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EXPERIMENTAL PHYSICS

A SELECTION OF EXPERIMENTS

BY

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AND

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SOMETIME FELLOW OF PETERHOUSE

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PREFACE

In the course of my work as a Demonstrator of Experimental Physics, which began in October 1888, many experiments have been devised for the instruction of my students at the Cavendish Laboratory. The three manuals on *Experimental Elasticity* (1908), on *Experimental Harmonic Motion* (1915) and on *Experimental Optics* (1925) describe courses of experiments in those subjects. Many experiments done in my Class had, by their nature, no place in these three volumes. Accounts of some have appeared in the *Proceedings of the Cambridge Philosophical Society* and elsewhere; others* have not, up to the present, been described by me, except in the manuscripts I have written for use in my Class.

The present volume contains accounts of experiments in Mechanics, Elasticity, Surface Tension, Viscosity, Heat and Sound. These experiments are not described in the three manuals already published. Prof. E. V. Appleton has called the new volume “The Odds and Ends Book”; I do not quarrel with his description.

My work as Demonstrator ceases on 30 September, 1935. It seemed right to prepare for that event by writing this book. I hope it may be of service to those who succeed me, and that it may be useful to students and teachers at the Cavendish Laboratory and elsewhere.

The book is, in one aspect, love’s thank-offering for the many happy years spent in the service of students. The work has often been hard, sometimes very hard, but hard work need not be misery.

Mathematical discussions of some problems in Surface Tension, Conduction of Heat and Sound occupy Chapters v, VIII and x. The Chapter (x) on Sound may seem over-long for the small

* In his *Practical Physics* (1926) my colleague and former assistant demonstrator, Mr T. G. Bedford, gave, by my permission, brief accounts of a few of these experiments.

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number of acoustical experiments described in Chapter xi, but I was anxious to bring out the character of the motion which the air has when a resonator is sounding.

The increase in the number of students led, some years ago, to the organisation of a new Practical Class in Electricity and Magnetism. The removal of these subjects from my Practical Course allowed them to be taught more fully than was previously possible, and compelled me to extend my course in Optics. The only, but very real, disadvantage is that students are now offered more than they can absorb in the time at their disposal.

I have abandoned a former project of writing a manual on *Experimental Electricity and Magnetism*.

To avoid the monotony of repetition, I record here my cordial thanks to each of the many friends who gave me help at any stage of the work.

Prof. Lord Rutherford, F.R.S., has seconded my endeavour to secure efficiency in my Class; he has been indulgent to me.

I have often sought the advice of Dr G. T. Bennett, F.R.S. By his help, many statements, particularly in the dynamical sections of the book, were put into precise forms.

The theory of the Sessile Drop in Chapter v was suggested by the interesting, but mathematically invalid, work of Mathieu. By using an elliptic integral method, to the same degree of approximation as I had adopted, Prof. R. H. Fowler, F.R.S., verified equation (25) of § 102 and equation (30) of § 104.

Several students gave their help during vacations. Messrs T. B. Rymer, C. L. Cook, J. G. P. Baker, R. Stone, K. G. Tupling, W. A. B. Carter, J. W. Jeffery and J. L. Roberts assisted in the preparation of the manuscript; Mr C. H. Garrett and Mr D. A. Crooks gave effective help in the correction of the proof sheets. My chief debt is to Miss F. W. Stubbins, of Girton College, who gave her help in the summers of 1929 and 1930. Besides transcribing for the press much of my rough manuscript, she made a large number of the drawings for the figures.

For some years I have had the help of Mr J. A. Ratcliffe, Fellow of Sidney Sussex College, and of Dr N. Feather, Fellow of Trinity College, as demonstrators. Their experience gave weight to their comments on the proofs of the first six chapters. It is

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usually taught that the stable length of a cylindrical soap film, of radius a , is $2\pi a$, and this is true under suitable conditions. Dr Feather's criticism led me to the result that, if the pressure excess be maintained at the *constant* value $2T/a$, where T is the surface tension, the maximum stable length is only πa .

Dr Guy Barr, of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, read the proofs of the Chapter (vii) on Viscosity. His expert knowledge of Viscometry made his help of great value.

Dr Barr, and Dr Allan Ferguson, East London College, made some useful remarks on the Chapters (v and vi) on Surface Tension.

Dr J. K. Roberts, sometime Assistant in the Heat Department of the National Physical Laboratory, made a careful revision of the Chapters on Heat. The Chapters on Sound were read by Dr J. E. R. Constable, of the Physics Department of the National Physical Laboratory, and also by Mr W. R. Dean, Fellow of Trinity College. Mr Dean's detection of a mathematical error led me to set out in full the *exact* equation for spherical waves of sound.

The Cambridge Philosophical Society and Messrs W. G. Pye & Co. have lent blocks for several figures.

The work of the Staff of the Cambridge University Press has won my admiration and my gratitude.

I owe very much to my assistant, Mr C. G. Tilley, for his faithful help for over fifteen years, and for his unfailing kindness and thought for me. If the apparatus described in this book be efficient for its purpose, it is, in many cases, due to Mr Tilley's resourcefulness, to his knowledge of workshop methods, and to his skilled craftsmanship. In former years, I received much help from Mr F. Lincoln and Mr H. D. Roff, instrument makers at the Laboratory.

I have authorised Messrs W. G. Pye & Co., of Cambridge, to supply apparatus made to my designs.

I dare not conclude without a word of grateful testimony. For about seven years, I went through a dark time of nervous and physical weakness, with a complete breakdown in 1910. At the end of 1914, there came into my hands Miss Dorothy Kerin's

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little book, *The Living Touch*, a record of her miraculous healing. It opened my eyes, as they had never been opened before, to the present-day Power of the Living God, the Creator of the universe. As an immediate result, all the old weakness left me, and I was well. In recent years, at Miss Kerin's hostel, Chapel House, Mattock Lane, Ealing, London, many have realised the greatness of the Lord's Power and Love, and have learned to trust Him.

G. F. C. SEARLE

Cavendish Laboratory

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