Extracts from the papers of
Sir Charles Wheatstone

WHEATSTONE 1: Working papers, experimental notes and correspondence relating to the development of the electric telegraph, [1836-1960]

K/PP107/1/4

[1835-1869, 1898]

Bundle of papers entitled ‘experimental apparatus-electricity’, comprising working notes and correspondence relating mainly to electric telegraph equipment including a letter between James Clerk Maxwell (1831-1879), physicist and Professor of Natural Philosophy, King’s College London, and Charles Wheatstone, concerning the quantity of electricity required to charge a wire, 1862; notes on various pieces of electrical apparatus, principally components in the electric telegraph, including the induction relay, finger input key, circuit breakers, and proposed equipment designed to improve the performance of telegraph printers and reduce the power consumption of the telegraph, with rough sketches and illustrations; inventory of telegraphic accessories; instructions for the construction of a portable meteorology station; correspondence by John Frederick William Herschel (1792-1871), mathematician and astronomer, regarding Kew Observatory and academic vacancies at the University of Melbourne, Australia, 1848-1852, [1848-1862]. Correspondence between Alexander Siemens (1847-1928), electrical engineer, and John Cutler (1839-1925), Professor of English Law and Jurisprudence, King’s College London, on telegraphic cables, 1898.
Letter to Wheatstone from John Frederick William Herschel (1792-1871), physicist, regarding academic vacancies at the University of Melbourne, Australia, 1852 May 1.
Dear Mr. Cutler,

With reference to our conversation at the Club a short time since, I have pleasure in sending you herewith:

1. Sample of the 1879 Atlantic cable (French)
2. Sample of the 1881/2 Atlantic cable (British)
3. Sample of the 1891+ Atlantic cable (Commercial)
4. Sample of the 1879 cable recovered in 2520 fms after being submerged for 16 years.

I trust they will be of interest to you.

Believe me,

Very truly yours,

[Signature]

John Culter, Esq. F.C.
44 New Square, Lincoln's Inn.
23 Nov 1869.

Sir,

Our attention has been called to a paper in Vol XVII of the proceedings of the Royal Society wherein you describe a New Deep Sea Thermometer made from your suggestion by Mr. Casella.

We beg to forward for your perusal our Treatise on Meteorological Instruments published as far back as 1864 and bring under your notice paragraph 29, page 90, in which you will there find a description of the exact instrument named.
in your paper, our instrument which we claim to have invented and sold years before our book was published. We have to add that this thermometer is well known to the leading thermometer makers and to some more so, than to Mr. Rosetta, who ought to have made you aware of the fact.

We are in

H. Negretti & Zambra

Hutton Foundry
K/PP107/1/4/6
Photograph of Wheatstone's automatic telegraph transmitter taken by Monsieur Louis, 374 Euston Road, [1863-1864].
8 Palace gardens Terrace
Kensington W
1862 March 4

Dear Sir,

I have calculated the amount of electricity required to charge a long wire such as you use to carry off small charges. Suppose it to be an ellipsoid of length 2a and breadth 2b the exact expression for the electrical capacity is

\[ \frac{4a}{\ln \left( \frac{a + \sqrt{a^2 - b^2}}{b} \right)} \]

the capacity of a sphere radius \( a \) being taken for unity. If \( b \) is small compared with \( a \), we may write the expression

\[ \frac{4a}{\ln \left( \frac{a}{b} \right)} \]

or

\[ 10.726 \frac{a}{\text{common log } \frac{a}{b}} \]

K/PP107/1/4/7
Letter to Wheatstone from James Clerk Maxwell (1831-1879), Professor of Natural Philosophy at King's College London, 1860-1865, regarding a calculation of the amount of electricity needed for charging a particular wire, 1862 Mar 4, page 1.
This for a rod with round end whose length is five times its breadth, the charge would be \( 1.236 a = C \).

If the breadth were \( \frac{1}{2} \) of the length, the charge would be \( \frac{1}{2} \) of the first and on breadth \( \frac{1}{5} \) of length.

\[
\begin{array}{cccc}
\frac{1}{5} & \frac{1}{50} & \frac{1}{500} & \frac{1}{5000} \\
\frac{1}{2} & \frac{1}{3} & \frac{1}{4} & \\
\end{array}
\]

When the length and breadth vary in the same proportion, the charge varies as the length simply.

The charge of circular discs varies as the radius and is independent of the thickness; if the thickness is small, I have no doubt these results are valid.
given in the mathematical treatise
but as the formula for rods illustrates
your remarks to me on the 23rd Feb
I have thought it worth while to
send you it.

yours truly
JM Clerk Maxwell
The principle of this relay is the moment by the principle current of an alter. Dynamic coil in the core proximity of a powerful alternate magnet, the direction of one coil towards the other causing the complete action of a bent current; one of these bent currents acting upon the instrument. The current to the point made to have, and the other by one resistance within the inertia of the power as provided by the instrument position.
When a current of small intensity is transmitted through a long wire it suffers some appreciable diminution before the current arrives at its maximum at the middle and the current itself must last an appreciable time to reach it. But if the current instead of being weak and continuous were instantaneous and emphatic, the maximum at the middle would be arrived at immediately and the same pair of objects would be perfectly distinct. If therefore, instead of employing the current of a voltaic battery, we were to use the discharges of a Leyden jar or those of an electric eel to produce the signals they might be perfectly equal and distinct.

For equal Leyden jars might be kept constantly charged with opposite electricity, one by one, and when in communication with either of them according as the positive or negative current is required.

The liquid analysis of iron is magnetic. What would be the effect of making an electro-magnet of the liquid analysis? Would not the original magnetism be very much impaired if not destroyed?
The velocity of electricity cannot be properly measured in a case of wires on account of the mutual action of the wire on each other. The difficulty may however be obviated by the effects of induction eliminated by the following arrangement. Draw a tube into two parallel rows of wrought iron and wind the wires back and forth between them so that the windings of the current wire can be adjacent. Let it be on an opposite wire, and combine this operation in some fine wires. Thus each wire is conducted as on the common wire of different wire brass and different materials, and it with a little current in the ordinary way and subject to the effects of this induction.

K/PP107/1/4/11
notes describing measuring the velocity of electricity through a wire, [1835-1869], pages 3 and 4.
A great roller on an arm connected with the moving point, roller in a trough containing the liquid with, and by moving into chamber, and other parts, and the smaller one connected with the mechanism in such a manner that it is never the larger roller is constantly rotated with it, and the small movement of the head with the roller is to be observed by the operator. The small one, the accidental difference of force of the roller in the manner to which moves the smaller roller as in going round with is.

The roller is to contain paper against the head of paper at the moment it is removed or returning, returning.

The roller with, against the head of paper, at the joint when it is in contact with the horizontal surface of the roller extrudes across the leading.
Printing Telegraph

The type should be constructed on the principles of Sholes' type-disk mechanism. When the hand strikes on the type at the moment it prints to the letter, a local circuit is completed while acts on the printing hammer, and the adjustment which enables the switch to be jumped.

New automatic arrangement for this:

A horizontal cylinder divided into 30 rings, each ring containing the paper which of the rings gives the corresponding letters. A separate wire runs from each ring and a movable pin attached to each.

Reports paper of width equal to 30 reports. The paper to advance one inch for each revolution of the cylinder.

Each letter wire occupies the same time for its production.

As the wheel has quick the type which may be used to move.

If a battery is not employed the local circuit must only be actuated. And, if the only wire were an operator, the paper might be made very great.
Notes and rough diagram showing a ‘magnetic key for the line printer with alternate currents’, [1835-1869], page 1.
Notes and rough diagram showing a ‘magnetic key for the line printer with alternate currents’, [1835-1869], page 2.
K/PP107/1/4/15
Rough sketch by John Matthias Augustus Stroh (1828-1914), telegraph engineer and inventor, showing battery cells, [1835-1869].
K/PP107/1/4/16
Drawing of a portable telegraph switch housed in a wooden box, [1835-1869].
K/PP107/1/4/17
Drawing of a telegraph key or switch, [1835-1869].
K/PP107/1/4/19
Notes and rough diagram of a 'new magneto-electric Telegraph with finger keys', [1835-1869].
The object of the present improvements is to vary the system of paper prepared with a series of strips which may be of the same size, to produce a definite printing instrument, marked by means of lines, either of the subject learnt as in the case of the alphabet, or of 3 or more columns for the purpose of increasing the number of subjects without the parts increasing the number of characters.

In this improvement it is possible that the parts attached to the instrument may not be magnetic in nature but be other materials, so that the subject may be marked by means of lines or dots, and the number of the characters or marks by means in the opposite directions. The number of the subject and of the columns between the markers is regulated by the distance of the appearance of one row on the perforated paper from the next. As the subject of the page is long as the distance of the current remains unchanged, recommendation was made to use a current in the opposite direction as a check against the other current.
The Papers of Charles Wheatstone
K/PP107/1/4 - Papers relating to the development of the electric telegraph

K/PP107/1/4/20
Notes describing improvements to Wheatstone's telegraph through the use of strips of perforated papers, [1835-1869], page 2.
Rough diagram showing 'Mr [Augustus] Stroh's [(1828-1914), telegraph engineer and inventor] method of directing mechanical power to work perforations', 1868 May 13.
Note with sketch diagrams describing a 'telegraph by direct rotation', [1835-1869].
Notes describing ‘The Corrector’ an instrument to ensure the indicator on a telegraph receiver shows the correct letters even when a message is sent rapidly, [1835-1869], page 1.
Notes describing ‘The Corrector’ an instrument to ensure the indicator on a telegraph receiver shows the correct letters even when a message is sent rapidly, [1835-1869], page 2.
Notes describing an automatic printing telegraph similar to a typewriter in which Wheatstone suggests that the letters should not be arranged alphabetically written on reverse of a printed flyer for the St Marylebone and Paddington Association, [1852-1869].
Note describing a ‘writing telegraph’ with a single gear or marker, [1835-1869].
Notes describing an automatic telegraph receiver to print Morse code, [1835-1869], page 1.
Notes describing an automatic telegraph receiver to print Morse code, [1835-1869], page 2.
K/PP107/1/4/31
List of apparatus and descriptions including 'rheotomes', 'rheotropes' and pendulums, [1835-1869], page 1.
9. Only mention nothing, the more white, the more
    necessary.
10. So with references.
11. Apparatus for varying the resistance of the
    electric. The latter must be so constructed as not
    to be very non-electric, compared.
12. Apparatus for making any number of calculations
    separately by means of these means.
13. Apparatus for making any number of calculations
    at the same time, the operation to be very much
    regular or complex.
14. Repeated sums being done between these
    memorandum numbers.
15. Apparatus for the transmission of calculations
    signs to desired operators.
16. Brackets for them better, but over gages too.
A Telegraph may probably be worked with a much
life expenditure of power in the following way :
Connect with the bare ends of the wires of the electric
magnet a small voltaic battery while 'producing in the tube a current
in the same direction as the battery of the electric wire, and so
adjust the power that the instrument shall not act. As
much life power in the current battery will then make the
instrument move. This life may be made adjustable by the
same regulator.

If the current is less a little stronger than the battery
supplying them is a chance of the wires some remaining
unwound. This un wound will most likely be obtained by making
the motion of the wires some cent to cause the voltaic
battery current, so that the electromotive force should be diminished,
but instantly the current takes back the field which circuit comes
into play again.

Notes and sketch diagram describing 'Latent Power' in a 'Counterpoize Battery' in relation to powering tele-
graph apparatus, [1835-1869], page 1.
If a short circuit were to be made, which I do not think will be, the current will naturally cause the return of the power, return may be used, to return in the same line in a self-magnetic, and a perfect separate circuit.

In this case, even a permanent magnet may be employed instead of the electromagnet.

The evidence of the short circuit may be greater in proportion to the length of the primary circuit electrically. Thus, if a short circuit of 3°C:30°C does not work, then 1°C may be reduced to 1°C, and the length may be shortened to 1°C, and then the current may be worked at 1°C. If the current be 1°C, then the length may be reduced to 1°C, and the current may be worked at 1°C, and then that current may be worked at 1°C.

The current, in short, may be maintained in a more permanent manner than that, by the introduction of the return in a perfectly separate circuit, and by having a strong current of power, which can be suitably maintained by the current in the short circuit.

K/PP107/1/4/33
Notes and sketch diagram describing ‘Latent Power’ in a ‘Counterpoize Battery’ in relation to powering telegraph apparatus, [1835-1869], page 2.
Notes describing Wheatstone’s ‘Magneto-electric field Telegraph’, [1835-1869].
K/PP107/1/4/38
Drawing of three-fingered telegraph key, [1835-1869].
New Telegraph.

The beautiful curve formed by the combination of vibrating motions may be intended as telegraphic signals in the following manner.

The subject apparatus must be constructed in such a manner that it may be used in the same way as the wave machine. As soon as the wave machine has been set in motion, it will send out a signal to the other end of the line. The signal must then be received by the other end of the line, where it will be indicated by a pointer moving on a scale.

Each signal must be transmitted by a separate wire, and the wires must be connected to the wave machine by a series of levers.

This has the advantage of being simple and effective, and it may be used in various ways. 1. By having two waves transmitted through two separate wires. 2. By having two waves transmitted through the same wire, and the pointer moved by the motion of the wave.
Description of an idea for a telegraph based on the curves and vibrations produced by Wheatstone's wave machine, [1835-1869], page 2.
Notes describing an 'extremely rapid Reading Telegraph', [1835-1869].
K/PP107/1/4/41
Note saying, 'In all Electric Telegraphs, hitherto invented, which present the characters successively to the eye, the rapidity of reading is limited by the time necessary for the eye to dwell on each successive character', [1835-1869].
Rough diagram by John Matthias Augustus Stroh (1828-1914), telegraph engineer and inventor, of a toothed cog attached to an electromagnet [1835-1869].
Sketch diagrams showing key relays of unequal currents on reverse of a letter of receipt from John Mare from Taunton [according to 1871 census an ‘investor in m[e]s[sa]ges’], [1869], page 1.
Sketch diagrams showing key relays of unequal currents on reverse of a letter of receipt from John Mare from Taunton [according to 1871 census an ‘investor in m[e]ss[es]’], 1869 Jul 16, page 2.
Sketches of various apparatus including William Fothergill Cooke (1806-1879) and Wheatstone's five needle telegraph, a bell receiver, a Wheatstone bridge and 'Bain's apparatus' [Alexander Bain (1810-1877), clockmaker and inventor], [1835-1869].
Notes describing an optical telegraph or electromagnetic telegraph, [1835-1869], page 1.
The Papers of Charles Wheatstone
K/PP107/1/4 - Papers relating to the development of the electric telegraph

K/PP107/1/4/45
Notes describing an optical telegraph or electromagnetic telegraph, [1835-1869], page 2.
K/PP107/1/4/46
Colour drawing of Wheatstone's automatic telegraph transmitter, [1858].
K/PP107/1/4/47
Notes describing a recording telegraph using a moving stylus, [1835-1869].
Notes describing improvements for a telegraph dial, [1835-1869], page 1.
The making spring of the armature may be dispensed with by the following means. A cam placed on the axle of one of the inner wheels must be set on the back of the frame. When the cam is not engaging the cam wheel, the pointer free to move and also for half the time the inner wheel, the cam then moves so as to bring the inner wheel.

This plan might be used also for the telegraph, in this case the current would pass in the reverse and letters could come to mind. This plan is only applicable where

1. Causing the armature to revolve by the mechanism thereby engaging with the making spring.

2. Placing the hand or letter inside on a screw wheel instead of the rope wheel.

3. Describing another movement by means of the same magnets at the moment the telegraph begins to act, opposite to the making electric and the armature.

4. Multiple magnets for electric machines for their reversed powers.

5. Relay circuits.
Notes describing the possibility of a telegraph with a detent but without an escapement and telegraphic communication between remote parts of London; on reverse of flyer for a raffle to win a portrait of Michael Faraday (1791-1867), physicist, [1835].
Notes describing an invention 'to enable the indicator of a large dial to be moved rapidly with the same certainty as the indicators of the small dials usually employed,' [1835-1869].
My dear Playfair,

One word again attends this notice of the Corporation at Blackfriars on Monday last. There were two numbers in the sheet, and the notice was to be at Peggy's house.

The house which did not receive any communication from you, but it will not be the worse if you send me another.

E.

2.12.5

1.15

6.7.5

4.

...
My dear Tyndall,

I sent you Rebecchi's curious pamphlet on the method of communicating by electricity from end to end, which I have had in my possession upwards of 20 years. I am enclosing a copy to the other committee, p. 18.
K/PP107/1/4/61
List of experiments using various telegraphic apparatus written by John Matthias Augustus Stroh (1828-1914), telegraph engineer and inventor, [1835-1869], page 1.
List of experiments using various telegraphic apparatus written by John Matthias Augustus Stroh (1828-1914), telegraph engineer and inventor, [1835-1869], page 2.
K/PP107/1/4/62
List of electrical apparatus made by John Matthias Augustus Stroh (1828-1914), telegraph engineer and inventor, including galvanometers, dischargers, rheometers, and electrometers [1835-1869].
List of items for the Meteorological Register including the preparation of a syphon barometer and wet and dry thermometers, a report by a committee consisting of Wheatstone, John Frederic Daniell (1790-1845), Professor of Chemistry at King’s College London, and William Snow Harris (1791-1867), natural philosopher, a telegraph thermometer and a report of the Balloon Committee, 1843 Jul 3, page 1.
List of items for the Meteorological Register including the preparation of a syphon barometer and wet and dry thermometers, a report by a committee consisting of Wheatstone, John Frederic Daniell (1790-1845), Professor of Chemistry at King's College London, and William Snow Harris (1791-1867), natural philosopher, a telegraph thermometer and a report of the Balloon Committee, 1843 Jul 8, page 2.
List of items for the Meteorological Register including the preparation of a syphon barometer and wet and dry thermometers, a report by a committee consisting of Wheatstone, John Frederic Daniell (1790-1845), Professor of Chemistry at King's College London, and William Snow Harris (1791-1867), natural philosopher, a telegraph thermometer and a report of the Balloon Committee, 1843 Jul 3, page 3.