

agitation of a soap-film. A glass tube, blown into a shape somewhat resembling a tobacco-pipe, had its mouth closed by such a film, while its open stem was connected with a sounding flask. I did not succeed in producing any visible agitation. When the film was uniformly illuminated, or when it had become thin enough to produce iridescent colours, on holding a high-pitched tuning-fork near the open end of the stem, the whole surface of the film was immediately covered with concentric rings, having the centre of the film for their centre. This belongs to the class of effects so vividly described by Mr. Sedley Taylor. A fork of the pitch of the sounding gas produced no visible effect upon the film.

*January 20, 1881.*

THE PRESIDENT in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read :—

- I. “On Gravimeters, with special reference to the Torsion-Gravimeter designed by the late J. Allan Broun, F.R.S.”  
By Major J. HERSCHEL, R.E., F.R.S., Deputy-Superintendent of the Great Trigonometrical Survey of India. Received October 31, 1880.

(Abstract.)

In the course of 1878–9 some correspondence passed between Major-General Walker, the Surveyor-General of India, and the late Mr. Broun, on the subject of an instrument designed by the latter, the fate of which General Walker was desirous of learning. Interrupted by the death of Mr. Broun, General Walker requested the Director-General of Stores for India to inquire if the instrument could be procured for the Indian Government. It had meanwhile become the property of the Royal Society. In order to comply with the Surveyor-General's intention, the loan of the instrument was then obtained from this Society, and it was placed in the hands of the author of this paper to examine and report upon.

The paper consists mainly of a narrative account of the examination, and the conclusions to which he has been led regarding instruments of this class.

A very similar, if not identical, design having been published in the "*Comptes Rendus*" of the Paris Academy, by the late M. Babinet, the author contributes to the history of the subject some letters written by Babinet anterior to the said publication, with the object of showing the concurrent identity and independence of the two designs.

The principle on which the bathometer of Dr. Siemens appears to be constructed is then considered. Although intended to measure sea-depths, and on that account called a bathometer, it is none the less a gravimeter in principle, and its construction, when properly understood, reminds one forcibly of the typical form as originally proposed, by way of illustration, by Sir John Herschel in the "*Outlines of Astronomy*." The indications of the bathometer, it should be said, are only to be interpreted empirically.

The principle on which the gravimeters of Broun and Babinet are designed is thus emphasized by the latter:—"Ce qui distingue surtout ma méthode, c'est le fractionnement de la pesanteur, de manière à équilibrer l'effet d'un poids considérable, par la torsion d'un fil métallique de force moyenne, et restant dans les limites de l'élasticité parfaite."

It is doubtful whether Babinet's conception ever took practical form as an actually constructed instrument; at any rate, no published record of its performance exists. Broun's design, on the other hand, after many vicissitudes, took the shape of the instrument now under consideration. It was made for him by Müller of Stuttgart, who appears to have taken extraordinary pains to give effect to the intentions of the designer.

Mr. Broun exhibited his gravimeter in the Loan Collection of Scientific Instruments at South Kensington, in 1876, where it was placed alongside of Dr. Siemens' bathometer. A description of it appeared in the catalogue, corrected by himself, but it is faulty and inadequate, owing to the declining health of the owner having prevented his acquiring a practical acquaintance with his instrument; nor was he able to do so up to the time of his death. It was, therefore, with the very scantiest preparation that the present examination was undertaken.

The principle of Broun's gravimeter is easily understood, but the manipulation of the instrument is so troublesome that it is more than doubtful whether in its present form results of any practical value could be obtained with it. The various grounds for this opinion are explained in the course of the report. As a fact, no observations, such as were naturally desired to test its sensitiveness, could by any means be obtained, owing to a radical defect of construction, which the maker has unfortunately failed in overcoming, although special attention has been bestowed upon the point. To explain this, some description of the instrument is unavoidable.

If a heavy bar be suspended by two parallel inelastic lines, the force which is exerted when the position of rest has been quitted varies, in all positions, as the force of gravity at the time: if the angle of disturbance and all other attendant circumstances be strictly the same, the proportion between the vertical and horizontal forces is constant; and if the suspending lines are long, as compared with their distance apart, this constant is a small fraction. This is "*le fractionnement de la pesanteur*" of which Babinet speaks. We are to regard the horizontal force as representing gravity and varying with it, at different times or places. Now, if the suspension had been by a single instead of a double line, and that elastic, the horizontal force exerted in consequence of disturbance would have been independent of the weight of the bar, and therefore also of variation of gravity. It would be a constant force, as far as gravity is concerned.

In the torsion gravimeter these two kinds of suspension are combined—the constant being adjusted so as to balance exactly the inconstant force, by the addition or subtraction of a minute subsidiary weight to the primary weight carried by the double lines.

It would be difficult to explain briefly the mechanism by which the condition of equilibrium is ascertained to be perfectly secured: enough has been said to render the source of failure intelligible.

Success must evidently depend on constancy in the force exerted by the single wire; and this on the fixity of attachment of the ends of the same. It appeared by repeated trials and experiments of different kinds that this attachment was faulty: further experiments, having for their object to remedy the defect, proved unavailing; and at last the attempt—and with it the intended trial of the instrument as a gravimeter—was abandoned, as under the circumstances hopeless.

Unsatisfactory as this result undoubtedly is—especially for the credit of so developed an instrument—the inquiry has not been entirely barren of useful result. The theory of the machine had not been fully considered, and at least one important point would seem to have escaped recognition altogether. There is reason to think that had it been seen that the double suspending lines must practically perform a function precisely similar to that for which the single wire is provided, the latter would have been dispensed with. It is true that this implies not only other modifications of design but also the further recognition of the part actually played by the torsion of the double wires, of which no sign appears in anything that has yet been published about it. But it is scarcely doing violence to the ingenuity which developed a complicated machine to suppose that it would have seized upon and utilised a mode of simplification had attention been directed to it.

The simplification to which allusion is here made, has been brought to the notice of the Society in a previous paper.

In some other respects also, the examination may be said to have borne fruit: for occasion was taken to determine the weights and dimensions of parts, and to show the degree of accuracy which might be looked for in such an instrument, supposing it capable of fulfilling its intended purpose. Some defects of construction also of a general character have been pointed out which may serve as hints to future constructors.

It should be said in conclusion, that so much of the present paper as deals with Broun's gravimeter in particular, was prepared and submitted as a report in the first instance, to the India Office, and that it was communicated to the Society for publication, by permission of the Secretary of State for India in Council. What may be called the historical part was subsequently added, by way of introduction, to make it more worthy of that honour.

II. "Experimental Researches into Electric Distribution as manifested by that of the Radicles of Electrolytes." By ALFRED TRIBE, F.I.C., Lecturer on Chemistry in Dulwich College. Communicated by Dr. GLADSTONE, F.R.S. Received December 15, 1880.

(Abstract.)

The paper is divided into three principal parts; the distribution of the ions of copper sulphate on silver plates; analogies between the distribution of ions and that of static electricity; and analysis of electrolytic fields.

When a solution of copper sulphate is electrolysed with silver electrodes, the negative electrode becomes covered with a deposit of copper, the positive with a coating of silver peroxide. The author has shown that if a metallic rod or plate is placed lengthwise between the electrodes in a liquid undergoing electrolysis, the plate does work identical in kind with that being done by both electrodes. It follows that a silver plate in copper sulphate will be found coated on one part with copper, and on the other with silver peroxide. The superficial distributions of these ions were examined. A rectangular electrolytic cell, a solution of copper sulphate, and copper electrodes were employed. The electrodes were of the same breadth and depth as the cell. In the centre of the liquid, lengthwise and perpendicular to the electrodes, a plate of thin sheet silver was fixed.

In all cases the distributions of the two ions on the plates or even on bodies of various other shapes, were invariably unsymmetrical, the negative ion generally spreading further than the positive. The dis-