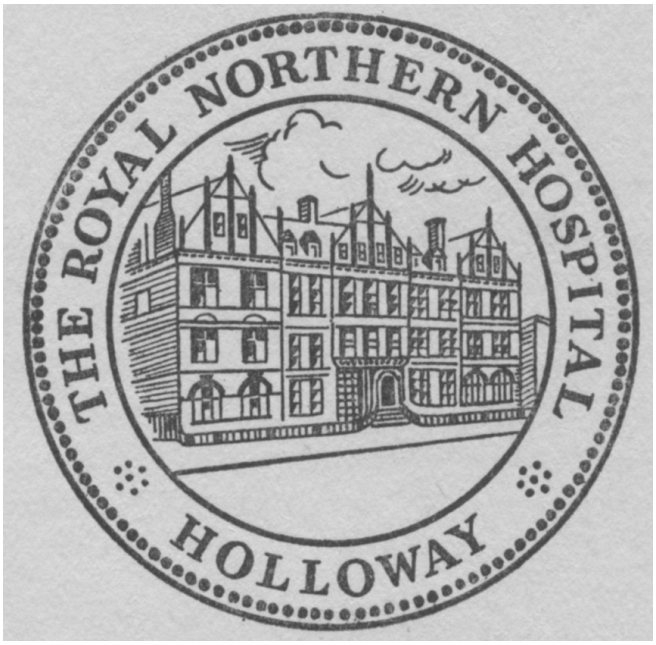
The Invisible Light



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Editorial.

Having completed the last issue of The Invisible Light in May 2020, who would have imagined that I would be writing this as we are about to enter another period of lock-down? I trust that the two papers in this issue are of interest. The first is by Dick Mould and is about the pioneer medical physicist Major Charles ES Phillips. Dick's paper shows his deep knowledge of his topic. Charles Phillips was highly influential in the early days of radiography and radiology and we are thankful to Dick for his hard work in revealing this remarkable person to us.

My own piece is about the life and work of Kathleen Clara "Katie" Clark. Katie was as influential in the radiographic world as Charles Phillips was in the world of physics. The paper is based on a presentation that I made at the History of Imaging session at UKIO 2020 and that was held on-line. I spent many hours with the late Marion Frank talking about Katie Clark. Marion would have been 100 this year and I still miss her. She was my mentor for all things radiographic. Marion had many tales to tell, including using the famous textbook 'Positioning in Radiography' to prop up a wardrobe!

I enjoyed the recent film 'Radioactive' and have written about it (details below). Rosamund Pike, a well-known UK actor, plays the role of Marie Curie, while Sam Riley, also a UK actor, is her husband and scientific collaborator Pierre Curie. The film is based on the graphic novel 'Radioactive: Marie & Pierre Curie: A Tale of Love and Fallout,' written by Lauren Redniss and published in 2010. If you see an interesting film, or read a good book and want to write about then please sent me your work. It's often difficult to know what is either released or published and all information that you can provide is welcome.

Do we really stand on the shoulders of giants? (8 June 2020)
https://www.auntminnieeurope.com/index.aspx?sec=sup&sub=cto&pag=dis&ItemID=618864
Is the new Marie Curie movie worth watching? (6 July 2020)
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What must radiologists know about the abscopal effect? (26 August 2020)
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50 years of CT scanning approaches (22 September 2020)
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Major Charles Edmund Stanley Phillips (1871-1945)
X-ray & radium pioneer, artist, musician
& Secretary of the Royal Institution

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Abstract
This article is a biography of a wealthy experimental physicist, artist & musician, who was one of the founders of the Röntgen Society and of the Institute of Physics. He was also the United Kingdom's first hospital physicist (at the Cancer Hospital, London, which is now renamed the Royal Marsden Hospital). This biography is a journey into a long vanished world of science and it brings into focus several famous scientists of the years before World War I. Because of the scientific reputations & wealth of his father & grandfather, the latter being involved in the laying in 1857 of the first transatlantic telegraph cable, Charles Phillips gained entry at an early age to the scientific establishment of his era: a feat which otherwise would have been impossible. When he died in 1945 he left in excess of £1.25 million to the Institute of Physics.

Key words: Charles E.S. Phillips, Lord Kelvin, Sir William Crookes, Sylvanus Thompson, Olaus Henrici, Oliver Heaviside, Wilhelm Conrad Röntgen, röntographs, X-ray imaging in 1896, X-ray tubes, radium, radiation measurement, The Röntgen Society, The Royal Institution, The Institute of Physics, The Royal Academy of Arts, Stradivarius violins, hospital physics, Cancer Hospital {London}, Royal Marsden Hospital, transatlantic telegraph cable, army marching luminous compass, glass-blowing

Introduction

In the 19th century the industrial revolution changed the United Kingdom from a largely agricultural society with a static population to one which by the end of the 1800s would have been unrecognisable 100 years earlier, with advances including the railways, industrial production mechanisation in many industries such as those related to coal & steel, cars which had replaced horse-drawn vehicles, the telephone and electric lighting. At the same time, the population moved in large numbers from the countryside to the overcrowded towns and cities which housed the factories and industrial complexes which had made many agricultural workers redundant. The Great Exhibition at the Crystal Palace in Hyde Park, London, in 1851 celebrated the new industrial age with exhibits from all over the world.

It was during this 19th century that what can be termed the *amateur gentleman scientist of independent means* appeared within the scientific spectrum. These wealthy scientists, often with little or no formal education at a university or college, could afford because of their inheritance, to set up and fund their own laboratories and study whatever took their fancy. One such experimental scientist was Charles Edmund Stanley Phillips (1871-1945) who at the early age of 23 became a member of The Royal Institution and knew such eminent scientists as Lord Kelvin (1824-1907), Sir William Crookes (1832-1919) and Sylvanus Thompson (1851-1916).

Phillips published relatively little by today's standards and is now primarily known for his bibliography of X-ray & radium literature for 1896-1897 which he described as "being a ready reference index to the literature on the subject of Röntgen or X-rays" [1].

Charles Phillips died on 17 June 1945 in Lymington, Hampshire, where he had recently moved from Shooters Hill because of the bombing of the capital in World War II. His obituary [2] in *Nature* was only brief. "By the death of Charles Edmund Stanley Phillips on 17 June, many will mourn the death of a very interesting personality. Phillips was born on 18 February 1871, his father being Samuel E. Phillips, one of the co-founders of Johnson & Phillips, the firm which made some of the earliest

electric marine cables. He was educated privately and studied, for a short time only, at the Central Technical College, South Kensington." {In 1907 this College joined with the Royal College of Science and the Royal School of Mines to become Imperial College of Science & Technology and then in 1908 became part of the University of London.}

In 1945 when lectures at the Royal Institution were given to celebrate the life of Major Phillips, the then President of the Royal Institution, Sir Henry Hallett Dale (1875-1968) [3] who was an English pharmacologist & for his study of acetylcholine as agent in the chemical transmission of nerve impulses shared the 1936 Nobel Prize in Physiology or Medicine with Otto Loewi; recorded in the concluding lecture that Charles Phillips "belonged to a type which, under the rapidly changing conditions of the modern world is likely, one would fear, to become *rarer* – that of a man whom a fortunately inheritance has put beyond the need and the duty of working for livelihood at some business or profession, who, nevertheless, has so keen a mind and so lively an interest, as to give eagerly of him time and his substance, and to devote his natural talents with real diligence, to some freely chosen field of science, art or scholarship." Dale also stated [3] that "Phillips had three cherished ambitions in his life and realised them all in a single triumphant week {in 1925}.

{**1**} Election to the Athenaeum Club.
{**2**} A picture hung on the line at The Royal Academy.
{**3**} Acquiring a Stradivarius violin."

Charles Phillips was a fascinating character as a scientist, artist & musician who remained active throughout his life. His first Presidency was that of the Röntgen Society 1909-1910 (**Figure 1**) and from 1929 until his death he was the Secretary of The Royal Institution. In addition from 1925-1945 he was the Honorary Treasurer of the Institute of Physics [4]. His last published paper [5] appeared in 1944, on the topic of glass-blowing. On his death in 1945 he left in his will £1.25 million plus property to the Institute of Physics [4]. The three generations of the Phillips family are given below. Charles married in 1903 but had no children and he also had no brothers or sisters.

Samuel Elkens Phillips (alive 1872)
▼
Samuel Edmund Phillips (1848-1893)
▼
Charles Edmund Stanley Phillips (1871-1945)

Figure 1. The Röntgen Society Presidential photograph of Charles Phillips,1909-1910.

My own links with Charles Phillips are very tenuous in that as a junior physicist in 1961 at the Royal Cancer/Marsden Hospital, London, I found in a forgotten corner of the library of the nearby Chester Beatty Cancer Research Institute a faded album of photographs stuck onto crumbling cardboard pages which were entitled "*Röntographs*" (**Figure 2**) and dated June 1896 [6]. I then learnt from the Professor of Medical Physics, W.V. Mayneord, that his predecessor as chief physicist in the 1920s, was a millionaire who rode to work each day on a horse from his home in Shooter's Hill to the hospital in South Kensington. The life of a physicist in 1961 was significantly different with a salary of £44 per month and a method of transport either walking, bus or London underground tube train!!

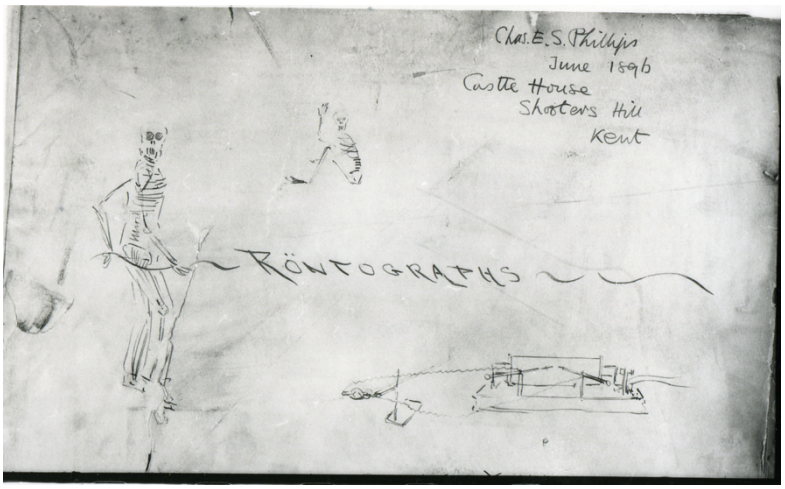


Figure 2. Title page of Charles Phillips collection of 1896 X-ray photographs. Two skeleton cartoons are on the *left* and *bottom right* is a sketch of an X-ray tube and an induction coil.

Transatlantic telegraph cables between Ireland & Newfoundland 1857-1866

1857

Five attempts were made over the period 1857-1866 to lay a cable across the floor of the Atlantic Ocean. Whereas it would take at least 10 days to deliver a message by ship, it would take a matter of minutes by telegraph. The first transatlantic cable laying starting from County Kerry in south-west Ireland was unsuccessfully attempted in 1857 (the cable broke on the first day, was repaired, but broke again at nearly 3,200 metres depth after which the operation was abandoned for 1857). It was finally completed in August 1858. But this was only a partial success. The first official telegram to pass between two continents was a letter of congratulation from Queen Victoria to President James Buchanan of the USA on 16 August. However, the cable was destroyed the following month when Edward Orange Wildman Whitehouse (*Wildman Whitehouse* as he generally styled himself) applied excessive voltage to it using high voltage induction coils whilst trying to achieve a faster telegraph operation. Whitehouse had been appointed in 1856 the *Electrician* to the *Atlantic Telegraph Company* and was responsible for the testing of the 1857-1858 cables and for the design and operation of the equipment which would transmit the telegraph signals. After this failure Whitehouse had only one further involvement in the cable industry, when in 1861 for a few months he was consultant on the Malta-Alexandria cable project, [7].

Samuel Elkens Phillips

The grandfather of Charles Phillips, Samuel Elkens Phillips was involved in a junior capacity with Whitehouse in the unsuccessful laying of the first transatlantic telegraph cable in 1857 as well as with the Malta-Alexandria cable project in 1861.

Wildman Whitehouse: physician, surgeon & telegraph engineer

Wildman Whitehouse in 1836-38 was an articled student of the Royal College of Surgeons and in 1838 was awarded the Silver Medal of the Society of Arts for his method of making casts from morbid anatomical preparations. He published the technique in the *Medical Gazette* 29 September 1838. In 1838-39 he studied at University College London (UCL), anatomy & physiology, practical anatomy,

medicine, chemistry, midwifery, medical jurisprudence & botany. In 1840 he was admitted to the Royal College of Surgeons; also awarded a silver medal by UCL for the second prize in the practice of medicine and awarded a certificate of the Society of Apothecaries. In 1841 he was a House Surgeon at the Sussex County Hospital in Brighton. Whitehouse although trained as a physician & surgeon, gave up his practice in the 1850s when he became interested in electricity & telegraphy. In 1853 he was awarded his first patent: on telegraphic communications. He was in 1870 a founding member of the Society of Telegraph Engineers; in 1872 elected a Fellow of the Royal Astronomical Society; and in 1876 admitted as a Fellow of the Royal College of Surgeons. He was born in Liverpool in 1816 and died in 1890 at his home in Brighton, [7].

1865-1866 cables

In 1857 the cable laying ships were converted warships, the HMS *Agamemnon* and the USS *Niagara* whereas in 1865 the new cable was laid by Isambard Brunel's *Great Eastern* starting on 15 July. However, on 31 July after 1,968 kilometres had been paid out the cable snapped near the stern of the ship and the end was lost. The *Great Eastern* returned to England and the *Anglo-American Telegraph Company* was formed to lay a new cable and repair the broken one. This venture started on 13 July 1866 and several times as the cable was unrolled the Captain, Sir James Anderson, observed that nails had been driven into the cable, with the motive of destroying it. Anderson posted that if the offender was caught on board, he would be thrown into the sea without further trial. From then on the sabotage ceased! Cable laying was completed on 27 July.

Lord Kelvin 1824-1907

Lord Kelvin was a pioneer in telegraphy and according to *The Scotsman* newspaper of 12 December 1863 was the "ruling light" throughout the attempts to lay the cable unsuccessfully in 1865 and successfully in 1866. Kelvin's sounding machine is still in existence. It belongs to the Hunterian Museum in Glasgow, is currently on display at the Royal Society of Edinburgh where it is described as "*Hand Sounding Machine*. In April 1874 Sir William Thomson (Lord Kelvin) presented a paper to the Society of Telegraph Engineers on "Deep Sea Sounding by Pianoforte Wire" in which he described his success in sounding to a depth of 2,700 fathoms. In 1876 Kelvin was able to express his opinion that the old system of sounding by hemp ropes had done its last work during the voyage of HMS Challenger."

Samuel Edmund Phillips 1861-1893

Samuel Edmund Phillips when a boy was brought into telegraphy because his father Samuel Elkens was engaged in working with Wildman Whitehouse on the first Atlantic cable. Subsequently he was a junior clerk in 1861 when he accompanied his father on the Malta-Alexandria cable expedition. Later he was described as "an inventor who devised a fluid insulator which was largely adopted in India." His final address was Castle House, Shooters Hill, Kent (in the 20th century: London SE18), where he had his own laboratory: which on his death in 1893 was taken over by his son Charles, [8]. A memorial to Samuel Edmund is located on the south side of Shooters Hill on the western slope of the hill, with the inscription

"In Memoriam Samuel Edmund Phillips
Born April 9th 1848. Died July 22nd 1893.
Write me as one who loves his fellow men".

Society of Telegraph Engineers 1870

In 1870 the Society of Telegraph Engineers was founded but by 1892 had become the Institution of Electrical Engineers (it is now The Institution of Engineering & Technology in Savoy Place, London). Samuel Elkens Phillips the grandfather of Charles, and his father Samuel Edmund Phillips (1848-1893)

were both founder members. Their membership records are still in existence as are those of Charles Phillips [9].

His grandfather in 1870 lived in Plumstead and worked at the Telegraph Works, North Woolwich: whereas his father in 1870 lived in Hackney. In January 1892 Charles, who was living at Castle House, Shooters Hill, Kent on the outskirts of London, applied to be a student member of the IEE. The application form stated "He is at present a Student of Electrical Engineering at the Central Institution, South Kensington. He comes of age on 18 February 1892. Recommended by W. Claude Johnson.". Charles was transferred from student membership to associated membership in May 1894, whilst he was still a student at the Central Technical College {which eventually formed part of what is now Imperial College}. The Chairman of the IEE who signed the transfer form was Sir William Crookes.

Patent for Fare Verification in Public Vehicles 1872

In 1872 Wildman Whitehouse & Samuel Elkens Phillips (then of Homerton) had Great Britain patent 1872/3016 accepted for "Improvements in recording apparatus specially for the verification of fares in public vehicles". This was a gadget making use of siphon pens to plot on a tape a time marker, speed over each minute, time of arrival and departure, number of passengers on/off and time all linked to charge rates [7].

Johnson & Phillips marine cable company 1875

The father of Charles was Samuel Edmund Phillips was a co-founder of the Johnson & Phillips Company which specialised in cable gear & advertised as telegraph engineers and electricians. Founded in 1875 and located in Charlton, south-east London, the company continued to prosper after Samuel Edmund's death in 1893 (and probably this company's profits were the major source of income of Charles Phillips because no evidence has been found to show that Charles entered into any paid employment or indeed worked for Johnson & Phillips). In an advertisement in the 1885 *Electrician's Directory* it was stated that the company were contractors to Her Majesty's Post Office, India Office, War Office, the Admiralty and other Government Departments. In a 1917 advertisement for the company it stated that what was on offer was "Complete equipments of cable machinery, accessories and stores for cable laying and repairing steamers". A list of ships fitted with cable machinery by Johnson & Phillips 1882-1964 is extensive and includes work in Brazil, Australia & New Zealand, China, South Africa, Japan, France, Italy, USA, Canada & India [8]. It is likely than Samuel Edmund Phillips held 50% of the company's shares and that he passed these onto his only son Charles Phillips which would explain Charles' millionaire status.

Röntographs 1896 & laboratory notebooks

Röntographs

The unique album of X-ray radiographs [6] collected by Charles Phillips in June 1896 (**Figure 2**) contained röntographs taken by himself and also some taken by his friend Osborne Mance. The first röntograph in the album was taken by Phillips on 15 February 1896, only one month after the very first radiographs taken in the United Kingdom: this was by A.A. Campbell Swinton. This was described as "Taken with Lenard tube and 5" induction coil. Exposure 1 hr. 45 min.", (**Figure 3**). The second röntograph illustrated here (**Figure 4**) was taken by Mance, but is undated. The most common early part of the anatomy to radiograph was the hand, but this is the only X-ray image I have ever seen of a hand bitten by a tiger.

Figure 3. Röntograph taken by Charles Phillips on 15 February 1896. His first was made on 10 February 1896.

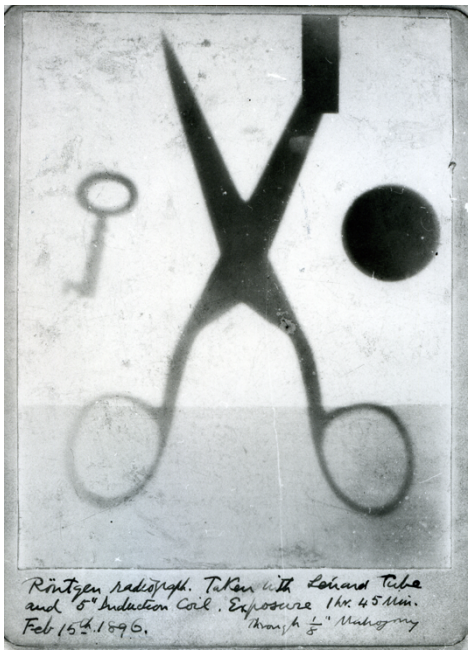


Figure 4. Röntograph labelled "Hand bitten by tiger [taken by H.O. Mance].

Sir Henry Osborne Mance 1875-1966

Brigadier-General Sir Henry Osborne Mance, KBE {1929}, CB {1918}, CMG {1917}, DSO {1902} as he was later to become [10], was an Army Royal Engineer and his engineering interests no doubt led him to experiment with X-rays in 1896. He published only two papers on X-rays: one with Charles Phillips and one on his own, [11, 12]. An entry in Charles Phillips' laboratory notebooks for 21 April 1896 notes "Mance, Moore and self working on Röntgen effects. Found peculiar behaviour of one tube. See letter to *The Electrician*. Tried also Rontoing white hot platinum thus but no results obtained whether Pt heated with current or flame."

His paper written on 4 June 1896, commenced with the following paragraph. "When experimenting with focus tubes which have normally too high a vacuum, and therefore require occasional heating by means of a spirit lamp to obtain the best results, it is sometimes no easy to determine when the desired degree of vacuum has been obtained and whether the radiation is of that form which distinguishes best between flesh and bone." {This refers to X-ray quality, i.e., the degree of hardness of the tube, although this was not totally understood by all experimentalists in mid-1896. Mance designed and illustrated schematically in his Letter to the Editor of *The Electrical Review* a fluoroscope consisting essentially of a small cardboard box, a cardboard tube, a block of wood and a

fluorescent screen. He terms it a *ray-tester* for Rontographs. He concluded: "Until a satisfactory result is obtained on the screen it is of no use proceeding with the experiment. In long exposures the rays can be constantly examined and the most favourable conditions maintained by occasionally heating the tube or altering the spark length." [12].

Of the 28 Röntographs in the Charles Phillips album [6] a total of 11 were taken by Mance. These included the knee of General Sir Charles Warren (1840-1927), an officer in the Royal Engineers, who fought in the Boer War and later in life was Commissioner of the Metropolitan Police, London, 1886-1888, at the time of the Jack the Ripper murders. Another of Mance's Röntographs was captioned "Foot showing that metal can be detected even behind the bones." In addition, one of Phillips' Röntographs was of "Mance's little finger".

During the Boer War in South Africa Mance served as Deputy Assistant Director of Railways & Armoured Trains (Kimberley line) and was in 1902 awarded the Distinguished Service Order (DSO). He also served in World War I, and from 1916-1920 was Director of Railways, Light Railways & Road at the War Office and Transportation Adviser to the post-war British Delegation in Paris 1919-1920. He later served in East Africa & in Iraq. His obituary in 1966, not surprisingly omits mention of his X-ray experiments 70 years earlier and concentrates on his work for the British School of Archaeology in Iraq: in 1929 he was its first honorary treasurer. He was also technical advisor to the Ottoman Bank. [13]

He did however receive a mention by Robert Whipple during the Royal Institution October 1945 meeting to commemorate the life & work of Charles Phillips, [14]. "I think Phillips must have first become interested in scientific work with the discovery of X-rays. His friend Sir Osborne Mance tells me that it was on the occasion of a lecture at the Royal Institution that Phillips told him of Röntgen's discovery and of his intention to carry out research on the subject. He must have put his resolution into effect almost at once, because he commenced to make X-ray tubes in his father's laboratory in the garden at Castle House, Shooters Hill, early in 1896". Whipple continued: "Sir Osborne tells me he has a photograph marked "Very early skiagraph of hand taken with Lenard tube by C.E.S. Phillips, 35 minutes exposure". Sir Osborne has kept some of Phillips' letters about this date: in one, written in July 1896, he writes "I've got an experimental vacuum tube nearly finished which takes to pieces and can be cleaned and exhausted ..... There seems no doubt that the X-rays consist of rays having various different properties and are by no means homogeneous"".

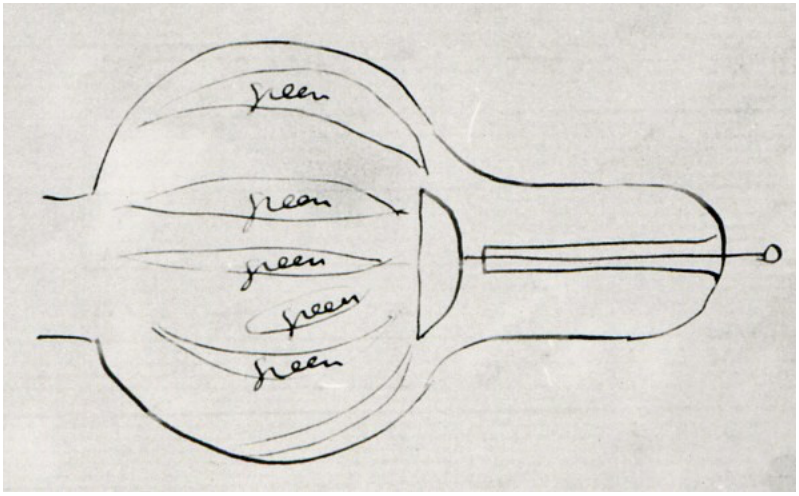
Laboratory notebooks 1892-1899

The still existing laboratory notebooks of Charles Phillips commence in 1892 when he was experimenting with electric discharge tubes and vacuum pumps. He was a well established experimentalist by the time that Röntgen discovered X-rays and among his notes for 1899 was one entitled "*Influence of Form of Bulb*" referring to A.C. Cossor, a manufacturer of X-ray tubes. **Figure 5** shows the focus tube he used with green streamers marked. His text is given below, with his underlines and strikethroughs.

"Cossor tells me that the best position of cathode is just within its tube. If the cathode be placed a little beyond so that it appears somewhat in the wider portion of the bulb the glass will be covered with green streamers and patches thus :- (**Figure 5**). The Antikathode should be placed at twice the focal length of the curved cathode. Osmium is good as a ~~reflector of~~ radiator of X-rays. So also is osmium-iridium. Both are rare. The former allows of a sharper focus (??) & hence gives better definition. Small tubes are better for penetration than large tubes. A tube of an inch in diameter will give X-rays with a small double plate Wimshurst. Mr. Cossor uses no drying appliance when exhausting his bulbs – neither on the Fleuss or Sprengel (vacuum pumps)."

Earlier, Phillips describes his Lenard tube (**Figure 3**) of February 1896 under the title "*History of the Tube*". "At first when I excited the tube it glowed with a blueish colour with flickering whiteish flames here and there. This gave no Rönto-effects with one-quarter hour exposure. The tube then turned greenish after two days pretty continual excitation and Rönto-effects were obtained with 1 hour exposure. The tube became bathed in green flames internally licking the glass after another day or two and then the best effects were obtained. This best condition lasted about one week and then the resistance of the tube began to increase. ....".

Figure 5. The 1899 X-ray bulb with the green streamers indicated.



Phillips also experimented with manufacturing different compositions of glass [15-18] for use with electroscopes. His notebooks also show that he experimented by making a glass pen and he describes this as follows. (**Figure 6** is written using his glass pen.) "This is written with a glass pen. It writes without the least effort & glides easily & smoothly over the paper. The glass pen has passed through many stages of development until the present fine type has been reached. A free flowing pen may also be made like this one I now use. On the whole I think it is a bit too free". Accompanying this text is a sketch of a house, a clown with a top hat and a violin. This is another example, besides **Figure 2**, of Phillips' ability as a cartoonist. Many other examples are to be found in the notebooks with his favourites being clowns.

Figure 6. Drawing & writing with a glass pen.

Lecture on X-rays 1896

There is only a single published report, by Sir Henry Dale, of any of Charles Phillips' activities as a student. This was during early 1896 and occurred in Reading, Berkshire, and was told to Dale by Phillips [3]. "Many years ago (when I was a student in Kensington) a friend (medical student) and I organised a *Lecture on X-rays* (which had just been discovered) at the Town Hall. I have at home one of the display bills carried by sandwich men about the town. The Town Hall was packed. I was the lecturer: my friend sat at an entrance at a table and took the money. The Mayor presided. It was thought to be a great occasion - young scientist from London etc., etc. My word what a joke it was. I had a heap of apparatus and arranged with a local photographer to keep open so as to be ready to develop a radiograph. A lady in the audience volunteered and I radiographed her hand amid breathless excitement. My assistant rushed off down the street to the photographer and soon returned with the plate which was then shown on the screen, amidst loud cheers. My friend and I cleared £25 between us when all expenses

were paid and incidentally had a most amusing evening. It was the first public *Lecture on X-rays* in this country".

However, whether this was truly the first public lecture on X-rays in the United Kingdom cannot be confirmed and for example the electrical engineer A.A. Campbell Swinton who lectured at the London Camera Club & Royal Photographic Society (presumably not *public* lectures); or the photographer Henry Snowden Ward who lectured in Southport on 26 March 1896, and possibly elsewhere earlier, might have priority.

The Electrician 1896-1906

The first radiological journal, the *Archives of Skiagraphy*, was first published in 1897. It is not therefore surprising that many of the early published communications on X-rays were carried in the pages of journals devoted to electricity & electrical engineering. *The Electrician* was one such journal and was the choice of Charles Phillips. It was established in 1861 and termed "A Weekly Illustrated Journal of Electrical Engineering, Industry & Science."

Announcement of Röntgen's discovery

The Electrician's announcement of the discovery of X-rays was published on the front page of the Friday 10 January 1896 issue. This is reproduced here verbatim. "A SENSATIONALLY-WORDED story has come to hand from Vienna, via the columns of last Wednesday's *Standard*. It seems that Prof. RÖNTGEN of Würzburg University, while experimenting with some cloth-screened vacuum tubes in a dark room, in which some sensitised paper happened to be lying about, found that the paper became acted upon by electromagnetic waves. Further investigation enabled Prof. RÖNTGEN to obtain a "photograph of a human hand, showing only the bones and the rings on the fingers," the hand being laid upon a wooden case containing photographic paper, so as to intercept the passage of the rays. The whole phenomenon seems likely to admit of ready explanation, when the conditions of the experiments are more fully published. We cannot, however, agree with the newspapers in regarding this discovery as "a revolution in photography"; there are very few persons who would care to sit for portraits which would show "only the bones and the rings on the fingers.""

Communications by Charles Phillips

The published articles, notes & letters by Charles Phillips in *The Electrician* are given in references [11, 16, 17, 19-31]. A search through the pages of *The Electrician* for the years 1907-1914 produced no communications by Phillips. His *Bibliography of X-Ray Literature 1896-1897* was also published by *The Electrician* [1]. From 1904 when the journal commenced, he was to place most of his communications in the *Journal of the Röntgen Society*. Apart from Osborne Mance [11] and H. O'H. Moore, he only had one other co-author at the end of the 19th century, James Mark Barr [20-23] who was a fellow electrical engineering student at the Central Technical College, South Kensington.

Signalling cable experiments 1899

Barr & Phillips were referred to as "two former students" by Olaus Henrici FRS (1840-1918), Professor of Mechanics & Mathematics at the Central Technical College writing on 10 December 1896 to Oliver Heaviside (1850-1925), and it seems that Charles Phillips was also experimenting with signalling as well as with X-rays, at the end of the 19th century. Henrici's letter is reproduced below [9].

Writing from **34, Clarendon Road, London W**.
"Dear Mr. Heaviside,
The other day two former students, Mr. Barr & Mr. Phillips, saw me in order to communicate some experimental results of theirs. They had studied your paper on signalling through cables, at least Barr had done so. Mr. Phillips has a good Laboratory including a piece of an experimental cable I think ¼ mile long. These experiments seem to be of value and as they were due to your papers they may interest you. At all events the men seem anxious to hear your opinion on them. As they are too shy to write

directly I promised to write to you. The whole arrangement as described on the enclosed sheet seems ingenious.
Believe me, Very sincerely yours, O. Henrici."

Röntgen Society 1897-1926

Founding of the Society

The following is taken from the paper in the first issue of the *Journal of the Röntgen Society* [32], written by John Jewell Vezey, who was the Honorary Treasurer of the Society until his death in 1908. "The formal inauguration of the Society took place in St. Martin's Town Hall on 5 November 1897. There was a very large attendance and Professor Silvanus Thompson FRS, the President, gave a most brilliant address. Many distinguished men attended, including Sir William Crookes, Dr J.H. Gladstone, Earl Crawford and Dr Ferrier, and the exhibition of apparatus and radiographs was full of interest and bore ample evidence to the value of the work which had been done in the short time since Professor Röntgen called attention to his discovery and the immense interest it had excited."

Vezey also commented [32] "That looking through our Archives here have been some 60 papers read before the Society since its foundation, besides the valuable Presidential Addresses. I mention a few of special interest." Those mentioned included two presentations to the Society by Charles E.S. Phillips. {**1**} "On the functions of an auxillary electrode in X-ray bulbs." (January 1902) and {**2**} "Photographic reversal under the combined action of various radiations." (December 1903). The first [33] was mentioned in his June 1902 paper in the *Archives of the Roentgen Ray* and the second [34] was published in April 1904, also in the *Archives*.

Journal of the Röntgen Society

The first journal to be the official journal of the Society was the *Archives of the Roentgen Ray* but it was not solely the Society's journal. Because of this, in July 1904 a new journal was founded under the sole control of the Society: the *Journal of the Röntgen Society.* It was published in 19 volumes between 1904 and 1923, when it became the *British Journal of Radiology* (*Röntgen Society Section*) for volumes 20-23 (1924-1927). Thereafter the name of the Röntgen Society disappeared from the journal title which was only *the British Journal of Radiology* (New Series. Volume 1, Number 1, January 1928), [35]

Charles Phillips was on the Editorial Committee of the Journal at its inception in July 1904. The other members of the 1904-1905 Committee were Sir James Mackenzie Davidson, Adolph Isenthal, Sir Herbert Jackson, F. Harrison Low, John Macintyre, C.W. Mansell Moullin, Ernest Payne, John J. Vezey and H. Snowden Ward. The Editor was James H. Gardiner who was to edit the journal for 14 years.

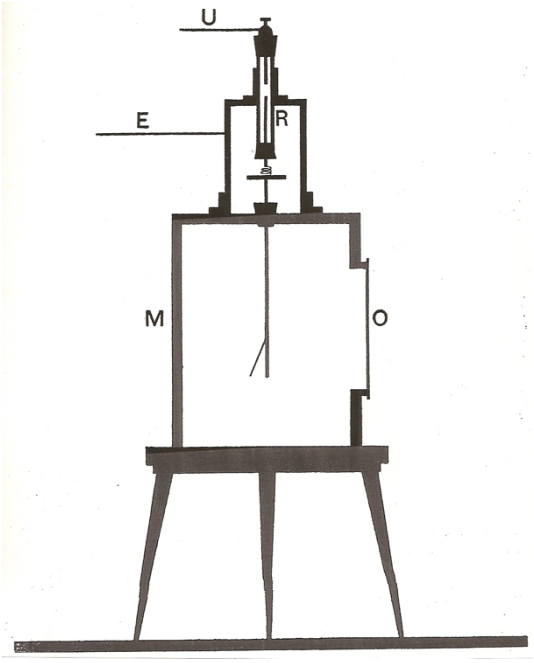
A total of 15 communications by Phillips, including his Presidential Address, have been identified in the pages of the *Journal* between 1904 and 1926 [36-50]. These papers are not limited to X-ray applications but also include work on radium & radioactivity: particularly interesting being the need for a standard of radioactivity. Phillips [37] led the Discussion Evening of the Röntgen Society planned for 1 March 1906 [46]. Six headings were recorded. {**1**} The possibility of expressing radio-activity in terms of existing units. {**2**} The need for a radio-active standard. {**3**} The property (chemical or physical) which offers the best guide as a measure of radiant energy. {**4**} The question whether there need be three standards corresponding to the three types of rays from radio-active bodies, or whether the standardisation of one type is capable of expressing relatively the activity of the others also. {**5**} The advantages of a uranium standard and suggestions for its preparation. {**6**} A possible radium standard. Some experimental details as to the best way of setting it up. Charles Phillips also published on standardisation in the 1907 *American Quarterly J Roentgenology* [51]

President of the Röntgen Society

Charles Phillips was one of the original founder members of the Röntgen Society in 1897 and was President for 1909-1910. His Presidential Address is published in the *Journal* in January 1910 [42]. His Presidential photograph is reproduced in **Figure 1**.

At the end of his Address he describes his latest experimental measurement set-up and includes a schematic cross-sectional diagram of an electroscope, **Figure 7**. "The electroscope is slowly charged through a very highly insulating liquid. The tube **R** contains a little Pinene. The wire **U** connects with a constant voltage, say 200 volts from the mains. A steady deflection of the pointer denotes the zero reading, but on bringing radium beneath the lead base the reading changes to a new steady value. Thus by varying the distance of the radium, the eye-piece scale can be calibrated and specimens of radium very rapidly compared. I bring this arrangement to your notice also, because it may be of service in enabling the behaviour of an X-ray lamp to be kept under observation during an exposure for a therapeutic treatment. The aluminium window **O** allows the rays to pass freely into the instrument, which may be situated at some considerable distance from the X-ray bulb."

Figure 7. Electroscope for measurements during X-ray therapy.



Royal Society of London 1898-1901

In the 19th century and early 20th century FRS (Fellow of The Royal Society of London) was the only way of having one's work published in the revered journal the *Proceedings of The Royal Society of London*. Phillips' experiments with discharge tubes led to the observation of the rotation of a luminous ring in the electrical discharge tube within a static magnetic field; the effect soon became known as the "*Phillips' Phenomenon*"[52] (also sometimes called the *Ring effect*.). His laboratory notebooks (and also archive letters in the IET which were written by Charles Phillips) detail how he brought this phenomenon to the personal attention of established physicists such as Lord Kelvin, Sir William Crookes and Sylvanus Thompson, and also gave them demonstrations. Such was Phillips' excitement at being published in the *Proc Royal Society* in 1898 that he even stuck into his notebook the envelope of the letter bearing the news of his paper's acceptance [53] by The Royal Society. He read this paper, termed a Preliminary Note, which was communicated by Sir William Crookes FRS, before The Royal Society on 15 December 1898. The full paper was published in 1901 in the *Transactions of the Royal Society* [54] with an abstract appearing in the *Proc Royal Society* also in 1901 [55]. The only other publication by Phillips in a Royal Society journal was a Preliminary Note in 1899 on *Diselelectrification Produced by Magnetism* [56].

Correspondence with Sylvanus Thompson 1899-1900

The following correspondence [9] shows that Charles Phillips met Lord Kelvin, Sir William Crookes and Sylvanus Thompson to discuss his work on the Phillips' Phenomenon. Indeed, he made use of Thompson's apparatus at Finsbury Technical College. Coincidentally the method of transport from London to Shooters Hill at the end of the 19th century is described and there is a reference to the Boer War and the siege of Ladysmith (2 November 1899 to 6 January 1900, [57]). No copy of the "Ladysmith

photograph" could now be found and as far as can be ascertained, Phillips never visited South Africa. All the letters are those written by Phillips to Sylvanus Thompson but no replies from Thompson exist in the IET archives. The underling of words for emphasis are those of Charles Phillips.

19 June 1899

Writing from **Castle House, Shooters Hill, Kent.**
"Dear Dr Thompson,
Sir W. Crookes writes that he wishes to put off his visit here until early July, owing to numerous engagements this month. Now I wonder if it would be more convenient for you to come then or at an earlier date. The trees are in full leaf & the country around looks perfect. The actual time required to ascend this hill counting from the hour of departure from Charing Cross would be 30 minutes to Blackheath and then a 20 minute drive, making in all something under an hour between London & here. But all the while it seems too much to expect that you can find time to come. The reception last Thursday was I think very much appreciated. Unfortunately I had to leave early to catch a reasonable train from London.
With kind regards to Mrs. Thompson, I am yours truly Charles E.S. Phillips"

17 October 1899

Writing from **Castle House, Shooters Hill, Kent.**
"Dear Dr Thompson,
I am very delighted at the prospect of showing the ring effect to Lord Kelvin. My assistant will call at the college this afternoon to see Mr. Coles and ascertain when we may bring the apparatus to your laboratory. I propose to send the things to Finsbury tomorrow as you will remember we shall have to exhaust for a good three hours before a clear crisp ring is obtained. And then again on Thursday morning the exhaustion must be begun about 10 at the latest in order to be thoroughly ready by 11.30 or so. You will understand that at so short notice I can do little more than repeat what I showed yourself and Sir W. Crookes last year. It will be splendid to hear what Lord Kelvin says about the glowing ring.
With kind regards, I am yours truly Charles E.S. Phillips"

7 March 1900

Writing from **The Royal Institution, London**.
"Dear Dr Thompson,
Lord Kelvin came on Monday as arranged, and was vastly interested to see a magnetic flux diselectrify a positively charged body. He suggested placing two symmetrical planes of metal in the magnetic field in such a manner as to insure the lines of magnetic force being at right angles to the lines of electric force (a condition I have always aimed to get with existing arrangements). He could not see why the positive & negative electrification should behave so differently & seemed to incline towards the view that difference of area was playing an important part in the matter. That is, if the positively electrified body had a greater surface area than had the surface relatively negative to it the result might be different to that obtained when the conditions were the reverse. Hence his suggestion of symmetrical discs.

My ideas on the subject have been greatly widened by what Lord Kelvin said and it was pleasant to hear him express the hope, as he left, that he would be able to again visit me here when the work had proceeded further. I am of course going to test his suggestion as to the discs at the first opportunity I get & let him know the result.

As to the Photo !!! which I spoke of on Sunday, you'll be amused to hear that the sale is actually on the increase ! It is curious to think that I have no copies yet even for my friends --- all I get printed are grabbed by the shops. 100 prints have been sold in three days !!
I am yours truly Charles E.S. Phillips"

31 May 1900

Writing from **Castle House, Shooters Hill, Kent.**

"Dear Dr Thompson,
I wish I could have sent a further paper to the Royal Society this session on the Luminous Rings. Personally I have no doubt now as to the mode of their formation. After many experiments the whole effect seems very clear until one comes to the actual cause of that incoming stream of + ions. It is at this point of course that the enquiries merge into what I have referred to as 'diselectrification produced by magnetism' and that matter appears to offer peculiar difficulties.

By now I have tried Lord Kelvin's suggestion as to the charged parallel plates placed symmetrically in the magnetic field, and have obtained strong diselectrification as before. During the past few months I Have given all m available time to this question of 'diselectrification' and I am afraid the work is not yet at all complete.

But what I wish to say now is that as I should have to refer very often to the diselectrification experiments in any complete paper on the Rings I felt that a more detailed account of those experiments should be handed in to the R.S. beforehand. And this made me hesitate to publish further at present and so my chance this session is lost.

I hope however that during the next few months to have carried the work a step further & that I may be permitted to contribute then a more complete account of the whole investigation that has heretofore been possible. It is so easy to think a working hypothesis final because it satisfied a few cases but I am anxious not to rush into print with any explanation which may be ultimately be shown to be ridiculous.

We are now back at Shooters Hill again and as my time at the Davy Faraday {Research Laboratory of the Royal Institution} has been extended till July next I come to London each day. I was very glad to hear from Mrs. Thompson that she liked the Ladysmith Photo: its sale has given one of the war funds nearly £30.
Yours truly Charles E.S. Phillips"

Royal Society of Edinburgh 1906

In November 1906 Charles Phillips was elected as a Fellow of the Royal College of Edinburgh (FRSE) with the following four eminent scientists acting as his proposers, [58].

Lord Kelvin (Sir William Thomson) FRS, FRSE.
{Physicist & mathematician who was Professor of Natural Philosophy, Glasgow University, 1846-1899. Chancellor of Glasgow University 1904.
Knighted in 1866 and created Baron in 1892.
President of the Society of Telegraph Engineers 1874.
President of the Royal Society 1890-1894.
President of the Royal Society of Edinburgh 1890-1895.}
[1824-1907].

Alexander Scott FRS, FRSE.
{Superintendent 1896-1911 of the Research Laboratory of the Royal Institution.
Director 1919-1938 Scientific Research, British Museum, London.}
[1853-1947].

Sir James Dewar FRS, FRSE.
{Fullerian Professor of Chemistry, Royal Institution 1877-1923.
Jacksonian Professor of Experimental Philosophy, Cambridge University 1875-1923.
Famous for his work on the liquefaction of gases.}
[1842-1923].

William Richard Hodgkinson CBE, FRSE.
Professor of Chemistry & Metallurgy,
Artillery College, Woolwich, until 1918.}
[1885-1935]

Charles Phillips published only a one paper in the *Proceedings of the Royal Society of Edinburgh*. The manuscript was received on 17 May 1908 when it was read at a meeting of the Royal Society. The lecture and paper were entitled *The Preparation of a Glass to Conduct Electricity* [15]. He introduced his work with the following words. "The electrical conductivity of most glasses at a temperature of about 100°C is barely a measureable quantity. For this reason, and on account of the fact that glass conforms to the general rule applicable to non-conductors in showing an increase of resistivity for a fall of temperature, this material has come to be regarded as practically incapable when cold of allowing the passage of an electric current. With a view to the further study of electrical conductions in glass, and also because of certain experimental advantages which a conducting glass would possess, I have endeavoured to produce a transparent vitreous substance having that property."

He studied many different compositions of glass and finally settled on one with the composition of "32 parts of sodium silicate, 5 parts of borax, 0.8 parts of lead oxide & 0.2 parts of sodium antimoniate." It was found to conduct well and also had the advantage of being colourless {J.H. Gardiner tested for Phillips the transparency to ultra-violet light and to X-rays of a 0.5 mm thick plate of this glass [18]}. Phillips also commented on the uses of the glass as follows. "Plates of the glass are already in use for the windows of electrometers and electroscopes, and fibres have been found to be sufficiently conducting over their surface to justify their replacing the gold leaves in the latter instrument."

Ionisation-based unit for X-ray measurement 1906-1908

A unit based on the ionisation effect, was used for measurements of relative intensities soon after the discovery of X-rays, but Paul Villard (1860-1934) is generally credited (1908) [59] as the first to suggest a quantitative unit. However, there are two references which pre-date Villard's work. In 1906 when Joseph Belot (1876-1953) was discussing radiotherapy & radium therapy [60], he remarked that "one of the scientific methods of measurement is that derived from the ionising power of X-rays" and "it gives us a means of measurement more precise than any other, and has the advantage of furnishing a unit, X, which is based on the CGS system. I believe that this method will speedily find favour in radiotherapeutic practice." Unfortunately Belot did not define his X unit.

Then in 1907 at a meeting of the American Röntgen Ray Society [51], Charles Phillips advocated a unit based on ionisation either by X-rays or a radioactive element. In the subsequent discussion, the well respected American X-ray pioneer, Charles Lester Leonard (1861-1913) of Philadelphia, said the following. "Why should not a unit be adopted that can be expressed in these commonly employed terms? A unit of ionisation will then be the quantity of electricity passing across a unit (spark) gap in unit time under the influence of radiation at unit distance under standard conditions of barometer and temperature."

Night-Marching Compass 1909

In the Commemoration Meeting at the Royal Institution on the life & work of Charles Phillips, Robert Whipple (1871-1953) [14] who was Chairman of the Cambridge Scientific Instrument Company & who in 1944 donated his collection of 1,000 scientific instruments to the University of Cambridge, stated the following. "From the national point of view, one of the most important services that Phillips rendered the country was the suggestion of the luminous night compass dial. The first model is in the Science Museum, South Kensington and the label accompanying it states "This original compass was devised in 1909 by Major Phillips for use as a night marching compass by the army, and was shown before the Royal Society of that year. The broad line diametrically across the lid, together with the mark upon the card and the adjustable index line projecting inwards from the case are rendered luminous by a trace of radium associated with zinc sulphide." This instrument must have been the pioneer of many thousands of such instruments."

Cancer Hospital, Fulham Road, London 1911

Charles Phillips was invited by Robert Knox (1867-1928) diagnostic radiologist & radiotherapist at the Cancer Hospital, Fulham Road, London (later to become the Royal Marsden Hospital) to become the

honorary physicist to the hospital: and therefore one of the first two hospital physicists in the United Kingdom [61]. The other was Sidney Russ (1879-1963) of the Middlesex Hospital, London.

Knox published a standard textbook, *Radiography, X-ray Therapeutics & Radium Therapy* in 1915, with the 2nd edition in 1919, and in both editions Phillips was to write a substantial section on the *Physics of Radium* [62, 63]. The text deals largely with the techniques of manipulation & construction of container for radioactive sources, the preparation particularly of radon, and the details of sealing radium containers. He also discussed many problems of measurement, making use of ingenious electroscopes which he himself constructed & designed.

1914-1918 World War

During World War I Charles Phillips acted as physicist to the X-ray Advisory Committee of the War Office and retained his military association as a member of this Committee until it was disbanded in 1939. He worked with Major Sir Archibald Reid who during the war arranged a course of training in practical X-ray work for army medical orderlies to overcome the shortage of radiographers. Phillips gave the physics lectures & Russell Reynolds the medical lectures at the Royal Herbert Hospital & Imperial College. {He was also elected an Honorary Lecturer in Radiology in University College London.} He was awarded the Order of the British Empire (OBE) [Military] for his services and was mentioned in despatches, [61, 64].

The subject of X-ray localisation of foreign bodies was of great interest during the war and the *Journal of the Röntgen Society* published a series of discussion papers in 1915 [65-70]. In the contribution of Charles Phillips [46] he opened with the words "I am glad of the opportunity to take part in this discussion, for it has fallen to my lot to be responsible during the war, for the X-ray work at the Royal Herbert Hospital, Woolwich." The journal also carried a review in 1918 entitled *X-rays and the War* [71]. This was the Presidential Address by Captain G.W.C. Kaye

On 29 April 1919 a joint meeting was held of the Röntgen Society and the Faraday Society on the subject of *Examination of Materials by X-Rays* [72] and in the report of the meeting was the following paragraph which mentioned the war work of Charles Phillips. "Dr R.E. Slade, the new Director of the British Photographic Research Association discussed the efficiency of the photographic plate as a detector of X-radiation, and considered in particular the quality of rays which would give the maximum contrast in photographs through metals. Mr. J. Brooksbank described his method of testing X-ray tubes for definition; this has been used by Major C.E.S. Phillips in the War Office X-ray laboratory.".

Institute of Physics 1921

At the Royal Institution Phillips Commemoration Robert Whipple stated [14] that "In the long run, Phillips greatest contribution to science was his work in connection with the Institute of Physics. The need for some professional Association of Physicists had been discussed by several leading physicists during the last Great War but no active steps had been taken to bring such an Association into being. On 23 November 1917 Phillips read a memorandum to the Council of the Physical Society urging the formation of an Institute of Physics. It expressed lucidly the desirable objects of the Institute."

The Institute was founded in 1921, Phillips was a member of the first Board and was Honorary Treasurer from 1925 until his death in 1945. The first journal of the Institute was the *Journal of Scientific Instruments* and it was in this journal in 1944 that Phillips published his final scientific paper [5]. On his death he left more than £1.25 million to the Institute. [4]

Royal Institute of Oil Painters 1924-1938

Charles Phillips exhibited 17 paintings at the Royal Institute of Oil Painters exhibitions: from the 41st exhibition in 1924 to the 55th exhibition in 1938. Unfortunately none were illustrated in the catalogues. The titles of his exhibits were as follows. Near Winchelsea. Lake Maelog. {1924} The Quarry, Lewes. {1925} Piddinghoe, Sussex. On Shooter's Hill. Still Life Group. {1926} On Shooter's Hill. {1928} A Jug of Flowers. {1931} Still Life. {1932} The End of the Mantlepiece. The Harpisichord. Marshide,

Kent. {1933} Still Life. Landscape. {1934} Flower Group {1935} Still Life – The Pudding. {1936} Spring Blossoms. {1938}, [73].

Royal Academy of Arts 1925 & 1938

Charles Phillips exhibited twice at the Royal Academy of Arts Summer Exhibition: in 1925 and in 1938. He was listed in the Dictionary of British Art for British Artists 1880-1940 as a "landscape painter", [74]. The subject of the two paintings were "The Old Mill, Winchelsea" {1925} and "On the Purbeck Hills" {1938}, [75]

Athenaeum Club 1925

One of Charles Phillips three cherished ambitions was to become a member of the Athenaeum Club, London. He achieved this in the ordinary ballot on 22 April 1925 [76]. His profession was given as "Physicist to Cancer Hospital, Honorary Lecturer on Radiology, University College London. There were 75 votes "For" and four "Black balls". Among those who signed the application "to certify to his eligibility from personal acquaintance or knowledge of his works" the following seven eminent scientists are an indication of the circles in which Charles Phillips must have moved in the first quarter of the 20th century. The appointments listed immediately following the names are those held in 1925 and given in the Athenaeum records. Additional information is given inside the brackets.

Professor Ernest Henry Starling CMG, FRS. *Proposer*.
{Physiologist}
[1866-1927]

Professor Charles James Martin CMG, FRS. *Seconder*.
{Physiologist}
[1866-1955]

Sir Herbert Jackson FRS,
Emeritus Professor of Chemistry, King's College, London.
{It was Jackson who in 1896 was probably the first to propose
a focus X-ray tube with its curved cathode: although
claims have also been made by Herbert Schallenberger
of the General Electric Company, USA
and by Campbell Swinton in London.
President of the Röntgen Society, 1901-1903.}
[1863-1936]

Sir Robert Robinson FRS,
Government Chief Chemist.
[1869-1949]

Colonel Sir William Henry Willcox,
Medical Adviser, Home Office.
[1870-1941]

Sir Charles Vernon Boys FRS.
{President of the Physical Society, London, 1916-1918.
President of the Röntgen Society, 1906-1907.}
[1855-1944]

Sir Richard Arman Gregory.
Emeritus Professor of Astronomy, Queen's College London.
{Assistant Editor & Editor of Nature for 44 years 1895-1939.}

[1864-1952]

Alan Archibald Campbell Swinton FRS.
{It was Campbell Swinton who made the first medical
X-ray image in the United Kingdom.
This was of a hand on 13 January 1896, using an exposure time of 20 minutes.
President of the Röntgen Society, 1911-1912.}
[1863-1930]

Sir Richard Tetley Glazebrook FRS.
Fellow of Trinity College, Cambridge.
{Director of the National Physical Laboratory.
President of the Physical Society, London, 1903-1905.
President of the Institute of Physics, 1920-1921.}
[1854-1935]

Royal Institution of Great Britain: Secretary 1929-1945

1894-1945

Charles Phillips was elected to membership the Royal Institution in 1894 at the early age of 23 years and by the time he died in 1945 he was one of the half-dozen oldest members. His proposer was Lord Kelvin who was associated with the transatlantic cable firm of Johnson & Phillips. His seconder was Sir James Dewar (who in 1906 also acted as one of his proposers for the FRSE). His supporters were Sir Frederick Bramwell, then Secretary of the RI, Professor Sylvanus Thompson and Mr. B. Wood Smith. [77] Phillips served as Secretary of the RI 1929-1945 and a *Meeting Commemorating the Life & Work of Major Charles E. S. Phillips OBE, FInstP*, was held at the RI on 1 October 1945 with Lord Rayleigh, the President of the RI in the Chair [3, 14, 77-79] .

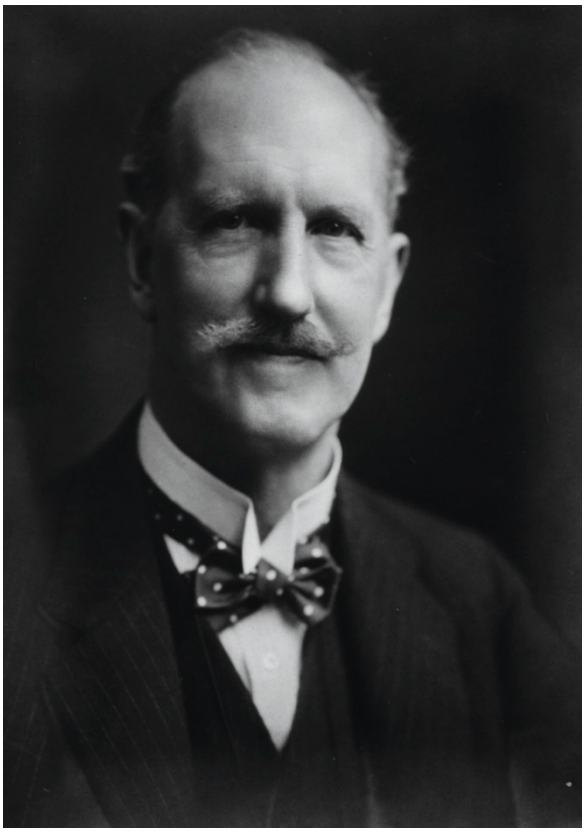
Friday discourses

The Royal Institution regularly holds Friday discourses and Phillips delivered two. These topics were very different: *Electrical & Other Properties of Sand* (11 February 1910) [80] and *The Characteristics of Violin Tone* (31 May 1935) [80]. Phillips was "no mean performer on the violin" and he studied and experimented with the structure & material of violins. His main aim was to ascertain the fine tone associated with violins made by such masters as Stradivarius, of which he had an example. The character of the notes with their harmonics were registered on an oscillograph by Phillips, [77]. Phillips inherited his musical talents from his mother who was a gifted organist, pianist, harpist & composer. She encouraged her son from his earliest days to make music for himself; she showed him chords on the piano and he marked the notes with paper labels and then played them for himself. As a small boy he made himself a fiddle from a cigar box. He also learnt to play the bagpipes, the banjo & the bones!", [79].

British Institute of Radiology: President 1930-1931

20 years after being President of the Röntgen Society, Charles Phillips became President of its successor, the British Institute of Radiology but seldom published in the *BJR* [81-86]. His Presidential Address was published in the *British Journal of Radiology* [84] and dealt with the then present and the future of X-ray & radium applications, rather than looking back to the early days of the pioneers. His final scientific publication in the *BJR* was a note [85] on the preparation of radium salts for therapy. Although he published later on the Presidential Badge of the British Institute of Radiology [86], and in 1942 an obituary of Sir William Bragg [87]. His own obituary appeared in the *BJR* in November 1945 [61], written by William Valentine Mayneord, his successor as Head of the Physics Department of the Cancer Hospital. **Figure 8** is Charles Phillips' BIR Presidential photograph of 1930.

Figure 8. Charles E. S. Phillips in 1930.



Memories of Cuthbert Andrews in 1956

Charles Phillips' musical abilities which have been mentioned earlier [79] were also referred to in 1956 by the X-ray manufacturer Cuthbert Andrews (1883-1972) in the following terms. "Amongst the shadows of the earliest days of our Society (the Society of Radiographers of which Phillips was a founder member) I have grateful memories of C.E.S. Phillips. He was a tall distinguished Englishman of the French stage, and a veritable amateur Admirable Crichton. A physicist of no small attainments, he formulated radium standards and experimented with selenium cells. His humour was irrepressible, both verbally and with pen or pencil. He exhibited at the Royal Academy, made, remade and played violins and spinets, and did a marvellous turn with the bones." [88].

This memory is a suitable way to bring to a close this biography of a most remarkable multi-faceted gifted scientist who was a member of that unique group of 19th century gentlemen scientists of private means who were able to experiment on whatever topic took their fancy at the time. This biography also brings to the fore the fact that he was also a gentleman in terms of his good nature as well as being a most amusing one.

Acknowledgements

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The Royal Society of Medicine, London. Mr. Rory Cook, **The Science Museum**, London. Ms. Gill Smith, **The Society of Radiographers**, London. Ms. Eva White, **The Victoria & Albert Museum**, London.

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Bookplate of the radiologist Frederick Melville.
(collection of Adrian Thomas)

The figure of the grim reaper is looking through a gas X-ray tube. Silhouetted in the upper left of the image is a Crookes tube, and on the upper right is a water-cooled contemporary (for the period) Metalix tube. The Metalix tube was protected for radiation, but was not shockproof.

"Our Katie": Kathleen Clara Clark
MBE, MSR, Hon.FSR, Hon.MNZSR, FRPS
(1898-1968)

By Adrian M K Thomas
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Introduction.

I have been interested in Katie Clark for many years, and spoke about her many times with my late friend Miss Marion Frank who was her student and whom she mentored. Kathleen Clara Clark was born in Fulham, London on 30th May 1898. The name Kathleen may be shortened to either Katie or Kitty. The choice of name would seem to be related to a geographical preference as confirmed by Jean Barrett, Past-President of the Society of Radiographers. Miss Clark herself said that: "They call me Kitty in the Air Force, as well as in Australia and South Africa. All over England I'm Katie." She is probably the best known British radiographer of the 20th century.
This paper is based on a presentation 'Kathleen Clara Clark (1898-1968) and the need for Standardisation' made at the History of Imaging session at UKIO 2020 and that was held on-line.

Early Life and Radiography.

At the age of 23 Katie began her training in radiography at Guy's Hospital in London which was the only civilian training school in the country. She suffered from rheumatism, and her early life was affected by this illness which had disrupted her education. Her lack of formal education had impeded her entry into her chosen profession of radiography. She completed her training course at Guy's Hospital in London in 1921, and passed the first ever qualifying examination ever held by the Society of Radiographers (SoR). As might be imagined her family was opposed to her choice of profession. There had recently been the high profile death of Dr. Ironside Bruce from Charing Cross Hospital in London from the effects of radiation. Her family finally acquiesced, although they still disapproved, and it is recorded that she was given an entire outfit of clothes made from silk since it was believed that these were impenetrable to radiation!

The story of the development of radiography is interesting, and Katie Clark played a major role. As a background to her story it should be remembered that the Society of Radiographers in the United Kingdom had been set up in 1920, and in this year we celebrate its centenary. Letters had been written from the new society to lay assistants in the various X-ray departments and invited applications for membership. Those who had been in active practice for over of 10 years were given membership without examination. All other applicants had to take a new examination. The first regular batch of students was entered for examination in January 1922. There were 45 students of which 20 passed and were duly awarded the certificate of the Society (the MSR or Member of the Society of Radiographers).

Many women entered radiography by way of nursing, with men often coming via the army. Her lack of nursing experience initially made it more difficult for Katie to find employment. She initially worked in at the Princess Mary's Hospital for Surgical Tuberculosis in Margate and Margate General Hospital; from 1922 to 1927, before moving to the Royal Northern Hospital in London. A few months after starting at Margate she undertook the training of student radiographers, and teaching was to be the major feature of her career.

The Sir Archibald Reid Memorial Medal.

The Society of Radiographers awarded a medal in memory of Sir Archibald Reid. The number of entries for this competition in 1927 were extremely disappointing, and only five papers were received. These were submitted to four independent radiologists for judgment, and they reported that,

in their opinion, none of the papers were of sufficient merit to earn the medal. The Council therefore decided to award the money prize of five guineas, and withhold the medal. Two papers were considered by the adjudicators to be of equal merit, and the money prize was divided equally between Miss K. Clark and Mr. C. Grover.

The Royal Northern Hospital.

The Royal Northern Hospital was a voluntary hospital situated in Holloway in London N7, and serving a poor part of North London. The hospital badge is shown on the front cover. The hospital with its associated hospitals was not as well-known as the large general hospitals in the centre of London. The hospital was located in an unfashionable district with few wealthy or influential inhabitants. The hospital served a population of about one million. In the period before the National Health Service there was the need for fund raising, such as a Ball held on the evening before the Derby race, to provide resources for the services. The hospital had an excellent reputation with many eminent consultants on the staff including the surgeon Hamilton Bailey.

One such project in the 1920s was a new X-ray department. The old X-ray accommodation in the Holloway Road block was now inadequate and more space was needed for the equipment and for the protection of the staff. The Electrical Department had been started in 1908 with Dr. Robert Knox in charge. The department provided Electrical treatments and diagnosis, and diagnosis and treatments using X-rays, and in a few cases using radium. For the new department the large sum of £4,000 was needed, and the hospital's Ladies' Association was able to contribute £1,750. Work on the new department began in 1926 and it opened in 1927. The old department became a lecture theatre for nurses and postgraduates. Further additions and improvements were made to the diagnostic department in 1937, being supported by the executors of the will of the late General the Hon'ble. Robert White. In addition there was a new Deep-Therapy Department and Apparatus (for Radiotherapy) and a new Light Department (for Actinotherapy).

Kathleen joined the Royal Northern Hospital in 1927 as a junior radiographer and remarkably only 8 months later was the Radiographer-in-Charge, which post she held until 1935.

She was aware of the lack of adequate training for radiographers, and so she founded a School of Radiography at the Royal Northern Hospital in 1929 which became a model for schools elsewhere. Kathleen was by then Senior Radiographer and she became the first tutor of the School, remaining until 1935. Kathleen proved herself to be a gifted teacher. The School of Radiography was one of the first in the country and soon made a name for itself, attracting many pupils. In 1956 twelve students were accepted annually and the course for the Diploma of the Society of Radiographers lasted two years.

In 1935 with M R Bell at the Royal Northern Hospital she wrote a paper Neck of Femur Technique. This was an important paper, and described the radiographic procedure that was necessary in cases of fractured neck of femur. Adequate imaging of the hip was needed for surgical pinning of the fractured femoral neck.

The Ilford Radiographic Department at Tavistock House

In 1935 she left the Royal Northern Hospital to became the co-founder and Principal of the Ilford Radiographic Department at Tavistock House, where she was involved in instruction and research into radiography and medical photography. Kathleen did however retain her links with the Royal Northern Hospital. The new department opened in February 1935 and Kathleen joined in October 1935. She had an established reputation The department was formally opened on 2 December 1935 by Major General Sir Ivor Philipps who was Chairman of Ilford Ltd. There had been some concern about the ethical aspects of seeing patients in the new department, and reassurance was made that the department was located in the shadow of the British Medical Association and would be run on purely professional lines for the benefit of medical science. As Philipps emphasized in his opening address,

Ilford saw their interest as not ending with the manufacture of the film, and wanted to collaborate with the users to help in the promotion of the science and the development of the photographic technique. In many hospitals clinical photography was part of the X-ray department. The department was to serve as a meeting place for those interested in radiography. The department was well equipped (**Table 1**). The X-ray apparatus was supplied by the British manufacturer AE Dean who was based in Croydon. Under her guidance the Ilford Department of Radiography and Medical Photography at Tavistock House developed a worldwide reputation.

Figure 1: The bust of Miss K C Clark which was placed in a treasured position in the reception area of Tavistock House. It was made by Kathleen Parbury ARBS after she had attended an Ilford refresher course as a radiographer. The bust is currently displayed at the Society of Radiographers. Photograph by Adrian Thomas.

Table 1. The Rooms in the Ilford Department of Radiography and Medical Photography at Tavistock House

1. Completely equipped X-ray Department.
2. Studio for clinical photography.
3. Model darkrooms.
4. Small lecture room.
5. Exhibition room.

Ilford was a large company selling all that was needed for photography. It had been founded in 1879. 1907 Ilford X-Ray Plate. An X-ray sales department was founded in 1930 with EWG Wesson of the French company Wellington and Ward as the head. Ilford was always committed to an educational role, seeing their role as instructing photographers as well as selling the necessary materials. Their book *'The Ilford Manual of Photography'* went through many editions and was highly influential and successful. It was initially published in the 1890s, and had started hundreds and thousands of photographers on their careers. Ilford already had the Holborn Galleries Centre for photography and Wesson saw the need for a radiographic centre. This came to fruition in 1935 when Tavistock House was set up. Tavistock House was a medical radiographic department and was located in Tavistock House, the building of the British Medical Association. The head of the department was Kathleen C Clark, and her bust stood in the entrance hall for many years (**Figure 1**). A more appropriate choice could not have been made as she was a well-known figure in the radiographic world. The aim of the department was to obtain practical experience in radiography, and to improve the utilization of X-rays. The purpose was as a centre for teaching and demonstrations and not for sales. Within a year of

starting, and with the help of Frederick Melville, Kathleen began her work on 'Positioning in Radiography' which was destined to become a world-famous textbook. It was published in 1939 and sold for 3 guineas (£3.15p) which was a significant sum. It had 500 pages and 1400 illustrations and diagrams, and be 1942 had sold about 6,500 copies. The book became the standard work of reference for radiographers and has been through many editions. Many radiographers will have heard of 'Kitty Clark' and have used the textbook. Her teaching slide collection has been preserved, and even today remains a useful teaching resource.

Kathleen Ophir Theodora Parbury ARBS (1901-1986)(known as Kate) who made the bust of Katie was a radiographer at the General Hospital in Edinburgh. She was a talented author, artist and sculptor and exhibited at the Royal Scottish Academy exhibition in 1941. She was world renowned. Her statue of St Aidan in St Mary's Church on Lindisfarne is well known. Her father W K Parbury was a doctor, and after a varied career was appointed as the first honorary radiologist to Bedford County Hospital and later to Kettering General Hospital. In 1924 Kate received the Diploma in Fine Art from the Slade School having studied under Henry Tonks.

The department taught hospital radiography students training for the MSR diploma of the SoR, postgraduate radiographers working for the Fellowship (FSR), and also doctors who wanted practical experience in radiography when working for the Diploma of Medical Radiology (DMRD). The department was able to consult hospitals, designers and manufacturers, and if necessary experimental work was undertaken to provide the answer to any specific radiographic question.

Positioning in Radiography is a very interesting book for several reasons. Firstly, it standardized the radiographic projections, and so similar projections were able to be made in all hospitals. Katie Clark was keen to standardize both positioning and exposure. Secondly, the book is very artistic. The illustrations do not come across as cold and entirely objective scientific images. It is therefore not surprising to read that the artist Francis Bacon acknowledged Positioning in Radiography as a crucial source, and commented that it was his favorite medical textbook. Lawrence Gowling indicated that Bacon repeatedly borrowed from the photographs in the book for his artistic work. The images of the body that Francis Bacon made have an almost radiographic quality and there is the impression that multiple layers of the body are seen at the same time and that one is not just looking at the skin surface. This was well illustrated by Professor Robert Clark from the University of South Florida in his inaugural lecture 'The Art of Radiography: how Positioning in Radiography by radiographer Kathleen Clara Clark influenced the art of Francis Bacon' for the British Society for the History of Radiology held at the British Institute of Radiology.

The 2nd Edition of Positioning in Radiography was published in January 1941. It was reviewed by "E.R.W." (E. Rohan Williams) for the BJR in May 1941 (E. R. W. BJR 1941; 14 (161): 161). The book has appeared in many editions. The 3rd edition appeared in June 1942 and the 4th in April 1945 and further editions appeared at regular intervals. The book became the most important book on radiography ever written, and was hugely influential. The great theme throughout the life of Katie Clark was the standardisation of radiographic projections and technique. Whilst standardisation might be seen in a negative manner for some occasions, for Katie standardisation was about promoting high quality and on advising as to the best technique that should be used to obtain optimal results.

The Society of Radiographers.

She was President of the Society of Radiographers from 1935 to 1937 (and also the first woman President). She had worked for a long time for the Society of Radiographers. Her predecessor as President Dr Leo A Rowden had proposed her as the junior vice-President. She was the first President to wear the President's chain of office, it having been presented to the Society of Radiographers by Leo Rowden in 1935 at the second meeting of the session. Her vice-President was Dr G W C Kaye. Her Presidential Address was given at the first General Meeting of the Society of Radiographers for the 1935-1936 session held at the Reid-Knox Hall, 32 Welbeck Street W1 on October 16th at 7pm with the subject 'Training and Employment.' The first radiographer president

was Mr. Ede. Mr. Ede at the presentation noted the criticism of the council by a section of the members. The tasks for her presidency included the question of unemployment, the British Medical Association register, the Fellowship and the redrafting of the Articles and Memorandum of Association (ref: October General Meeting 1935). She visited local radiographic societies during her time as president and on the 29th October 1936 spoke to the Midland Radiographic Society. She spoke on precision in radiography, and showed a ciné film on 'Radiographic Technique.' The visit was successful and much appreciated.

The Second World War.

During the Second World War Kathleen worked with the RAMC to perfect radiographic techniques for use in casualty clearing stations. From 1937 to 1939 Kathleen worked with the Chief Radiologist of the RAMC on the localisation of foreign bodies, which was to prove valuable when war started in 1939. In the June of 1939 she had made a visit to Sweden and Denmark to observe progress in radiography. She was able to meet the radiologist Eric Lysholm, and the neurologist Olivecrona. Eric Lysholm developed his widely used skull table for radiography which was almost universally in utilisation. She found that in Sweden the term 'radiographer' was unknown, the technical work being performed by radiologists and trained nurses.

Kathleen continued with a programme of technical demonstrations and exhibitions at Tavistock House, and the department was greatly valued. The normal commercial activities of Ilford in photography were greatly reduced and activities were expanded due to the high wartime demand for X-ray materials. As a company Ilford worked with the RAF in the production of films needed for aerial reconnaissance, and as a spin-off the new high speed emulsions resulted in improvements in X-Ray films. This was marketed as 'Red Seal' film which not only had a finer definition, but also the improved speed allowed for a lower X-ray dosage for the patient.

Experiments were made with Mass Miniature Radiography (MMR), which was in part stimulated by the shortage of X-ray film. MMR was used for the early detection of pulmonary tuberculosis, which was increasing in prevalence partly as a result to the poor wartime living conditions. The camera uses 35mm film instead of the full plate of 14in by 17in. The image on a fluorescent screen was recorded on the recently popularized 35mm film. Ilford promoted the special camera which had been designed by William Watson who worked with Kathleen Clark and it was made by the manufacturers Schall and Son Ltd. Patients could be screened quickly, and if the MMR study was abnormal a full sized chest film was obtained. In 1942 she was put in charge by the Medical Research council of a technical team to assess the value of the technique in examining office and factory workers. In 1943 she was to direct the training of 40 such teams that had been recruited by the Ministry of Health.

Following the German invasion of Norway the Norwegian Medical Services relocated in London and were housed next to Kathleen's department at Tavistock House. Ilford offered the Norwegians radiographic facilities, and as a result an experiment was undertaken whereby 23,000 Norwegian servicemen were radiographed. The experience proved the value of the technique. For her war-time services the Norwegian Government awarded Katie the Norwegian Liberty Cross.

Her book 'Mass Miniature Radiography of Civilians' (MRC special report series No. 251) was written jointly with P D'Arcy Hart, Peter Kerley & Brian Thompson appeared in 1945, and became the standard text on the topic. By 1943 70 mass miniature radiography units had been established throughout the country. The book was reviewed favourably by LGB in October 1945 (L. G. B. BJR 1945; 18(214): 326).

Mass miniature radiography of the chest was being developed in the 1940s. S Cochrane Shanks was to have given his Presidential Address to the Faculty of Radiologists (this subsequently became the Royal College of Radiologists) in 1940, however because of the conditions of the war it was not formally delivered. The paper is a most interesting study of mass radiography (Shanks BJR 1940; 14(158): 45-53) of the chest and is worth reading. There is a full account of the apparatus and technique needed. It was followed in that same BJR issue of February 1941 by a paper from K C

Clark, G R Maitland Cordiner and Phillip Ellman on X-ray screen photography for mass chest radiography (Clark, Cordiner and Ellman BJR 1941; 14(158): 54-62) and in July 1941 by "Further experiments in X-ray screen photography" by K C Clark, and K T Poulsson (First Assistant Radiologist, Oslo Municipal Hospital) in collaboration with H Courtney Gage (the Director of the Radiological Department, St Mary's Hospital, W2) (Clark, Poulsson, Gage BJR 1941; 14(163): 250-254) was published. There was considerable interest in mass chest radiography and it was thought to be useful in examining military recruits, for workers in the war industry and for the examination of season ticket holders for the public air raid shelters. The main object of mass chest radiography was to detect early pulmonary disease. The technique was to become more important in the 1950s when effective treatments for pulmonary tuberculosis with drug therapies became more available following clinical trials.

In 1945 she was awarded the MBE for her services to radiography, particularly for her work on mass miniature radiography of the chest. 'Kathleen Clara Clark, Radiographer in Charge, Ilford Ltd. For services in connection with Mass Radiography. 1944 Birthday Honours (MBE) Member of the Order of the British Empire (The Most Excellent Order of the British Empire)'.

The post-war period was a time of rapid technological advancement in film technology. The X-ray group made a study of the materials that were available for use as a base material for X-ray film, and these included triacetate, polycarbonate, and polyester. There were also investigations into automatic processing such as 'dunking', which replicated manual techniques, or the use of rollers for transporting films through the processing cycle. Other areas investigated including packaging the X-ray film without interleaving, the use of automatic film changing, and the use and future of silver emulsions as opposed to other techniques.

In 1948 she presented the 11th Stanley Melville Memorial Lecture, and perhaps unsurprisingly her subject was: 'Chest Radiography: an investigation into the possibilities of standardisation'. Katie knew the late Stanley Melville well starting from the very early days of her becoming a council member of the SoR, and so it must have been a particular pleasure for her to have been asked to present this lecture.

KC Clark was a member of the Radiological Sub-Committee of the Medical Research Council's Industrial Pulmonary Diseases Committee which made recommendations for the standardisation of radiographs in industrial pulmonary diseases. The committee that compared the memorandum consisted of Dr. J. G. Scadding (Chairman), Dr. L. G. Blair, Miss K. C. Clark, Dr. C. M. Fletcher , Dr. P . D'Arcy Hart, Dr. P. Kerley, Dr. A. Meiklejohn, Dr. C. L. Sutherland, and Dr. Alice Stewart (Secretary). Standardisation of radiography was needed for two reasons, which were those of initial diagnosis and subsequent grading of severity. High quality standard radiographs were obviously needed for accurate diagnosis. The radiographs could then be graded by comparison to a set of standard radiographs. The sub-committee commented that:

> 'The radiographic appearances in cases of pneumoconiosis afford the most reliable single piece of evidence for establishing the existence, the extent, and the type of the disease. Radiographs of high and consistent quality are necessary to diagnose the disease at its earliest possible stage and to follow progression. A mistaken appearance of abnormality may be produced in normal subjects by under-exposure and under penetration, and the abnormalities may be obscured in abnormal cases by over-exposure and over-penetration. The collection of films which we used is available for inspection on application to Miss K. C. Clark, Tavistock House North (1st Floor), Tavistock Square, London, W.C.I. There is no standardisation of X-ray equipment to ensure uniform output from one unit to another; different units from different makers with the same setting of the controls may give outputs which vary more than 100 per cent. There is urgent need for the manufacturers of X-ray equipment to agree upon the calibration of their sets, so that a radiographer may be able to ensure a given output with a given setting of the controls apart from variation in the mains supply.'

In November 1955, as part of their educational commitment, Tavistock House published a magazine X-Ray Focus which contained articles on X-rays and photography written by experts such as William Watson and Sidney Osborn. The first issue announced a 'T.H. Lantern Slide Collection'. The collection, the 'KC Clark Slide Collection', was an extensive collection of lantern slides for teaching purposes and could be borrowed for lectures. As an example of their utility, in the first 14 weeks of 1957 2,000 slides were sent out on loan to teaching centres. A selection of the slides have been digitised, and the slides are of the older glass lantern large format and are therefore of high quality.

A famous student of the Royal Northern Hospital was the late Marion Frank. Marion was Superintendent and Principal of School of Radiography at the Middlesex Hospital from 1949 until her retirement in 1981. Whilst at the Middlesex Marion had many contacts with Kathleen and Tavistock House and since the two were in close proximity Kathleen on many occasions was able to visit to see specific procedures being performed.

Tavistock House put on many instructional courses (**Table 2**) . The department was committed to education and to continuing professional development.

Table 2. Courses at Tavistock House.

1. Two weeks' revision course for student radiographers. Part I and II.
2. Three days' course for dental nurses and assistants.
3. Two days' course for veterinary surgeons, assistants and trainees in the fundamentals of radiographic technique.
4. Five days' postgraduate course for qualified radiographers. This concentrated 5-day course was a popular annual event. It was partly aimed at those who were unable to attend the evening lectures held during the year. Thirty lectures were given. Those attending the course were sent a questionnaire which would state the subject in which they were most interested.
5. Specialised individual courses could be arranged on request.
6. Closed courses arranged with university and hospital groups.
7. Courses in darkroom practice for darkroom workers. The department offered courses for preliminary and intermediate training of darkroom technicians. By this period the processing of X-ray films was largely rationalized, however it was still essential for darkroom technicians to be aware of the production of radiographs. It should be remembered that this was still in the period of manual processing, and wet processing was technically demanding and needed care to produce unblemished and permanent radiographs.

The 7th edition of Positioning in Radiography was published in 1956. The various sections were enlarged and new techniques were added. The book now contained 2,100 illustrations and was 100 pages longer than the 6th edition.

In 1958 Kitty was made an Honorary Member of the British Institute of Radiology in recognition of her contributions to radiography.

The International Society of Radiographers and Radiological Technicians

She was committed to fostering co-operation and contact between radiographers throughout the world and was a driving spirit behind the formation of the International Society of Radiographers and Radiological Technicians (ISRRT) which was formally founded in 1962 as a non-profit organization. Kathleen took part in preliminary meetings in Munich in 1959. The ISRRT is an organization composed of seventy-one national radiographic societies from sixty-eight countries representing more than 200,000 radiographers and radiological technologists.

Kathleen was particularly influential in formulating the educational policies of the ISRTT. Kathleen appointed Marion Frank to the Education Committee of ISRRT and succeeded her as Chairman following her death in 1968. The figure (**Figure 2**) from 1964 shows three great radiographers, K C Clark, E R Hutchinson and Marion Frank. Mr. Ernest Ray 'Hutch' Hutchinson was President of the Society of Radiographers from 1959-1960 and Miss Marion Frank from 1967-1968. Kitty Clark is on their right and looks rather tired. All three were committed to international radiography and were involved in the formation of the ISRRT. Marion Frank took over as Vice-President of ISRRT from Katie Clark and also as President of the Education Committee. Ernest Hutchinson was appointed Secretary-General and Treasurer of ISRRT.

Figure 2 : Three great radiographers, Katie Clark, Ernest Hutchinson and Marion Frank in 1964. Image from Marion Frank.

Retirement and Final Illness.

Katie remained as Principal at Ilford until her retirement in 1958. From the 1st May 1958 she was appointed as Consultant on Radiography to Ilford Limited, which post she held until 1964. Kathleen's role at Tavistock House was taken up by William Watson, who became Acting Head of the Department. William Watson was a remarkable man who made many contributions to radiography. He had joined Ilford Limited in 1939 and was a founder member of the SoR. He had performed original research on cine-radiology, body-section radiography, and stereography.

From September 1958 to February 1959 she undertook a lecture tour of Australia and New Zealand. In New Zealand she was awarded honorary membership of the New Zealand Society of Radiographers, and awarded the Watvic Jubilee Award for Merit in Radiography. In Australia she was made an Honorary Fellow of the Australasian Institute of Radiography. She presented the 8th Annual James N Young Memorial Oration.

Sadly she suffered an incapacitating stroke in September 1964 and was forced to stop working. She was cared for at the Cottage Hospital which was in Church Road in Welwyn Garden City where Marion Frank visited regularly. She remained deeply interested in radiography and always enquired about the welfare of her many radiographic friends. She mentioned all of her friends by name to Marion Frank and lived in the thought of past mutual experiences and the future of their radiographic experiences. (Frank, 1967). On October 20, 1968, Miss K. C. Clark died at the age of 70, after four years of hospitalisation. Her passing left a great gap in the world of radiography and was the end of an era.

Much has changed in the radiographic world since 1968. We now have ultrasound, CT scanning and MRI. However standardisation of technique remains as important in the world of MRI sequences or CT protocols as it did in the world of MMR and plain films. A 15th edition of Clark's Positioning in

Radiography was published in 2015 by CRC Press costing £103.40p. The current authors are Stewart Whitley, Gail Jefferson, Ken Holmes, Charles Sloane, Craig Anderson, and Graham Hoadley. Stewart Whitley is a worthy successor to Katie and is Director of Professional Practice at ISRRT. There are obviously many changes in the book since 1939, however the core values of radiography are unchanged. The introduction of digital radiography has profoundly affected our departments, and this is acknowledged in the book. The expression 'film' has been replaced by 'cassette' or 'image receptor.' There should, perhaps, be more detail on post-processing and image handling and marking in a digital environment. The radiographic images in the modern text have less contrast than the images in the first edition; however the earlier images were obtained using old high silver film. The older images look very different from our modern digital images. I am pleased that the book also reflects the extended role of technologist/radiographer, and there is a useful 'Radiological Considerations' sub-heading to all of the chapters giving the clinical context and an understanding of image interpretation requirements. The anatomical diagrams are good, and the labelling is as clear as in Katie's illustrations.

I showed the book to the radiographers in my own department and the book was universally greeted with enthusiasm. Everyone thought that the department needed a new book on radiographic technique to reflect modern practice. It is easy for a department to feel that since they already have a radiographic positioning book, that they do not need a new one since positioning does not change. This is not really the case and techniques develop and are refined as time passes. Whilst we should keep our old volumes of 'Positioning in Radiography' (and many with missing pages) I would recommend that all departments buy a copy of 'Clark's Positioning in Radiography.' The legacy of Katie Clark is safe.

Selected References and Reading:

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Hercock, R.J., Jones, G.A. Silver by the Ton. (1979) *Silver by the Ton. The History of Ilford Limited, 1879-1979*. London: McGraw-Hill Book Company (UK) Limited.
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ISRRT web site is http://www.isrrt.org (accessed 22 January 2020).
Jewesbury, E.C.O. (1956) *The Royal Northern Hospital, 1856-1956. The Story of a Hundred Years' Work in North London*. London: HK Lewis & Co. Ltd.
Jordan, M. (1995) *The Maturing Years. A History of the Society and College of Radiographers 1970-1995*. London: Society and College of Radiographers.
Moodie, I. (undated, ?1970) *The Society of Radiographers. 50 Years of History.* London: Society of Radiographers.
Rinsler, A. (2007) *An Illustrated History of the Royal Northern Hospital, 1856-1992*. Albert Rinsler, Whittington Hospital.

Appendix:

Annotated bibliography of Miss Kathleen Clara Clark (1898-1968)

Kitty Clark was a prolific writer and the following is a selection of her publications.

1935

Neck of Femur Technique, by K C Clark & M R Bell.
Royal Northern Hospital, London N7.
Radiography (The Journal of the Society of Radiographers) June 1935 Vol. I No. 6 p74-81.
An important paper on radiography of the femoral neck, so important in cases of trauma. Prior to this it was usual to take stereoscopic views, or to take the opposite joint for comparison. The lateral view described became standard for radiographers.

Training and Employment, by Miss K C Clark MSR.
Radiography (The Journal of the Society of Radiographers) June 1935 Vol. I No. 6 p154-162.
The Presidential Address was given at the first General Meeting of the Society of Radiographers for the 1935-1936 session held at the Reid-Knox Hall, 32 Welbeck Street W1 on October 16th at 7pm.
Reproduced in: Shadows, The Journal of the New Zealand Society of Radiographers. (K C Clark Memorial Issue) June 1970. Vol. 13 no. 2 p.16-20.

1937

Practical Radiography, by Miss K C Clark FSR.
(Presidential Address, delivered October 14th 1936)
Radiography (The Journal of the Society of Radiographers) 1937 Vol. III No. 25 p3-9.
A highly technical paper for a presidential address demonstrating her mastery of her profession.

1939

Positioning in Radiography (1st Edition), by KC Clark FSR.
January 1939, London: Messrs. Ilford: W. Heinemann, 482 pp., 1190 figs., price 3 guineas.
Reviewed: The British Journal of Radiology April 1939 Vol. XII, No. 136 p.252

Radiographic depth localisation of foreign bodies, by K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) November 1939 Vol. V No. 59 p195-211.
A detailed account of the various techniques needed for the localisation of foreign bodies that were so important in military surgery.

1940

A visit to Sweden and Denmark, by K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) February 1940 Vol. VI No. 62 p21-27.
Scandinavian radiography before the Second World War. This reads like the work of a travel writer.

Location of a metallic foreign body in the buttock, by Miss K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) 1940 Vol. VI No. 65 p105-106 (Read April 19th 1939).
A further paper on foreign body localization.

1941

Positioning in Radiography (2nd Edition), by K C Clark FSR.
January 1941, Ilford Ltd. & William Heinemann (Medical Books) Ltd.
Reviewed by E.R.W. (E. Rohan Williams): The British Journal of Radiology, May 1941 Vol. XIV, No. 161 p.54-62.

Experiments in X-ray screen photography with control direct radiographs, by K C Clark FSR, G R Mather Cordiner MB ChB DMRE and Philip Ellman MB MRCP.
The British Journal of Radiology, February 1941 Vol. XIV, No. 158 p.161.
A discussion on technical factors in MMR.

Inversion, Eversion and Rotation, by K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) 1941 Vol. VII No. 77 p98-99.
A paper on radiography of the lower limb and the influence of inversion, eversion and rotation.

Coventry and Warwickshire Hospital - Easter 1941, by K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) July 1941 Vol. VII No. 79 p98-99.
An account of wartime radiography in a busy hospital.

Further experiments in X-ray screen photography, by K C Clark FSR, and K T Poulsson MD (First Assistant Radiologist, Oslo Municipal Hospital) in collaboration with H Courtney Gage (Director of the Radiological Department, St Mary's Hospital, W2).
The British Journal of Radiology, July 1941 Vol. XIV, No. 163 p.250-254.
Further discussion of technical aspects of MMR including experience with the Norwegian Seamen's Bureau and Medical Service Department.

Letter, by K. C. Clark, G. R. Mather Cordiner, Philip Ellman.
The British Journal of Radiology 14 (161) pp: 186 (1941)..

1942

The Mass Examination of the Lungs by Miniature Radiography, by K C Clark FSR.
Radiography (The Journal of the Society of Radiographers) January 1942 Vol. VIII No. 85 p18-28.
This is the summary of a lecture given to the Scottish Radiographic Society at the Glasgow Royal Infirmary on 18th October 1941, and on the 21st October 1941 at Edinburgh Royal Infirmary. It is a practical account on the provision of an MMR service.

Positioning in Radiography (3rd Edition), by K C Clark FSR. June 1942.
Ilford Limited, William Heinemann Medical Books Ltd.

A complete X-ray department on wheels, by K C Clark FSR & W Watson FSR.
Radiography (The Journal of the Society of Radiographers) January 1942 Vol. VIII No. 85 p8-11.

Radiography of the Femoral Neck, by FP Fitzgerald FRCSI, KC Clark FSR.
The Lancet (1942) Vol. 240, Issue 6207, pp183-184, August 15.. - Elsevier
Published: August 15, 1942 DOI: https://doi.org/10.1016/S0140-6736(00)41476-5

1945

Positioning in Radiography (4th Edition), by K C Clark MBE FSR.
Ilford Limited, William Heinemann Medical Books Ltd, April 1945.
Review by C.W.: The British Journal of Radiology 19 (219) pp: 132 (1946).

Medical Research Council Special Report Series No. 251 Mass Miniature Radiography of Civilians for the Detection of Pulmonary Tuberculosis (Guide to Administration and Technique with a Mobile Apparatus Using 35-mm. Film: And Results of a Survey).
By Kathleen C Clark, P. D'Arcy Hart, Peter Kerley, and Brian C. Thompson.
London: His Majesty's Stationery Office, 1945.
Reviewed by L.G.B.: The British Journal of Radiology, October 1945 Vol. XVIII, No. 214 p.326.

1949

Positioning in Radiography (5th Edition) by K C Clark MBE FSR.
Ilford Limited, William Heinemann Medical Books Ltd, October 1949.

Chest Radiography: an investigation into the possibilities of standardization (The 11th Stanley Melville Memorial Lecture), by K C Clark MBE Hon. FSR.
Radiography (The Journal of the Society of Radiographers) May 1949 Vol. XV No. 173 p97-107.
Katie would return to the topic of standardisation in radiography on many occasions, and in this paper she demonstrated the depth of her technical mastery of the issues. This is classic radiography before modern automation. She describes the use of the Autotimer and looks forwards to the introduction of automatic processing.

1951

Positioning in Radiography (6th Edition) by K C Clark MBE FSR.
Ilford Limited, William Heinemann Medical Books Ltd, February 1951.

1953

An Introduction to High-Voltage Technique, by K C Clark MBE Hon. FSR.
Radiography (The Journal of the Society of Radiographers) February 1953 Vol. XIX No. 218 p21-34.
(Read to the Society of Radiographers in Welbeck Street, February 1952, with added comments in lieu of display material. The lecture itself was illustrated using slides and films.). An interesting and detailed account of radiography at 120kV, including a detailed account of the use of grids.

1956

Positioning in Radiography (7th Edition) by K C Clark MBE FSR.
Ilford Limited, William Heinemann (Medical Books) Ltd, December 1956. 105s.
Review: M. E. Guest, The British Journal of Radiology 31 (362) pp: 69 (1958)

1959

Review by KC Clark of: Patient Care and Special Procedures in X-ray Technology, by C. H. Vennes and J. C. Watson, pp. 203, 61 illus., 1959 (London, Henry Kimpton), 43s. The British Journal of Radiology 32 (384) pp: 823 (1959)

1960

A visit to the Southern Hemisphere Part 1 – Australia, by K C Clark MBE, Hon. FSR, Hon. FIR, Hon. MNZSR, FRPS (1959 Conference lecture).
Radiography (The Journal of the Society of Radiographers) May 1960 Vol. XXVI No.305 p.139-152

A visit to the Southern Hemisphere Part II – New Zealand, by K C Clark MBE, Hon. FSR, Hon. FIR, Hon. MNZSR, FRPS (1959 Conference lecture).
Radiography (The Journal of the Society of Radiographers) June 1960 Vol. XXVI No. 306 p. 179-189
Reproduced in: Shadows, The Journal of the New Zealand Society of Radiographers. (K C Clark Memorial Issue) June 1970. Vol. 13 no. 2 p.25-32

1964

Positioning in Radiography (8th Edition) by K C Clark MBE FSR.
Ilford Limited, William Heinemann (Medical Books) Ltd, July 1964. £6 6s.
(The author had been working on the 8th Edition when she became ill in 1964).
Reviewed by:
J H Middlemiss, X-Ray Focus 1965 Vol. 6 No. 1 p. 23-27.
R. E. Steiner, The British Journal of Radiology 38 (451) pp: 502 (1965).

1976

Positioning in Radiography. By K. C. Clark, 9th Edn., Vols. 1 and 2, pp. 786, 1974. (Published for Ilford Ltd. by William Heinemann Medical Books Ltd.), £15-00.
Reviewed by: P. M. Hoffman. The British Journal of Radiology 49 (577) pp: 75 (1976).
This is the first edition that was published following the death of Katie Clark.

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