighty volumes, but his claim to public notice rested chiefly on his invention of the Difference Engine, on which he spent immense labour and a large sum of money. Notwithstanding his eccentricities and his failings, Mr. Babbage was a mathematician and an inventor of whom England may be justly proud.

THE English Government Eclipse Expedition sailed this morning for Ceylon in the *Mirzapore* from Southampton, Mr. Lockyer in charge, expecting to reach Point de Galle on Nov. 27. They hope to confer with the Indian observers as soon as possible, and plan a concerted campaign. The experience of the last Expedition necessitated that the whole of the instructions should be rewritten; and the Eclipse Committee of the British Association, consisting of the following gentlemen:—Sir William Thomson, L.L.D., F.R.S., President, Prof. J. C. Adams, D.C.L., F.R.S., G. B. Airy, F.R.S., Astronomer Royal, Prof. Clifton, F.R.S., Warren de la Rue, D.C.L., F.R.S., Dr. Frankland, F.R.S., Captain Douglas Galton, C.B., F.R.S., George Griffith, M.A., J. R. Hind, F.R.S., W. Lassell, F.R.S., President R.A.S., Lord Lindsay, J. Norman Lockyer, F.R.S., General Sir Edward Sabine, K.C.B., President R.S., General Strachey, F.R.S., W. Spottiswoode, LL.D., F.R.S., Colonel Strange, F.R.S., Prof. Stokes, D.C.L., F.R.S., and Dr. Thomas Thomson, F.R.S., have had very hard work to get the arrangements completed, in which they have been most zealously assisted by the Government, and by the Peninsular and Oriental Steam Boat Company. Lord Lindsay placed at the disposal of the Expedition the whole of his valuable instruments, and has sent a photographic observer at his own expense. Several members of the Expedition have voluntarily given up a month of their time before starting to perfect themselves in spectroscopic and other observations at the Royal College of Chemistry, a most commendable example to others in similar situations. We have now only to wish the Expedition a prosperous voyage, and better fortune with regard to weather than was experienced in Sicily last year.

WE have to announce the return of Mr. Gwyn Jeffreys from

* Proc. Roy. Soc., vol. xv. p. 434.