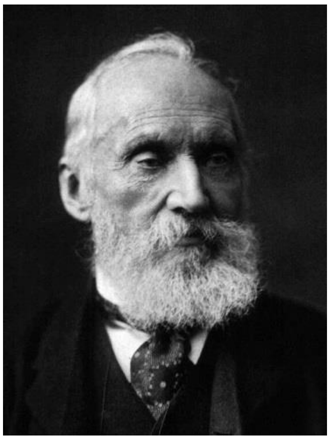
William THOMSON = Sir WILLIAM = Baron KELVIN of LARGS (1824-1907),
His Life and his activities in the world of telegraphy

Introduction



In June 1896 Glasgow was busily engaged in celebrating one of her great men. The City and its ancient University had combined to mark the 50th anniversary of William Thomson's appointment as Professor of Natural Philosophy (what we would now refer to as physics). Fifty years was certainly a long time to occupy a Professorial Chair – even allowing for the fact that Thomson had taken up his post at the remarkably early age of 22 – but this alone would not account for the celebrations. William Thomson, or Lord Kelvin as he had been known since Queen Victoria conferred a peerage on him in 1892, was more than just another long-serving academic; he was a household name and one of the most distinguished men of science of the Victorian age. His international reputation would be attested to by the presence in Glasgow of a host of distinguished scientists and academics from Europe, North America, Australia and Asia. A gracious letter would be received from the Prince of Wales, and the presentation of congratulatory messages from 90 universities, colleges and learned societies from around the world, ranging from Yale and Johns Hopkins to Moscow and Tokyo, would confirm the academic world's esteem for Kelvin.
A string of inventions – scientific instruments, echo sounders, an improved mariner's compass and, above all, his work on the Transatlantic telegraph cable – made him one of the best known inventors and scientists of the age. Fundamental work on electricity, magnetism, and thermodynamics had won him the respect of the academic world as well as international honours and distinctions. After Thomson was knighted in 1866 on the successful completion of the Transatlantic cable, France awarded him the Legion of Honour and Germany made him a Knight of the Order "Pour Le Mérite". The Royal Society of London, of which he had been elected a Fellow at the age of 27, had made him its President, as had the Institution of Electrical Engineers and the British Association for the Advancement of Science. Over the years he received many more honours; I have counted more than thirty.

PART 1: HIS LIFE STORY //1// (Notes) & [a] (Bibliography > Internet)

At the age of 22, the new Professor at Glasgow University had already had a glittering career and had published a dozen scientific papers. Born in Belfast (County Antrim, Ireland – now in Northern Ireland) on 26th June 1824 to an Ulster father and a Scots mother (who died when he was six years old), he had come to Glasgow as a child of eight when his father, James, had been appointed as Professor of Mathematics at the University. At what was even then the exceptionally early age of 10 years 5 months, William matriculated as a student at Glasgow University. Despite his extreme youth William won two prizes during his first session in 1834-35 and went on to win a University Medal, although he left Glasgow without graduating. Having reached the age of 16¾ he went south, to Peterhouse College //2// Cambridge. At 21 he graduated with high honours, then won the University's Smith Prize for mathematics. After finishing at Cambridge, Thomson went to Paris, where he worked in the laboratory of the physicist and chemist Henri-Victor Regnault to gain practical experimental competence to supplement his theoretical education. He returned in 1846 to take up the Chair of Natural Philosophy at Glasgow; indeed, at the age of 22 William was unanimously elected to it.
While Thomson's particular interest lay in the interface between mathematics and physics, he took a very wide sweep through all the physical sciences, from telegraphy and refrigeration to atomic theory and

geology. He was an inspiring, if demanding, teacher. Something of Thomson's style comes across in his own comments at his Jubilee celebrations:
"*To me the professor and his class of students are coefficients, fellow-workers, each contributing to whatever can possibly be done by their daily meetings together. I dislike the term lecture applied here. I prefer the French expression "conference". I feel that every meeting of a professor with his students should be rather a conference, than a pumping-in of doctrine from the professor perhaps ill understood and not well received by his students."*

William Thomson's greatest public fame came in 1866. The original Atlantic telegraph cable had been laid in 1858 and had promptly failed within a few weeks, having transmitted only a few hundred messages. Thomson had been involved with this first attempt, but he was to play an increasingly large part in the preparations for the successful attempt by the 'Great Eastern' in 1865/1866, accompanying the giant ship on its cable-laying voyage. Thomson believed both in practical involvement in the application of science and in the commercial development of scientific ideas. He was a director of the Atlantic Telegraph Company, besides acting as technical superintendent for the project, which after many setbacks and struggles eventually succeeded in laying the cable between Ireland and Newfoundland in July 1866. For his work on the transatlantic telegraph project he was knighted that year by Queen Victoria, becoming Sir William Thomson. Sir William, as he now was, went on to act as consultant engineer for a number of other submarine cables over the next ten years. Two of his inventions which were crucial to the success of the submarine cables were the **mirror galvanometer,** patented in 1858 and used for displaying the minuscule signals received over the cable and the **siphon recorder**, patented in 1867, which became the standard means of recording cable messages.
More on that here in PART 2.

In 1876 Thomson visited the United States and saw early demonstrations of **Alexander Graham Bell's** telephone. On his return to Glasgow he brought back the first pair of Bell telephones to be seen in Britain. New ideas always appealed to Thomson, and his Glasgow house was the first private home in the city to be equipped with electric lighting.
Appropriately for a scientist working in Glasgow, the centre of the Clyde shipbuilding industry and the birthplace of so much of the world's shipping, Thomson devoted a great deal of time and thought to questions of navigation. He patented a sounding device which made it easier and quicker to determine the depth of water under a ship. His other important navigational device was an improved mariner's compass. //3// Despite initial Admiralty scepticism, it was soon in general use. He also developed a device for producing tidal predictions.
Thomson established a company in partnership with **James White** //4//, his instrument maker, to manufacture and exploit his scientific inventions and patents. These inventions – Thomson was to register 70 British patents – made him a rich man. His annual earnings from telegraph patents alone earned him several times his professorial salary and enabled him to build his mansion house at Largs and run his 126-ton schooner yacht "Lalla Rookh" (named after the heroine of an oriental tale by the Irish writer Thomas Moore). A keen musician, having been a founder of the Cambridge University Musical Society, Thomson was also an active sportsman. Later in life he walked with a slight limp a result of a broken thigh sustained in a fall on the ice while enjoying a game of curling.

In his later years he became politically active, responding to his Ulster roots by becoming an active Liberal Unionist in opposition to Gladstone's Irish Home Rule Bill of 1886. //5//

He was ennobled in 1892 by Queen Victoria in recognition of his achievements in thermodynamics, and … of his opposition to Irish Home Rule, becoming Baron Kelvin of Largs in the County of Ayr. He was the first British scientist to be elevated to the House of Lords. The title refers to the River Kelvin, which flows near his laboratory at the University of Glasgow.

The above mentioned celebrations of 1896 might have marked Kelvin's fiftieth year as Professor but it certainly did not signal his retirement, and he continued working, writing scientific papers, and speaking at

conferences throughout the remainder of his life. Indeed he continued to register patents until the last year of his life. He carried out his duties as Professor of Natural Philosophy until 1899, at which time he was aged 75. With typical enthusiasm he then applied to the Senate of the University to be appointed as a Research Student. This kept his name on the University books and entitled him to pursue his investigations in the laboratories of the Department of Natural Philosophy. He three times refused the offer of the prestigious Cavendish professorship of physics at Cambridge University, preferring to stay in Glasgow
Active in industrial research and development, he was recruited around 1899 by George Eastman to serve as vice-chairman of the board of the British company Kodak Limited, affiliated with Eastman Kodak.

In 1904 Glasgow University appointed him as Chancellor – the titular head of the University.

Perhaps the most fitting and lasting tribute to Kelvin is his inclusion in that distinguished group of scientists whose names have been given to units of measurement – Watt, Joule, Pascal, Hertz, Faraday, etc. The degree Kelvin has been adopted as the "Système Internationale" base unit of thermodynamic temperature – an apt choice, reflecting Kelvin's early researches to establish the absolute zero of temperature //6//. Kelvin was, appropriately enough, an enthusiastic advocate of metric measurements, denouncing what he described as the "absurd, ridiculous, time-wasting, brain-destroying, British system of weights and measures"!...

He married twice: his first wife was Margaret Crum (1852-1870), his second Frances Blandy (1874-1907), but had no children from either marriage.
In November 1907 he caught a chill and his condition deteriorated until he died at his Scottish residence in Netherhall, near Largs, on 17 December. Such was his reputation that there was little doubt that he should be buried in London alongside the great national figures in Westminster Abbey. His funeral took place on 23rd December 1907. A crowded international gathering of scientists, statesmen, and representatives of the many worlds in which William Thomson had moved with such distinction saw him buried next to Sir Isaac Newton, John Herschel and Charles Darwin.

William Thomson profoundly influenced the scientific thought of his generation.
He was foremost among the small group of British scientists who helped lay the foundations of modern physics. His contributions to science included a major role in the development of the second law of thermodynamics; the absolute temperature scale (measured in degrees Kelvin); the dynamical theory of heat; the mathematical analysis of electricity and magnetism, including the basic ideas for the electromagnetic theory of light; the geophysical determination of the age of the Earth, theories and instruments related to submarine telegraphy; and fundamental work in hydrodynamics.

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<u>NOTES</u>

//1// This text is a good part of an article, written by Brian D. Osborne (+2008) that originally appeared in "The Highlander" magazine. I have slightly adapted it by shortening it an adding some small paragraphs. See Brian's interesting website [a]

//2// Peterhouse is a constituent college of the University of Cambridge; it is the oldest college of the university, having been founded in 1284.

//3// The development of iron and steel ships had given problems with the old form of compass – the metal of the ship affecting the compass needle. Earlier compensating compasses had used larger and larger needles and heavy masses of compensating magnetic material. Thomson's compass used the smallest possible magnetic needles and easily adjustable correcting magnets.

//4//. In 1850 James White (1824-1884) founded the firm ‘James White, optical instrument maker in Glasgow’. He was involved in supplying and mending apparatus for William Thomson's university laboratory and working with him on experimental constructions. By 1854, White was already producing electrical instruments - electrometers and electrical balances - from Thomson's designs.
In 1870 White was largely responsible for equipping Thomson's laboratory in the new University premises at Gilmorehill. From 1876, White was producing accurate compasses for metal ships to Thomson's design, and this became an important part of the business in the last years of his life. He was also involved in the production of sophisticated sounding machinery that Thomson had designed to address problems encountered in laying cables at sea, helping to make possible the first transatlantic cable connection. At the same time, he continued to make a whole range of more conventional instruments such as telescopes, microscopes and surveying equipment. White's association with Thomson continued until he died.
In 1899 Lord Kelvin resigned from his University chair and in 1900 he became a director in the newly formed limited liability company ‘James White Ltd’, which acquired the business of James White.
The company became ‘Kelvin and James White’ in 1900. [f]

//5// The Irish Home Rule movement was a movement that campaigned for self-government (or "home rule") for Ireland within the United Kingdom of Great Britain and Ireland. It was the dominant political movement of Irish nationalism from 1870 to the end of World War I.

//6// Absolute temperatures are stated in units of degrees Kelvin in his honour. While the existence of a lower limit to temperature (absolute zero) was known prior to his work, Lord Kelvin is known for determining its correct value as approximately −273.15 Celsius or −459.67 Fahrenheit.

PART 2: HIS INSTRUMENTS

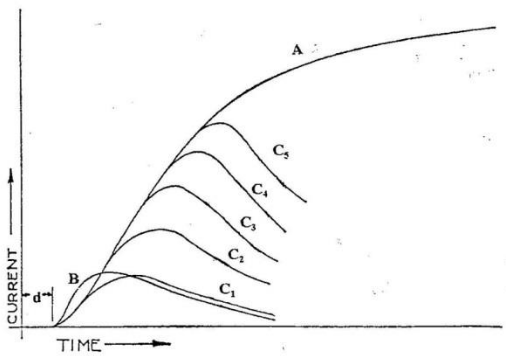
We have already learned in PART 1 a bit about William Thomson's involvement in the laying of the Atlantic cable. That was only a very brief summary. I can with pleasure and confidence refer those readers, who are interested to learn much more about the great adventure, to the very interesting website of my friend Bill Burns, who is a world authority in this domain. See [c]

2.1. A bit about Thomson's theoretical work, related to (submarine) telegraphy.

WARNING!! What follows is only intended to the technicians, electricians, and engineers between us…

What did our William invent behind his desk?.

Well, when studying the problem he could, theoretically, find out that the behaviour of an electrical signal sent over a very long line would not be the same as it was over a short line. Up to then only the electric resistance (symbol R-unit Ohm) was taken into account. But here there was a major problem besides the high resistance of a long line, namely also the fact of the large electrical capacitance: the cable, its insulation, and the water acting as a large capacitor (symbol C, unit Farad). And above all the standard Morse signals of dots and dashes constituted a series of rapid electric current changes through the cable (which acts as a 'low-pass' CR filter).
Thomson had presented his results in his seminar paper 'On the theory of the electric telegraph', read before the Royal Society in London in 1855.



The figure hereby shows us the current (I- in [mili/micro] Amperes) at the receiving end when a voltage (V, units Volts) is applied at the sending end, and this for different pulse-lengths (duration in time). Curve A shows the arrival when a continuous voltage is applied at the sending end. After a short interval of time 'd', shown as the transmission delay of the cable, the current begins to increase and approaches asymptotically the value V/R (Ohm's law).
Curve B shows the effect at arrival of an ultra-short pulse of applied voltage at the sending end: a small rise in current after the transmission delay, and then a gradual reduction to a quiescent value. The C curves represent a more practical situation when a Morse dot of finite length is sent. C1 is for a pulse with the duration of 'd', C2 for a length of '2d'; C3 for '3d'… &c.
These curves illustrate clearly that if an attempt is made to transmit a series of Morse symbols too rapidly, then the resulting changes in current at the receiving end will be superimposed on one another, and any distinguishable features will be lost. The main conclusion here is that Morse signals could be sent, but the speed of transmission would be very low.
Moreover, Thomson calculated that the time required for the current to reach a given fraction of its maximum value (much lower than the V/R) would be proportional to $R.C.l^2$ (l square!)???.Hence one can conclude that, for a given design of cable, signalling speed is inversely proportional to the square of the cable length. This theory was subsequently confirmed by C.F. Varley, who performed experiments on great lengths of cable in the East India Dock in London.

Several changes in operational methods were put in effect in the 1860s to ameliorate these difficulties. One consisted in using pulses of equal length but of opposite polarity, with the line being connected to earth in between each pulse so as to charge and uncharge the cable..
Better results were obtained with different methods of 'curbing' the rectangular pulses *(avoiding the steep up and down flanks)* before transmission. A popular example was William Thomson's 'automatic curb sender'. It was a kind of telegraph key that acted so that each signal was made by two opposite currents in succession: a positive followed by a negative, or a negative followed by a positive. The added current had the effect of "curbing" its precursor.

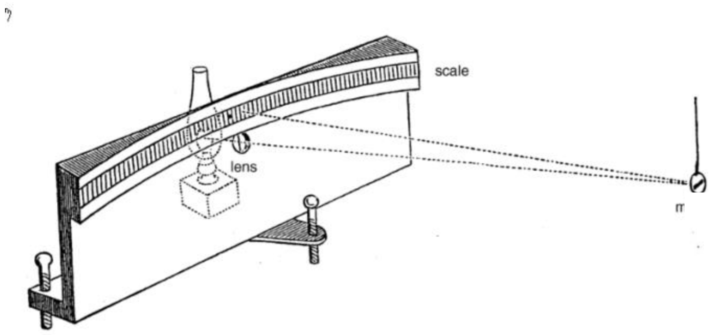
Transatlantic cable piece 1857

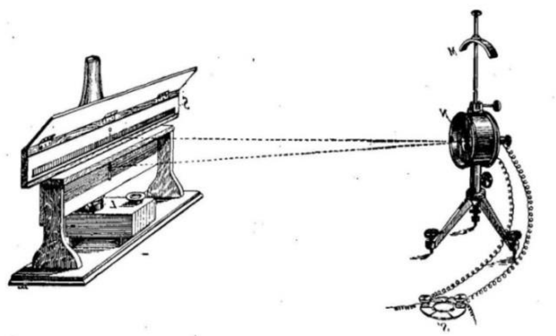
Transatlantic cable piece 1858

PS: In a paper published in "The Electrician" in 1887 Oliver Heaviside, developed a more complete theory of signal propagation. In it he showed that the inductance of the line (unit Henry, symbol H), previously neglected in performance calculations, could play a significant role in determining the shape of the received signal. If the series inductance of the line could be increased, there would be an improvement in the shape of the received signals. [I remember this still very well as I got this as an exam question during my engineering studies; that was, at the time of writing, 58 years ago...]

2.2. The Mirror Galvanometer

The mirror galvanometer was invented in the first part of the 19th century (By Poggendorf?) and became in use for detecting weak electric currents.
The principle is as follows:





A very small mirror is attached to a very fine wire. On the back of the mirror a small magnet is glued. Around it there is a coil with a lot of thin copper windings.
Even with a very small current through the coil, the magnet and therefore the mirror will move: to the left for a positive current, to the right for a negative current (see the operation of the one-needle telegraphs and the principle of Œrsted in my article 'Prof. Charles Wheatstone'.

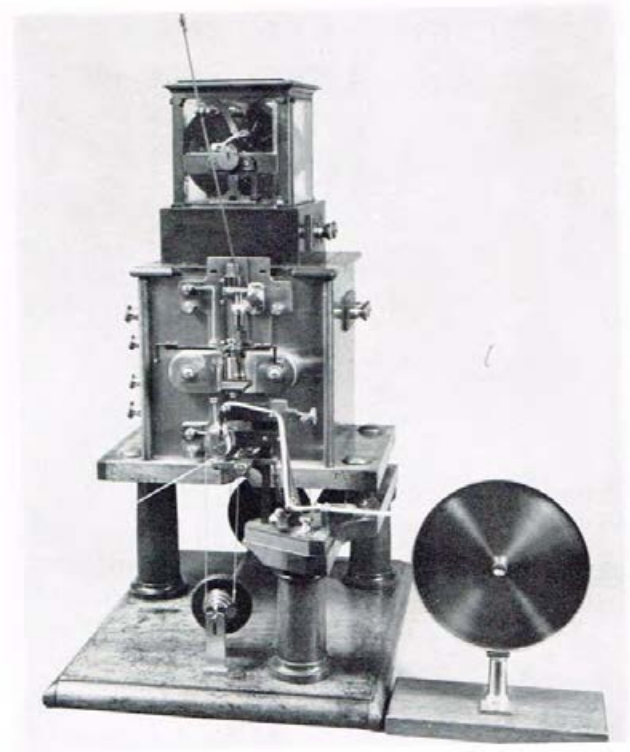
A beam of light is now projected onto the mirror from a certain distance. The light source is perpendicular to it and at rest the beam will be reflected to this light source. This reflected beam ends up on a scale or on the opposite wall.
A current of the order of micro-amperes may cause the mirror to move only one degree or even a fraction of it, but if the reflected beam is caught far enough from the mirror (e.g. on the opposite wall), one can clearly see and follow the deviation, which is proportional to the distance to the wall.
If the polarity of the electric current is reversed, the beam will shift to the other side. In that way we have a 'binary' system. And by giving the meaning of a 'Morse dot' to be a deviation to the left (say a positive current is sent) and a 'Morse dash' to be a deviation to the right (for a negative current) we can transmit a message coded in Morse!
Why one was not sending a short current (in time) to represent a dot and a longer current (of the same polarity) for a 'dash' is described in the theoretical study made by William Thomson and which I have tried to explain here above in 2.1. And there is more. He developed a mirror galvanometer that was much more sensitive than the existing ones (of which you can see, here above, two examples that once were in my collection of scientific instruments).

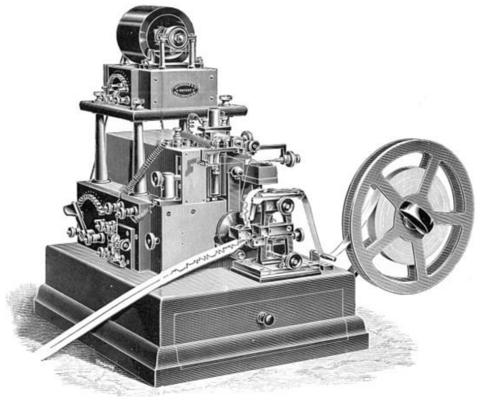
My high-grade four coil differential astatic Thomson mirror galvanometer, made by Louis Breguet

2.3. The Siphon Recorder [n]

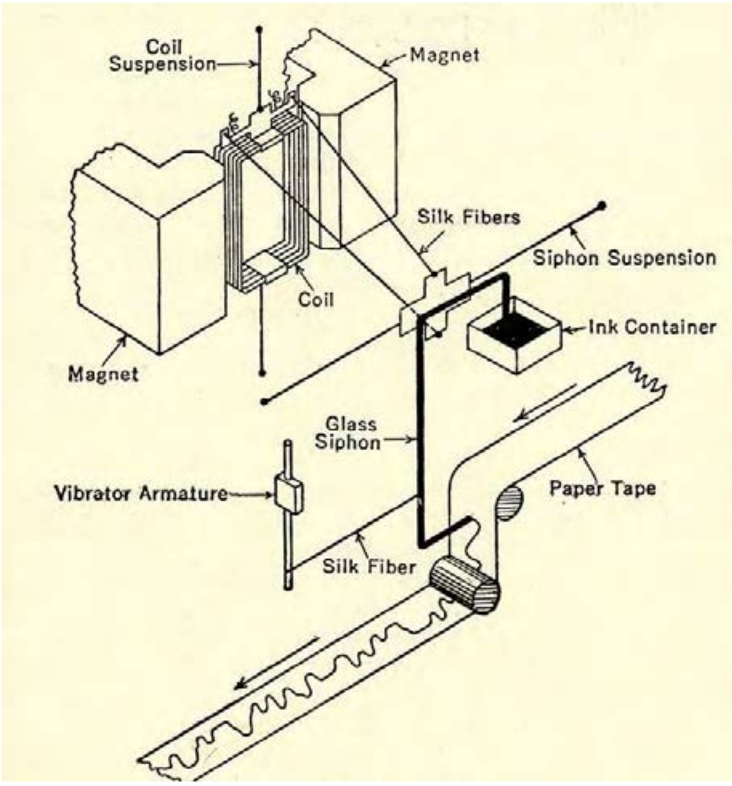
In 1867 William Thomson was again able to provide an ingenious solution for submarine telegraphy: he patented a sensitive receiver capable of providing a permanent record of the signal at arrival.
It was the "siphon recorder", which in the following decades became the standard cable receiving device. It resembled a modern moving-coil microampere meter, having a coil suspended between the poles of a very powerful magnet which moved when current flowed through it. This movement was conveyed to a capillary tube, one end of which moved across a paper ribbon, and the other end dipped into a well of ink. The writing end of the tube did not touch the paper, so the device was virtually 'friction free'; the ink was caused to emerge by maintaining an electric charge on the tube while the paper ribbon was held at earth potential as it passed over a metal roller. Therefore the instrument was equipped with a small electro-static generator (the 'mouse-mill') and a small electro-magnetic motor. Later on, the same result was obtained using an electro-magnetic vibrator. The ink was ejected onto the paper as a series of closely spaced dots, giving a straight line in the absence of a signal, but moving to the left or the right as the signal went positive or negative, to indicate a dot or a dash. In the U.S., and as marked by ATM (the Automatic Telephone Manufacturing Company), it became known as the 'undulator' and was in wide use for terrestrial as well as submarine cable operation well into the 1930s.[4]

The word ‘undulator’ was originally brought out by the Lauritzen company of Copenhagen.





The photo above left is the Thomson siphon recorder (c 1870), that is kept in the Science Museum, London. [3]. And the drawing below comes out of my ATM catalogue of 1921 [4]. Exactly the same model was brought out by Muirhead. [6]



The drawing explaining the functioning comes out of [c]

-Ref. [5] explains the functioning -in French- rather well and in detail.
-The same applies to [6], but then in German
- Strangely enough, T.H. Herbert doesn't write anything about submarine telegraphy in his (English) reference book of 1907, and therefore also nothing about mirror galvanometers.

Long ago an English dealer was offering me a real type Thomson siphon recorder. But it was incomplete and , anyway, the price was way too high for me; pity.

Once I had three models, based upon the basic 'Thomson principles' in my collection: an ATM, a rare Marconi and a Muirhead. Fortunately, I kept some photographs:

ATM

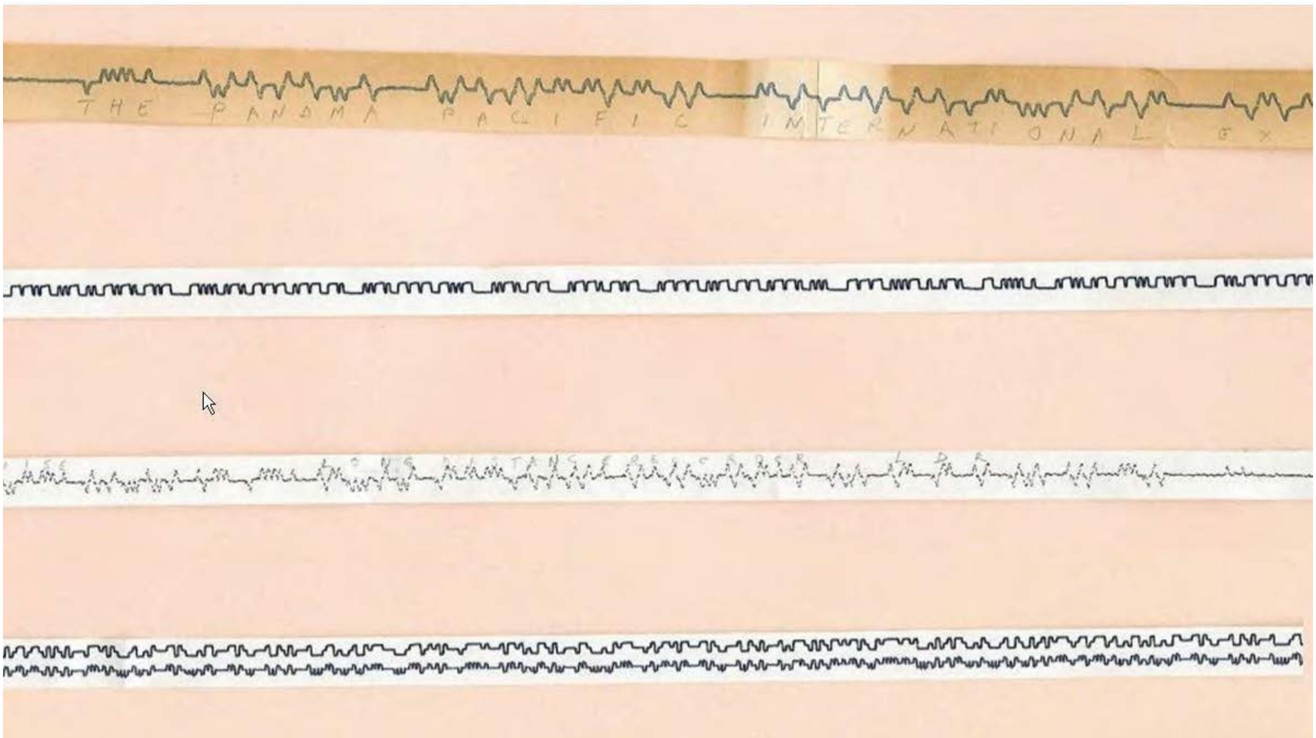
MARCONI

MUIRHED closed MUIRHEAD open

On the photo on the right the vibrator can be seen extending on the top at the right hand side.

Here are two examples of the ‘double current’ Morse keys as used by the sender.

And here you see what different devices wrote at the receiving end



PART 3: MISCELLANEOUS

The statue of Lord Kelvin in Kelvingrove Park, **Glasgow** University, is one of the most interesting places to visit, and in a small garden below the University Tower you will find the Lord Kelvin Statue. The statue was erected on this site in 1913 and was the work of Archibald MacFarlane Shannan, who was commissioned to immortalise Sir William Thomson, 1st Baron Kelvin of Largs, in bronze.

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BELOW: During his lifetime Lord Kelvin was showered with honours, but perhaps, most notably a statue was erected in the Botanic Gardens in **Belfast** in 1913. It still stands, just inside the entrance to the gardens, opposite the Methodist College entrance.

Engravings:

Front: KELVIN

Side:

President of the Royal Society
Chancellor of the University of Glasgow
following 53 years of service in the
chair of natural Philosophy
Pre-eminent in Elucidating
the laws of nature and in applying them
to the service of man

* **Coat of arms** of William Thomson, Baron Kelvin.

* **Motto**: **Honesty without fear.**

* **Signature**

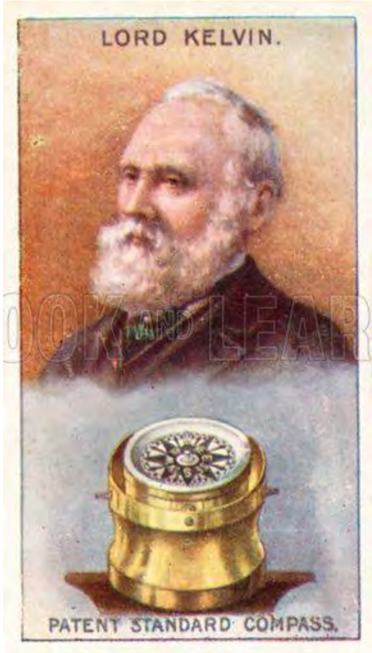
It is believed the "PNP" in his signature stands for "Professor of Natural Philosophy". Note that Kelvin also wrote under the pseudonym "P. Q. R."

* The town of Kelvin, Arizona, is named in his honour, as he was reputedly a large investor in the mining operations there.

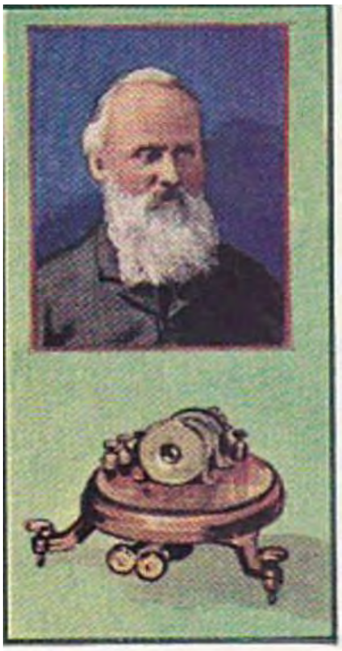
* Lord Kelvin was commemorated on the £20 note issued by the Clydesdale Bank in 1971; in the current issue of banknotes, his image appears on the bank's £100 note; he is shown holding his adjustable compass.

Chromo's

Here from Hill's Cigarette C

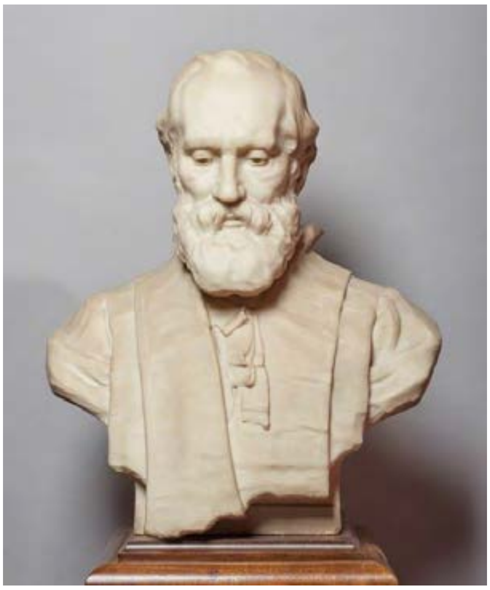


His magnetic compass



Marine galvanometer used on the 1858 Atlantic cable

His bust



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[1] HET INTERNET VAN DE 19de EEUW - Fons VANDEN BERGHEN - 2012 - 434 p. - 650 photos & illustrations - written in Dutch - only available (for free) via the Internet:
http://www.telegraphy.eu/pagina/boek/TELEGRAFIE%2025%20APRIL%20Fons.pdf

[2] HISTORY OF THE TELEGRAPH - Ken BEAUCHAMP - 2001 - 413 p.

[3] EARLY ELECTRICAL COMMUNICATION - E.A. MARLAND - 1964 - 220 p.

[4] TELEGRAPH APPARATUS and ACCESSORIES - ATM Co. Ltd. - 1921 - 133 p.

[5] TRAITE DE TELEGRAPHIE ELECTRIQUE - H.THOMAS - 1891 - 911 p

[6] GESCHICHTE DER TELEGRAPHIE - Th. KARRASS - Erster Teil 1909 - 702 p.

Internet
Google "lord Kelvin" and you get about 11 500 000 results! Here follows just a small selection:

[a] https://briandosborne.wordpress.com/

[b] https://booksfromscotland.com/bfs-author/brian-d-osborne/

[c] https://atlantic-cable.com Bill Burns's great website on transatlantic telegraph cables (and undersea communications in general)

[d] n a

[e] https://www.telegraphy.eu my own (second) website with plenty of articles.

[f] https://www.gracesguide.co.uk/James_White_and_Co

[g] https://en.wikipedia.org/wiki/William_Thomson,_1st_Baron_Kelvin

[h] https://www.britannica.com/biography/William-Thomson-Baron-Kelvin

[**i**] https://www.britannica.com/biography/William-Thomson-Baron-Kelvin/images-videos photos

[j] https://www.newworldencyclopedia.org/entry/William_Thomson,_1st_Baron_Kelvin

[k] https://www.undiscoveredscotland.co.uk/usbiography/t/williamthomson.html

[l] https://www.famousscientists.org/william-thomson/

[m] https://en.wikipedia.org/wiki/Mirror_galvanometer

[n] https://en.wikipedia.org/wiki/Syphon_recorder#cite_note-3

THANK YOU

My thanks go to my friend Bill BURNS for having corrected (again) my 'Flemish(Dutch) English. People with interest in the history of the Atlantic Cable & Undersea Communications must check his great website:
http://atlantic-cable.com