Bernard A Robinson 1888-1979: an unknown pioneer of electrocardiography

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The important contributions of Bernard A Robinson (1888-1979) (fig 1) to the early development of the electrocardiograph and of other scientific instruments have largely gone unnoticed. He is not mentioned in major British papers on the history of electrocardiography.¹⁻³ When I visited him in 1976 I was impressed to find that he had kept all his working notebooks, which were full of detail about the supply and testing of equipment. After his death these notebooks and his other papers were placed in the Science Museum Library, London.⁴ They are catalogued in six sections: notebooks (ROB1), correspondence and historical material (ROB2), internal technical memoranda (ROB3), instrument instructions (ROB4), other technical material (ROB5), and printed papers and catalogues (ROB6). There is a good deal of useful material in this collection not only about the early years of electrocardiography but also about other electrical instruments such as the Bock-Thoma heat recorder. This paper is based on our conversation and on an account he gave me of his work with Thomas Lewis.⁵

Visit to Einthoven

Robinson studied physics and electrical engineering in London and in 1905 he joined the Amalgamated Radio Telegraph Company at Cullercoats near Newcastle upon Tyne. Early in 1907 the company sent him to Professor Willem Einthoven's department in Leiden to obtain a model of the string galvanometer that Einthoven had invented in 1901.⁶ With the use of this instrument the earliest high speed *radio*-telegraph messages were transmitted at 110 signals per minute from Newcastle to Copenhagen and he became the first person to hear speech sent across the North Sea. He recalled that there were several models, all neat and about 6 inches high, with gold or platinum strings. Einthoven generously gave original electrocardiograms to Robinson and also copies of his articles, one of which (ROB5/1) is notable because the 16 pages are handwritten by himself (fig 2) in excellent colloquial English despite being a translation of a German paper.⁷ Professor H A Snellen kindly identified this reference and writes, "Einthoven certainly had a gift for languages. He learnt English, German and French at high school, and Latin and Greek afterwards. Later in life he was often heard to

Figure 1 B A Robinson circa 1925.

quote Latin authors. As you probably know he often published the same material two or three times in different languages with rather slight changes or even just translated literally. His teacher, Donders, often did the same, in contrast to Lewis." It is said that Einthoven perfected his English by reading a chapter of an English classic in bed every night.² It is certainly a tribute to the warmth of Einthoven's personality that he went to so much trouble for a young non-medical visitor.

The Cambridge electrocardiograph

The Cambridge Scientific Instrument Company had a royalty agreement with Einthoven to manufacture his string galvanometer and W D Duddell, FRS, inventor

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Figure 2 Page 1 of a 16 page manuscript with the annotation "Written by Prof Einthoven to B.A.R." It is a translation of the article "Ein neues galvanometer." It reads . . .

A new galvanometer by W Einthoven

Principle and Theory.

The Instrument to be described in this notice, and which may be called the String Galvanometer is based upon the well known Principle of the moving conductor in a fixed magnetic field. The moving conductor consists of a silvered quartz fibre which like a thread is suitably stretched in between the poles of an Electromagnet. On sending a current through the string the latter deflects vertically to the lines of force whilst the deflection in the centre of the string can be directly measured with the aid of a microscope with an ocular micrometer.

The considerations which have led to the construction of the string Galvanometer can best be explained in starting from an existing form of the Deprez-d'Arsonval Galvanometer and putting to oneself the question what amendments may be made on the apparatus for its improvement.

In the first the normal sensitiveness has to be considered. By normal sensitiveness is understood the deflections in m/ms upon a scale distant 1000 m/m from the mirror. For the . . .

of the Duddell oscillograph, produced a superb new design for them. The first one, a galvanometer only, was supplied to the physiological laboratory of Professor MacDonald at Sheffield late in 1905³ while the first electrocardiograph went to Professor E A Schafer in Edinburgh in 1908 for physiological work and another early one was sup-

plied to the Gutta Percha Company for electrical research—a reminder that Einthoven's invention benefited non-medical disciplines too. But for clinical work an entire assembly with all the associated equipment was required and the first complete Cambridge electrocardiograph "outfit," as Robinson called it, was made in 1911 and sent to Dr (later Sir) Thomas Lewis. Robinson had been recruited by Mr Robert Whipple to take charge of this development and he started work at Cambridge early in 1912 as assistant to Mr (later Sir) Horace Darwin.⁸

Working with Thomas Lewis

Robinson's work with Lewis is best told in his own words.⁵

I was introduced to Dr. Lewis in July 1912. At that time he was working with an Edelmann String Galvanometer, and had not got the Cambridge instrument working. Thursday was his research day in each week and it was arranged that as much as possible I should spend Thursdays with him. This co-operation was the main factor in the very rapid development of the cardiograph between 1912 and 1915. It relieved Lewis of all responsibility for the operation of the instruments so that he could concentrate on the physiological side. At the same time I was on the spot to counter any difficulties and immediately report to Cambridge suggested modifications for regular hospital and clinical use. As each new type of equipment was produced it was submitted to him for criticism, and we used prototypes together before being put into production. From then onwards Lewis only used Cambridge equipment. Thus the Cardiograph became a unified Outfit and each one supplied strictly up-to-date.

Lewis was 31 and I was 24 when I started working with him and that was an education in itself. During the three years I was associated with him so closely I never once saw him ruffled. He had a most equable temperament. Slim in figure, those penetrating eyes under heavy eyelashes were very expressive. Always quietly speaking, when anything went wrong we would look at each other and instinctively felt "Come on let's try again". He had infinite patience and there was much affection between us. He once told some visitors, "When 'BAR' is here the instruments always behave; so when he is away his photo hangs up".

Most of the work at that time was done on anaesthetised dogs and Lewis was most careful that they were tenderly treated before being "put under"; and, never under any circumstances allowed to recover consciousness.

One always had to have a plentiful supply of experimental electrodes ready. Prepared from approximately 3 mm od glass tubing and drawn out to about 1/2 mm bore, they were plugged with cotton wool saturated with 10% saline into which was embedded the thin connecting wire. Often half a dozen or more electrodes were in use at one time and the greatest care had to be taken in the positioning, and the right connection maintained for the recording. There was obvious pleasure in producing some irregular function of the heart; of taking the record, and then restoring normal rhythm without altering the position of electrodes. When we met a week later sometimes he would say "I'm puzzled by such and such a record last week so we must repeat and check each step." It really was a joy to work with him.

One of the major difficulties encountered by the Instrument Company in 1912 was the production of the "strings" for the galvanometers. Einthoven used quartz and then electrically bombarded from a silver electrode to obtain the conducting surface. This was a slow process especially when the finished strings were required to be 150 mm long and $3\ \mu$ diameter. The most urgent task therefore at that time was to produce strings! Compared with quartz, soda-lime glass was not only much easier to draw but also took the silver plating better using the silver nitrate-Rochelle Salt formula. They were equally satisfactory in the galvanometers. Much work was done trying pure metals and other materials but finally silvered glass strings were standardised. The glass was drawn down to $1\frac{1}{2}$ to $2\ \mu$, then silvered with $1\frac{1}{2}\ \mu$ coating and finally burnished before mounting. The burnishing was necessary to consolidate the spongy coating and give a clean cut edge for photography. At a later date I concluded that maximum sensitivity was not required but rather minimum time period for cardiograph work. I cut the length of the strings down to 100 mm and resistance of about 3000 ohms. Lewis made a number of tests and agreed, so they became standard for all outfits from 1913 onwards. This also had the advantage of speeding up production. From 1912 to 1919 all strings were made, mounted, and tested by myself. To a large extent this was due to War conditions and the difficulty of obtaining sufficient skilled personnel.

Before 1920 it was my prerogative to see every Outfit in Great Britain properly installed and the Heart Specialist tutored in its operation. This led to many friendships with the Giants of those days such as Prof. A D Waller; Sir James Mackenzie; John Parkinson; John Cowan of Glasgow; Hay of Liverpool; Ritchie of Edinburgh; Wardrop Griffiths of Leeds; Professor Ernest Rutherford when at Manchester and at the Cavendish; and a host of others.

In the early days when dealing with human patients Lewis sometimes would take simultaneous Mackenzie Polygraph and Einthoven records. Early in 1914 I suggested to Lewis that the pneumatic system of the Polygraph was not designed for maximum sensitivity. He immediately took me round to Mackenzie in Harley Street to discuss the matter. Mackenzie agreed with me and it was decided to redesign the instrument. The first new model was tested out by Lewis in July 1914 and fully approved. It was known as the Mackenzie-Lewis Polygraph in honour of these two great savants. However only five were made owing to the emergencies of the War requiring all instrument production for war purposes. Three of the five were believed to have been destroyed during the Second World War.

In the early days as cardiograph outfits became an essential equipment for Specialists so the analysis of records obtained often involved considerable ingenuity. I frequently received records stating that the sender could not decipher them and stating that it was "a quite unusual case". They did not like to send them to Lewis as they did not like to show their ignorance! The two main causes were either they had inserted the plate with the emulsion side reversed in the carrier, or else the right arm, left arm leads reversed by thinking of their own limbs instead of their patient. They were happy days of pioneering but very time absorbing when one was working all hours, seven days a week, under War conditions.

Robinson's warm account of Lewis's personality contrasts with the experience of others who found him difficult to know, impatient, and short tempered. Possibly co-workers with something to offer were more readily accepted as Paul White discovered when he showed Lewis how to use the slide rule. But it does emphasise Pickering's comment that those who gained his friendship knew a warm hearted man.

Robinson's expertise

Robinson's association is not mentioned in any of Lewis's papers nor is he acknowledged as part author of Chapter 1 of *Clinical Electrocardiography* but without his technical expertise Lewis would probably not have readily accomplished the work on the excitatory process in the dog's heart which won him his FRS. The new design of the polygraph was done entirely by Robinson who supervised its construction at Cambridge. Luckily he had kept an unused model and this (fig 3) is now in the Wellcome Museum of the History of Medicine at the Science Museum in London. The use of hard glass instead of quartz for the galvanometer string is not well known and its introduction was due to the invention in 1913 by Dr Keith Lucas of an electric heater to draw out the glass.²

The photographic recording of the electrocardiogram with the Cambridge apparatus was usually done on a glass plate but, like the Edelman company, they also supplied a camera with a long roll of photographic paper which was very useful for arrhythmia analysis. Robinson again showed his technical ingenuity by inventing an automatic developing process for the paper which he called "photo-tape." He wrote a useful paper with illustrations on electrocardiography in 1914.⁹

Figure 3 Mackenzie-Lewis ink writing polygraph.

Figure 4 Twin channel electrocardiograms from a dog's heart. From the inter-atrial septum and lead II (lower trace). (*Philos Trans R Soc Lond [Biol]* 1914; 205: plate 40).

Mackenzie and Osler

Robinson had first met Sir James Mackenzie in Waller's laboratory in 1912 and in February 1913 visited him at 133 Harley Street and was taken out to dinner. Soon afterwards he installed a Cambridge electrocardiograph there and recalled that "I took a number of cases for him and met Sir William Osler, Dr. John Hay, Dr. Bertrand Dawson and Dr. William Price all seeing the new instrument and it was my privilege to teach all the above at a later date how to use the electrocardiograph." His notebook (ROB1/4) records that plate camera No 25147 was sent to Osler at Oxford on 16 October 1914 and this must have been a repair or replacement because Osler was supplied with an electrocardiograph on 1 January 1912.³ But it was the 9th edition in 1920 of Osler's textbook edited after his death by T McCrae that first contained illustrations of electrocardiograms and they are not Cambridge recordings. Also in 1914 the Cambridge Company produced a double string carrier designed by W H Apthorpe that enabled two simultaneous recordings to be made with one galvanometer. Lewis used this extensively for his work on

Figure 5 Simultaneous recording of the heart sounds of the fetus and the electrocardiogram of the mother made by Thomas Lewis in 1914. (Fig 5 in Barron SL').

dogs (fig 4) and for phonocardiography (fig 5). One was sent to Einthoven in October 1914 but it seems doubtful if he ever used it. Professor Snellen writes, "As far as Einthoven's own galvanometer is concerned the ones he used were always made in his own laboratory with parts which he bought from specialised firms. When I worked in his laboratory three years after his death the room for electrocardiography was still intact but I saw only successive models of his own string galvanometer."

He was closely associated with Mackenzie too at the London Hospital whose outfit was installed in 1914. He recalled that "he was a very genial man that was the great thing about Mackenzie. I mean to say he would crack a joke about all sorts of things. He was a very charming man to talk to and work with." He admired "the marvellous John Parkinson" and related a remarkable incident involving him.

Factitious bradycardia at the London Hospital

For a demonstration Parkinson produced a healthy looking man of 26 and Robinson was dismayed to find a heart rate of about only 30 per minute. He thought something had gone wrong with the instrument but was immediately told that the patient was puzzling them and further that there were another nine apparently healthy young men with a similar rate. Electrocardiograms were taken from all of them and when repeated after 18 hours in hospital the heart rate was normal. Being unable to provide a medical explanation Parkinson asked Robinson to tackle the problem from the lay point of view. "After a time I got out of them that they were doping themselves. It was difficult to find out what was the dope because they did not wish to give it away but eventually they said it was the photographic chemicals metol and hydroquinone." They were simulating illness to avoid military service.

Robinson's papers in the Science Museum Library

By 1915 the Cambridge Scientific Instrument Company had made 35 complete electrocardiograph outfits and details of testing them are recorded in his two notebooks each of 254 pages (ROB1/3 and 1/4) that run from July 1912 to November 1918. These outfits went all over the world—for example, to Western Australia, Japan, Russia, India, France, and Canada, with 10 going to the USA. In addition, galvanometers only were sold, one of special construction being made for the Marconi Radio Telegraph Company. Other Cambridge equipment is also mentioned in the notebooks and includes the Duddell thermo-ammeter, a universal electrometer sent to Patna, an optical pyrometer, a thermo-couple potentiometer, and a sphygmo-oscillograph.

His correspondence (ROB2) is from 1952 to 1974. There are letters to the staff at Cambridge such as S L Barron and A F Wolfe and these contain valuable material on early elec-

trocardiographic work and its pioneers. In one of them he tells of re-soldering a string for Sir William Hume "i.e. 45 years with the galvo!" Several letters between Dr George Burch and himself relate to the placement of historical artefacts in the Tulane University Museum. The internal technical memoranda (ROB3) contain material on the Bock-Thoma Universal Recorder. Instrument instructions (ROB4) include a description in 1913 of the use of electrodes made of sponges soaked in zinc sulphate and sodium chloride as a substitute for the current method of immersing the limbs in salt solution. The section labelled "other technical material" (ROB5) has a 32 page typescript from Einthoven (ROB5/2) entitled "Additional appreciations concerning the string galvanometer." The final section on "Printed papers and catalogues" (ROB6) is large and interesting. It contains three historical accounts of the Cambridge Company and five monographs, 12 catalogues, and seven construction booklets issued by them. There are also four long papers on the electrocardiogram by Dr M Edelmann, two papers by Robert S Whipple, and a signed reprint from Einthoven.

Later work in industry

During the first world war he was also closely involved with the design and production of instruments for gun ranging and at the end of the war he was appointed resident technical engineer for Cambridge at Newcastle upon Tyne. His work now was with industry and included equipment for locomotive testing and the automatic control of blast furnaces. He became a member of the Institution of Electrical Engineers and contributed two comprehensive papers to their journal. One dealt with the development of methods of measurement¹⁰

and the other with electrical measuring instruments.¹¹ In the second world war he supervised the accuracy of Cambridge equipment used in ordnance and munition factories and after it he marked his retirement with an article that summarised 50 years of scientific instrument manufacture.¹²

Personal affairs

He and his wife, who had one son, were prominent in church affairs and they initiated a widely praised mission at Hexham, Northumberland, which they ran for 23 years. He was a diocesan reader for 58 years and was also a senior member of the British Red Cross Society.

I am indebted to Mr Alan Osborne for introducing me to Mr Robinson.

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