Early radio wave detectors

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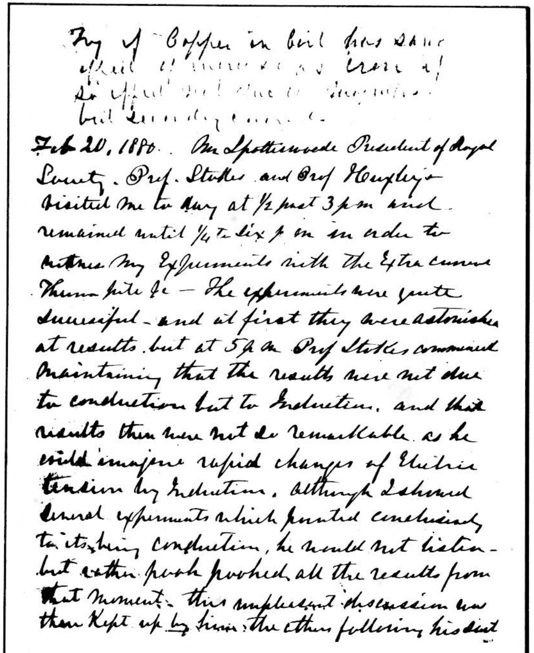
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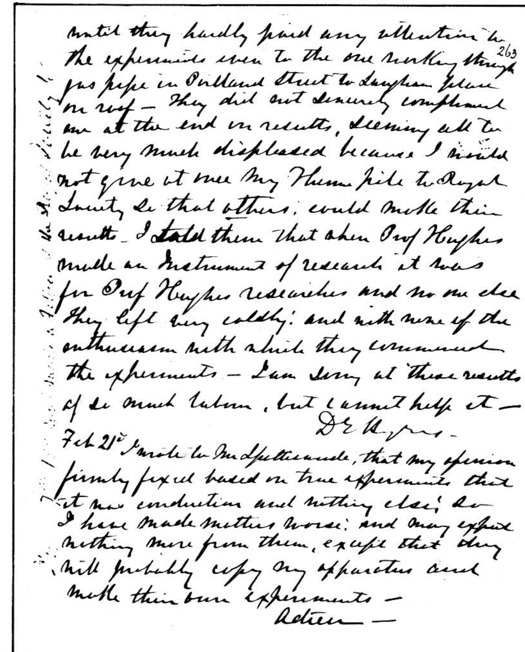
Feb 20, 1880. Mr Spottiswoode President of Royal Society. Prof. Stokes and Prof Huxley visited me today at 1/2 past 3 pm and remained until 1/4 to six p m in order to witness my Experiments with the Extra current Thermo pile &c — The experiments were quite successful — and at first they were astonished at results. but at 5 p m Prof Stokes commenced maintaining that the results were not due to conduction but to Induction. and that results then were not so remarkable as he could imagine rapid changes of Electric tension by Induction. although I showed several experiments which pointed conclusively to its being conduction, he would not listen — but rather pooh poohed all the results from that moment. this unpleasant discussion was then kept up by him: the others following his lead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until they hardly paid any attention to the experiments even to the one working through gas pipe in Portland Street to Langham Place on roof — they did not sincerely compliment me at the end on results, seeming all to be very much displeased because I would not give at once my Thermo pile to Royal Society so that others could make their results. I told them that when Prof Hughes made an instrument of research it was for Prof Hughes researches and no one else. They left very coldly: and with none of the enthusiasm with which they commenced the experiments — I am sorry at these results of so much labour, but cannot help it —

D E Hughes.

Feb 21st I wrote to Mr Spottiswoode, that my opinion firmly fixed based on true experiments that it was conduction and nothing else; so I have made matters worse; and may expect nothing more from them, except that they will probably copy my apparatus and make their own experiments —

Adieu —

Frontispiece ***Two pages from the notebook of Professor D.E.Hughes describing the visit of the Fellows of the Royal Society to his laboratory***
Note the comment added later in the margin — 'June 7 188(?) was made a fellow of the Royal Society!'

For Diana, Hywel and Cenydd

Preface

When I was a student at Imperial College, Third Year Honours students had to write an essay and deliver a short lecture on any subject of their own choice. I elected to give a lecture on early radio detectors, my interest in this topic having been awakened by reading the Science Museum *Handbook of Radio Communication* published in 1934. This interest continued after graduation, and over the years I have built up a set of references and given lectures under the auspices of various societies and institutions. It was after such a lecture, given at the Institution of Electrical Engineers Annual Conference on the History of Electrical Engineering at Manchester in 1975, that Dr. Brian Bowers and Mr. Keith Geddes made the suggestion that I might care to write a booklet on the subject for the Science Museum. It is from this suggestion that the present book has grown.

I am very grateful to the Director of the Science Museum for allowing me the privilege of being Visiting Research Fellow from February to September 1977, and to the Council of University College Swansea for granting me a period of sabbatical leave in order to take up this appointment. During this leave the burden of my laboratory duties and my tutorial classes was cast on my colleagues in the Department of Electrical and Electronic Engineering, and I am grateful to them for carrying this extra load.

Living away from home and travelling frequently to London is an expensive business, and I am indebted to the Science Museum for covering certain of the travelling costs, and to the Leverhulme Trust who awarded me a research grant to help defray expenses. My wife's fortitude in coping alone with the children in my absence was also a major factor in enabling this work to be undertaken.

It is a particular pleasure to acknowledge the assistance and kindness of the staff of the Science Library, South Kensington, who, with unfailing cheerfulness, helped me to chase up many of the obscure references containing the information on which this book is based. I am also very grateful to Keith Geddes, who read the manuscript and made numerous comments and suggestions for improvement.

I hope that other electrical engineers will find the subject as fascinating as I have, and that the rediscovery of some of the 'lost' phenomena described will remind them of the tremendous achievements of our founding fathers. The writer on the history of radio has one thing in common with the medieval historian: just as the lance is no longer used in warfare, having been rendered obsolete by later developments, so have many of these phenomena sunk into obscurity. Indeed, many of them have never been satisfactorily explained, and authors of the period often leave out of their accounts what we would nowadays consider to be vital information. One hazard, however, not shared with the medievalist is that it is quite possible for people who may have had first-hand experience of these matters to be with us today. If a mere stripling of forty odd years has got it wrong through lack of such experience, I crave their indulgence in advance.

Vivian J. Phillips
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Swansea, Wales

July 1978

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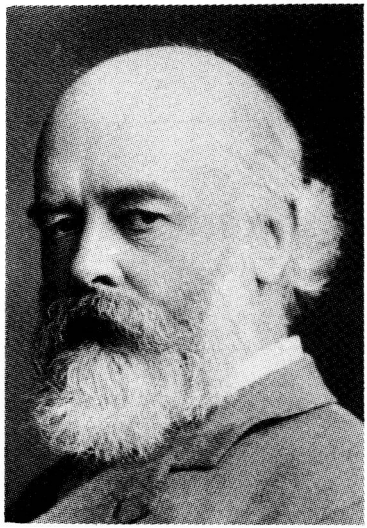

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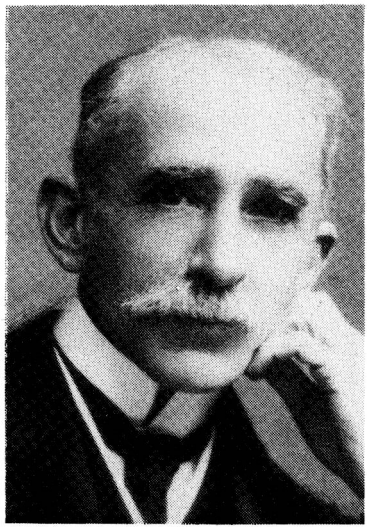

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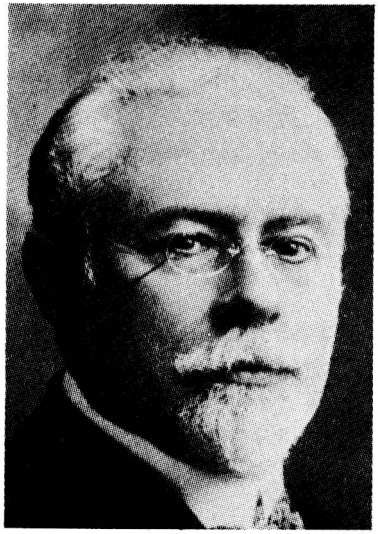

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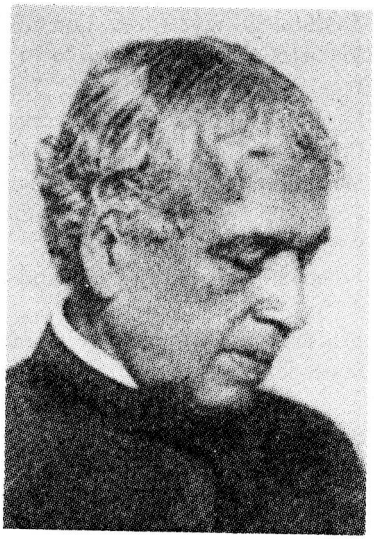

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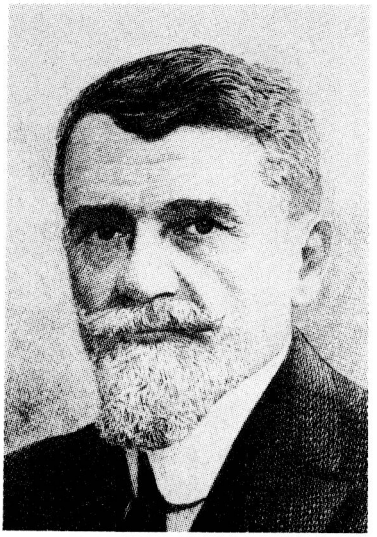

Gustave Ferrié 1868–1932

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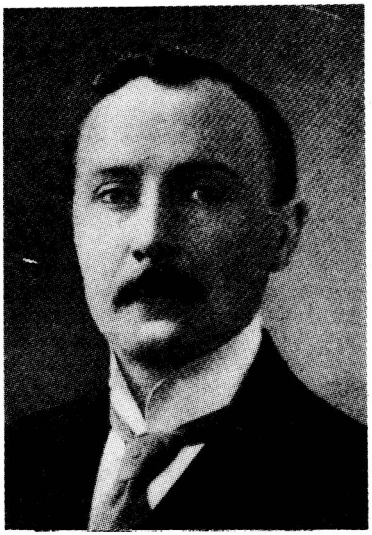

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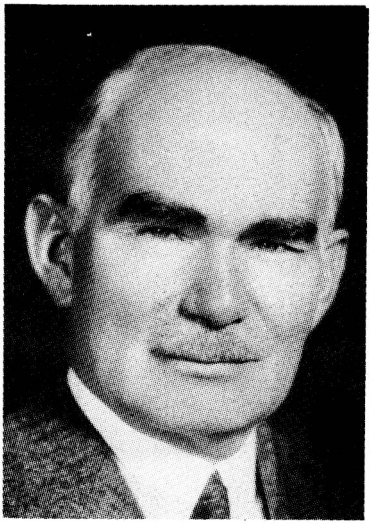

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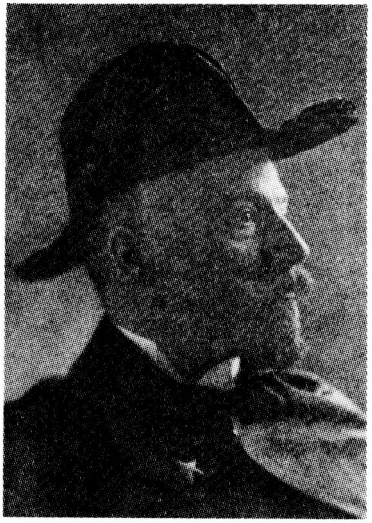

Marquis Luigi Solari 1873–?

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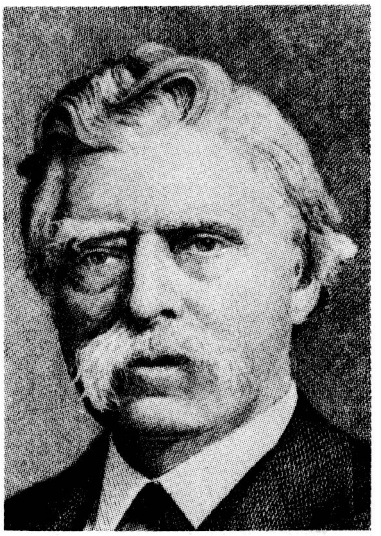

David Edward Hughes 1831–1900

Heinrich Rudolph Hertz 1857–1894

Edouard Branly 1844–1940

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Chapter 1

Introduction

Mankind has been endowed with the five senses of sight, hearing, touch, smell and taste. It is not surprising, therefore, that his scientific curiosity was aroused from the earliest times by the light he could see, the sounds he could hear and the heat he could feel. Although the physicist has rather neglected the senses of smell and taste, these too have received their share of attention from people with gastronomic interests and from those concerned with the manufacture of perfumes.

There are, however, many phenomena in nature which cannot be perceived directly, and these must be converted into a form appreciated by the senses before their presence is revealed. Thus a magnetic field must be rendered visible by the controlled swinging of a lodestone or the patterns of iron filings, and an electrostatic force must create visible sparks, audible cracklings or unpleasant shocks before we are aware of its presence. For this reason radio waves lay undiscovered until the nineteenth century although they had always been produced naturally during thunderstorms. During that century various scientific workers became aware that there was some unknown phenomenon which was causing inexplicable results in some of their experiments.[1] For example, in 1842 Professor Joseph Henry noticed that the discharge of a Leyden jar (the form of capacitor used in those days*) was able to magnetize needles situated in the basement thirty feet below although two fourteen-inch thick ceilings intervened.[2] He also noticed that lightning flashes seven or eight miles distant produced a similar effect. Again in 1875, Professor Elihu Thomson was using a sparking coil in a room on the first floor of the Central High School in Philadelphia. He

*The 'jar' was used as a unit of capacitance, and the Admiralty Handbooks continued to quote the conversion factor for jars to microfarads until well into the 1930s. J.A.Fleming stated in his book (Section 2, Reference 6) that the pint size jar had a capacity of about 1/700 μF and the gallon size 1/300 μF.

had connected one side of the spark-gap to earth and the other side to a large insulated metal can, and he discovered that when he held a sharp pencil point to a brass door-knob about a hundred feet away at the top of the building, small sparks could be seen each time the sparking coil operated in the room below.[3,4] In a paper written years later he recalled his experiences on this occasion and described an improved spark detection apparatus which was designed for him by Thomas Edison.[5] This consisted of two sharpened points forming a small spark gap contained in a dark box, which made it easier to observe the feeble secondary spark.

Perhaps the best documented of all these early observations were those made by Professor D.E. Hughes in London between 1878 and 1880.[6-9] Professor Hughes (who was actually a professor of music) had been experiencing difficulty in balancing an inductance bridge with which he was working (Fig. 1.1) and he eventually traced the trouble to a loose connection in the circuit. As it happened, he was also experimenting with some of his primitive microphones in the same laboratory. One of these microphones consisted of a steel needle lying in loose contact with a piece of coke, the whole being connected in series with a battery and a telephone earpiece. (Other types of loose-contact microphones such as those of Fig. 1.2 were also used by him.) Sound vibrations impinging on this microphone would vary the contact resistance and hence the current, thereby reproducing the sound in the earpiece. Hughes noticed that when the faulty contact on his bridge was made and broken this created noises in the earpiece even though the two sets of apparatus were far apart and unconnected in any way. He was quite excited by this discovery and went on to carry out many experiments,

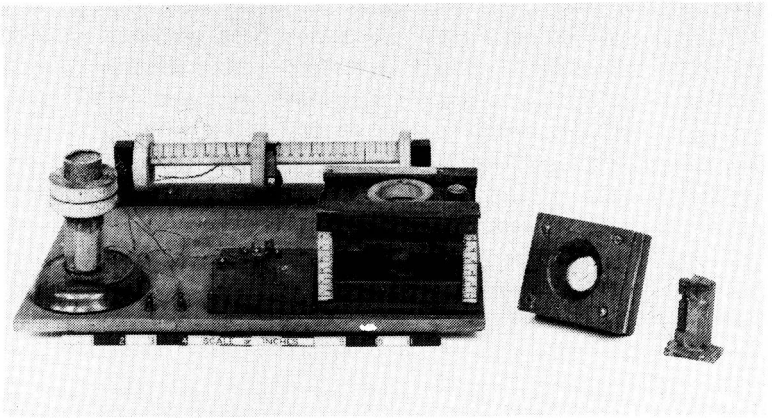

Fig. 1.1 *Hughes's induction balance circuit*
[Science Museum photograph]