ALBERT CHARLES SEWARD,

M.A. (Cantab.), F.G.S. University Lecturer in Botany, Cambridge. Has made extended researches in Fossil Botany, the results of which have been published in a series of papers and works, of which the following may be specified:—That on the Wealden Flora gives, for the first time, a critical and comprehensive view of the vegetation of this important geological period, and in many respects enlarges and modifies our previous knowledge of the subject: "On *Calamites undulatus*" (*Geol. Mag.*, vol. v., 1888); "Notes on *Lomatophloios macrolepidotus*, Goldg." (*Proc. Camb. Phil. Soc.*, vol. vii., 1890); "Fossil Plants as Tests of Climate" (Sedgwick Prize Essay for 1892); "On the Genus *Myeloxylon*, Brong." (*Annals of Botany*, vol. vii., 1893); "On *Rachiopteris Williamsoni*, sp. nov., a new Fern from the Coal Measures" (*ibid.*, vol. viii., 1894); "Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Nat. Hist.)"; "The Wealden Flora, Part I., *Thallophyta* to *Pteridophyta*. Part II., Gymnospermæ" (1894-95).

WILLIAM ASHWELL SHENSTONE,

F.I.C., Senior Science Master in Clifton College. Member of Council of the Chemical Society. Distinguished for his skill as an experimenter, for his ability as a teacher, and for his zeal in the introduction of improved methods of teaching physical science as a branch of general education. Author of the following and other papers:—"Ozone from Pure Oxygen" (*Journ. Chem. Soc.*, 1887); "The Volumetric Relation of Ozone and Oxygen," "The Influence of Temperature on the Composition and Solubility of Hydrated Calcium Sulphate and Calcium Hydroxide" (*Journ. Chem. Soc.*, 1888); "Some Improved Vacuum Joints and Taps" (*ibid.*, 1890); "Platinous Chloride as a Source of Chlorine," "The Adhesion of Mercury to Glass in the presence of Halogens" (*Journ. Chem. Soc.*, 1892); "On preparing Phosphoric Anhydride free from the Lower Oxides of Phosphorus," "Studies on the Formation of Ozone from Oxygen," Part II. (*Journ. Chem. Soc.*, 1893). Also author of the article on Ozone in the current edition of Watts' Dictionary; "A Practical Introduction to Chemistry" (Rivington, 1886); "The Methods of Glass Blowing" (Rivington, 1886); Life and Work of Liebig" (Century Series, Cassell, 1895).

HENRY MARTYN TAYLOR,

Barrister-at-Law. Fellow of Trinity College, Cambridge. Formerly Tutor of Trinity College, Cambridge. Third Wrangler and Second Smith's Prizeman in 1865. Author of papers in the *Mathematical Messenger*, as follows:—Vol. iii. p. 189, "Geometrical Explanation of the Equations for the Longitude of the Node and the Inclination of the Orbit"; vol. v. p. 1, 1876, "On the Generation of Developable Surface through Two given Curves"; vol. vii. p. 22, 1877, "On Certain Series in Trigonometry"; vol. vii. p. 145, 1877, "On the Porism of the Ring of Circles touching Two Circles"; vol. xi. p. 177, "On a Six-point Circle connected with a Triangle"; vol. xiii. p. 145, "On a Cubic Surface"; vol. xvi. p. 39, "On a Geometrical Interpretation of the Algebraical Expression which, equated to Zero, represents a Curve or a Surface"; vol. xvi. p. 143, "Extension of an Inversion Property." In the *Proceedings* London Mathematical Society: Vol. v. p. 105, 1874, "Inversion, with Special Reference to the Inversion of an Anchor Ring or Torus"; vol. xiii. p. 102, "A Geometrical Theorem concerning the Division of a p-gon into n-gons (with R. C. Rowe); vol. xv. p. 122, "The Relations of the Intersections of a Circle with a Triangle"; vol. xx. p. 422, a Geometrical note "On the Developable Surface through Two Conics Inscribed (or Escribed) in Two of the Faces of a Tetrahedron." In the *Quarterly Journal of Mathematics*: Vol. xxiv. p. 55, "On the Centre of an Algebraical Curve"; vol. xxvi. p. 148, "Orthogonal Conics"; vol. xxvi. p. 214, "Orthogonal Quadrics." In the *Philosophical Magazine*: Vol. l. p. 221, 1876, "On the Relative Values of the Pieces in Chess." *Philosophical Transactions*, vol. clxxxv. pp. 37-69, 1894, "On a Special Form of the General Equation of a Cubic Surface"; and "On a Diagram representing the Twenty-seven Lines on the Surface." Writer of the article on Geometrical Conics in the last edition of "Encyclopædia Britannica," editor of "Elements of Euclid" for the Syndics of the Cambridge University Press; author of two treatises—"On Great-Circle Sailing"; "On a Method by which a Steamer's Lights might show her Course."

JAMES WIMSHURST.

Member of the Consultative Staff, Board of Trade. Qualifications: (1) Improvements in Electrical Influence Machines, which are now universally approved and adopted by Physicists; (2) an Influence Machine which gives charges of electricity, alternating from positive to negative with each rotation of the disc (in this type the glass discs, without any metal upon them, are freely self-exciting); (3) has delivered a lecture upon Influence Machines at the Royal Institution, April 27, 1888, and read papers at the Physical Society, April 17, 1891, and June 22, 1893.

THE FLOW OF WATER.

MORE than one hundred years ago, the French philosopher Coulomb caused a disc suspended by a torsion wire to oscillate in a vessel of liquid, and he thus ascertained that the resistance to various bodies under such circumstances, when the movement is a slow one, varies directly as the velocity of the motion. This law of resistance, it should be noted, is quite contrary to that of the friction between solid bodies as investigated by General Morin. Colonel Beaufoy, Froude, and others, however, found that, at higher velocities, the resistance varied more nearly as the square of the velocity. The difference of the two conditions in which the variation was directly, or, as the higher power, undoubtedly represented on the one hand the condition of water in which the mere viscosity came into play, resisting the shearing stress of the layers in passing over each other, and on the other hand the condition when the breaking up of the water into eddying motion caused the resistance to become much greater.

Prof. Osborne Reynolds, about 1883, investigated the critical velocity at which this change of state occurs, and gave calculations concerning the critical velocity, accompanied by an account of some beautiful experiments. These experiments showed the sudden breaking up at the critical velocity of the stream in a glass tube, the water in which had been flowing quite steadily until that particular velocity was reached.

Now with water flowing in a tube or channel with wetted sides the velocity is greatest in the middle, and, according to the generally accepted theory, is zero at the sides. If this be the case, it would seem that in no event can the whole body of water in the tube break up into sinuous motion; for it is evident that, although it is possible to have one of the conditions by itself, viz. the condition of lower velocity and parallel flow, it is not possible to have the other condition by itself, viz. the condition of sinuous flow. This leads irresistibly to the conclusion that at some point or other there must be a surface of separation between the two.

Such a surface of separation obviously requires special means in order to make it visible. When colouring material is introduced into water flowing under ordinary conditions, it mixes up at once throughout the whole mass. If, however, air is injected into the water, it has been recently found that, in the portion in which the sinuous state exists, the small particles of air, which appear when viewed by the eye as a sparkling mass, prevent the transmission of light and reveal on a screen, when a special lantern apparatus is employed, the actual behaviour of the flowing water. Figs. 1 and 2 show a rectangular body placed in the stream under such conditions. The lines of flow in Fig. 2 result from the use of slightly soapy water, which is used for the production of air bubbles; whereas in Fig. 1 the air is injected into perfectly clear water, and larger bubbles are consequently formed.

Now, if the above figures are examined, it will be seen that round each there is a clear border line indicating a condition differing from that in the general mass of the stream. This not only occurs with obstacles placed in a flowing stream, but in pipes as in Fig. 3. At the International Congress of Naval Architects held at the Imperial Institute last July, this mode of representing the flow of water was brought forward for the first time. It was then suggested that, in this clear border line the water was flowing in layers with parallel motion, while in the main body of the stream the flow was taking place with sinuous, or broken-up motion, and that the change of critical velocity occurred at the darker border between the two. This dark border is always more intense the higher the velocity of the flow, the width of the border becoming correspondingly reduced.

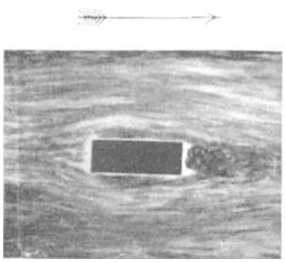

FIG. 1.—Clear water (thick sheet).

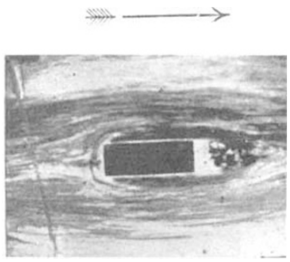

FIG. 2.—Soapy water (thick sheet).

As a good many important results turn upon this point, the subject has been pursued since that time by making a variety of experiments with bodies of varying degrees of roughness of surface, and with passages of various forms. One experiment, however, may be considered as a crucial test, which is to reduce the width of the channel itself, till it actually corresponds with the dimensions of the clear border. This has been done with the result indicated in Fig. 4, when what may be called the air method of making the flow visible entirely fails, the clear border line disappearing and the air passing through, not steadily as before, but spasmodically, while the clear border line of separation

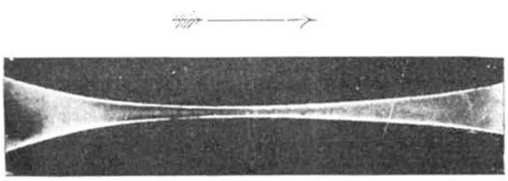

FIG. 3.—Narrow passage showing thin clear film.

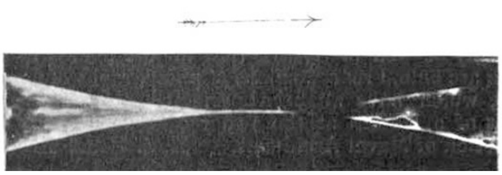

FIG. 4.—Passage still further reduced, showing failure of air method.

entirely disappears. One further step is now obvious, and that is to obtain, if possible, a sheet of water as thin as the border line itself, and examine its behaviour. The result of doing this has been brought forward in a paper read a few weeks ago at the meeting of the Naval Architects in London, when it was shown that in such a thin sheet of water stream line motion exists, thus indicating the absence of sinuous motion and the existence of the motion of parallel flow alone. Under these conditions, while it is impossible to make the motion of water visible, as before, by means of air, colour can be used, and colour bands, corresponding to the stream lines of the mathematician, can be obtained. Figs 5 and 6 indicate a comparison of these two methods to a semi-cylinder. Fig. 5, which is a case of a thick sheet, is an eddying mass of water all round, but is widest, of course, behind where the largest mass of slowly moving water exists. This case is particularly interesting, since it is a case for which the stream lines have been worked out on hydro-dynamical principles,

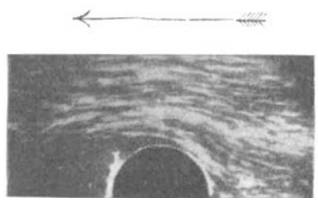

FIG. 5.—Semi-cylinder in thick sheet.

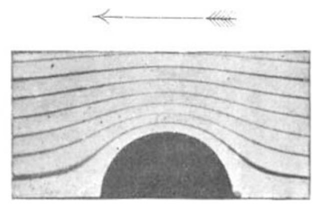

FIG. 6.—Semi-cylinder in thin sheet (test case).

and it is found, by carefully working out a test case, that for all practical purposes the results of the stream lines experimentally produced, agree with those theoretically obtained. As is well known the lines of flow for heat and electricity can be determined mathematically in the same way as those for a perfectly incompressible and frictionless fluid. Hence further verifications can be

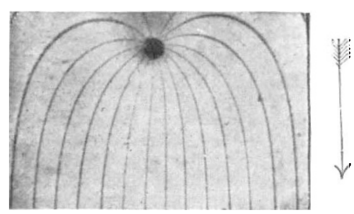

FIG. 7.—Uniform stream and "sink" in channel.

obtained by comparing the theoretical lines of force which have been worked out for electrical and magnetic problems. Fig. 7 is a case of the flow of water through a hole (called in hydro-mechanics a "sink"), and which corresponds to the flow of electricity from an electrified body into one of the wires of a wire grating (see Clerk-Maxwell's "Magnetism and Electricity," Fig. xiii., Art.

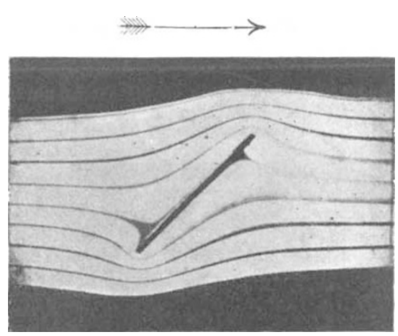

FIG. 8.—Inclined plate in thin sheet.

203, Vol. i.; third edition). A still more remarkable verification is that shown in Fig. 8, which is the case of water flowing past a plate inclined at 45 degrees. The central stream line has been predicted by Prof. Lamb to be a hyperbola, which dividing on the plate would flow round it and re-form on the other side, flowing away exactly as shown in Fig. 8, which figure can be compared with the illustration given in the treatise of Prof. Lamb.

Having thus found a way of representing stream lines by colour bands, various electrical problems, and problems connected with the flow of heat, can be solved in cases

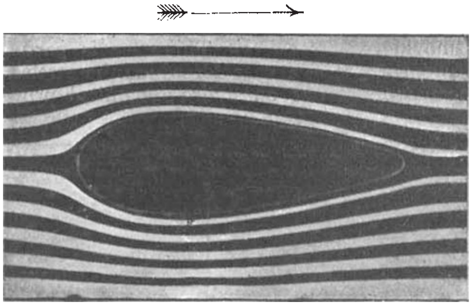

FIG. 9.—Section of screw shaft strut (broad colour bands in thin sheet).

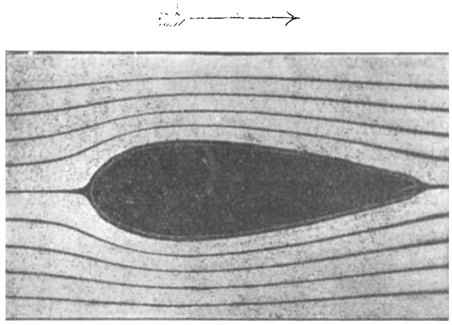

FIG. 10.—Section of screw shaft strut (narrow colour bands in thin sheet).

where it would be impossible to obtain direct mathematical solutions. It is sufficient for the present purpose to give one or two illustrations of the application of the method to problems of interest connected with the flow

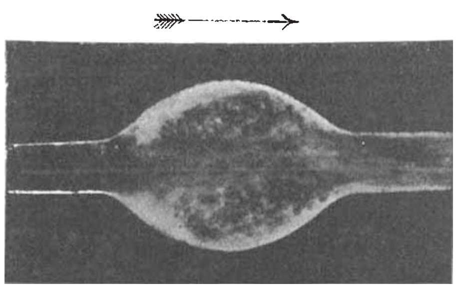

FIG. 11.—Sinuous motion in gradually enlarging and contracting channel (thick sheet).

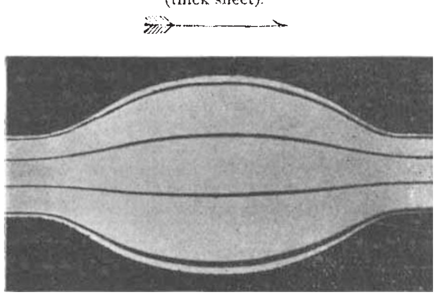

FIG. 12.—Colour bands in gradually enlarging and contracting channel (thin sheet).

of water. Thus, Figs. 9 and 10 illustrate the flow respectively in the case of broad and narrow stream bands round a section of the twin screw strut of one of Her Majesty's cruisers. This might of course be the section of a ship-shaped vessel moving through the water, and as is well known the width apart of the different stream lines would indicate the pressure and velocity in the fluid at every point. Thus stream lines can be obtained in such a case representing a process which for this form of section it would be practically impossible to do by any mathematical process. Figs. 11 and 12 illustrate the flow of water through a passage which gradually enlarges and then contracts. The former case represents the flow under ordinary conditions with the thick sheet of water; the latter case, Fig. 12, being the flow of the colour bands moving in a very thin sheet of water. One more case may be given even more remarkable than any of the foregoing, that is the case of a sudden enlargement of the section of a pipe. Fig. 13 represents the ordinary case of a thick sheet of water in which the eddies and whirls plainly indicate why it is that such a large loss of energy occurs under these conditions in a pipe; while Fig. 14 shows how a perfectly incompressible and frictionless fluid would flow under the same conditions. This is, however, actually what occurs with a thin sheet of water with suitably arranged colour bands.

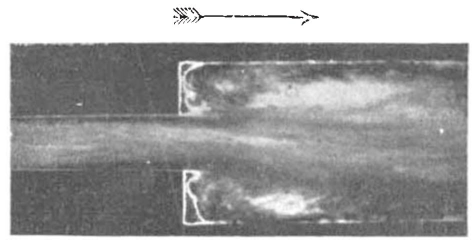

FIG. 13.—Sudden enlargement (thick sheet).

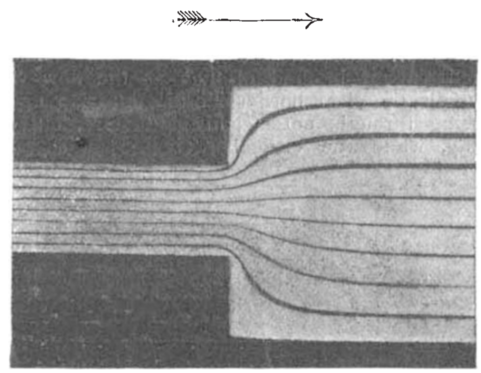

FIG. 14.—Sudden enlargement (thin sheet).

It may be well to remark that all the figures in this article are actual reproductions of photographs of flowing water, which have all been projected on a screen by means of a lantern at the two recent meetings of the Institution of Naval Architects. H. S. HELE-SHAW.

FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE preparations in Bristol for the meeting of the British Association on September 7 proceed apace, and local interest is now thoroughly aroused. The material for the handbook is nearly all in the hands of the editor (Dr. Bertram Rogers), and most of it in type. Among the contributors we note the names of E. J. Lowe, F.R.S. (Meteorology), C. Lloyd Morgan (Geology and Prehistoric Archæology), A. Bulleid (Glastonbury Lake Village), A. T. Martin (Roman Archæology), J. Latimer (History), J. R. Bramble (Architecture), Dr. D. S. Davies (Sanitation), J. W. White (Botany M.