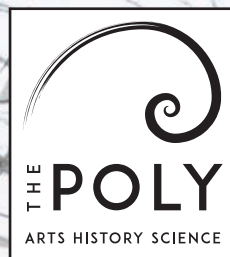
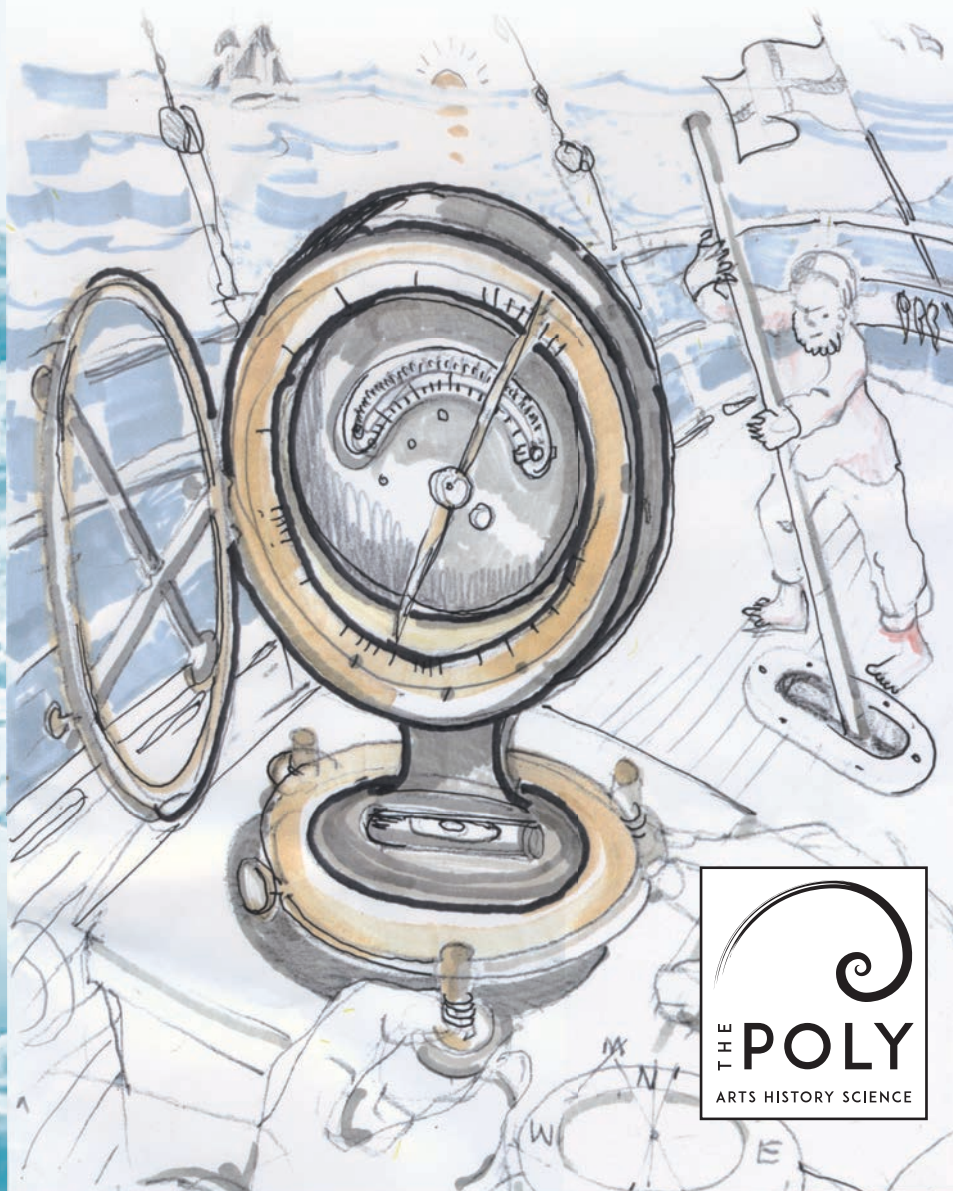


# THE POLY AND THE DIPPING NEEDLE



## 1833 TO TOMORROW

As the Poly continues to support scientific and artistic endeavour in its 187<sup>th</sup> year, I am delighted that the RCPS's talented and innovative founder, Robert Were Fox, is being celebrated with a blue plaque at Rosehill, erected courtesy of the Falmouth Civic Society and supported by Falmouth University. We have also rediscovered the wonders of his dipping needle, critical equipment for mid-19<sup>th</sup> century ships.

Edward Gillin's travels with the original still-working Fox type dipping needle from the Poly's archives have enthralled all of us who have followed his experiments and successes through his messages from St Helena... Cape Town... Mombasa... Zanzibar...

The Poly Board thanks all those who have been involved in these celebrations and in making Edward's adventures a reality.

*Sue Radmore  
Chair*

The Tanner Trust is delighted to have supported this imaginative and exciting project in two ways. First, with funding to repair the dipping needle's case to make it travel-fit for its exciting voyage of discovery, and secondly to fund the preparation and printing of this attractive commemorative booklet.

This fits well with the eclectic aims of the Tanner Trust. My father was an engineer with interests in travelling and new inventions, and would have loved this project, with its many facets, history, exploration, education, invention, a sense of place, and the advancement of science, all of which tally so well with the historic aims of the Poly, the long term repository of Robert Were Fox's dipping needle.

*Lucie Nottingham  
Tanner Trust*

My love affair with brass and mahogany probably started in my childhood when my father brought out an ancient microscope one Sunday lunchtime to look at the microflora of blue cheese. My passion was enflamed by an understanding of cabinet-making, followed by some years at the Telegraph Museum in Porthcurno.

The Fox dipping needle (and especially the carrying case) epitomises everything I hold sacred: invention, ingenuity, practical engineering and attention to detail.

I could not be more delighted that Edward Gillin has opened a new chapter in our understanding of this instrument, and I would like to thank everyone who has helped to make this adventure a reality

*Henrietta Boex  
Falmouth Art Gallery*

Robert Were Fox and his wife Maria lived at Penjerrick mainly during the summer months with their three children Anna Maria, Barclay and Caroline. He and Barclay were interested in plant acclimatisation, and they worked on this, creating the valley garden and digging out ponds.

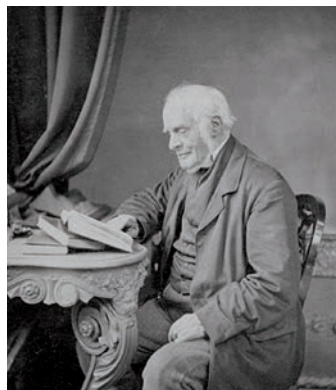
Open to the public, it is now a somewhat wild, uncommercialised garden, featuring rhododendrons, azaleas, camellias and huge magnolias, along with some vast original tree ferns and magnificent trees.

I am very happy that Robert Were's dipping needle has been brought back to Penjerrick, and to find that after nearly two centuries, it is still as accurate as when he designed it.

*Rachel Morin  
Penjerrick*

## ROBERT WERE FOX AND THE POLY

In 1833 the head of the prominent Falmouth firm G.C. Fox & Co was Robert Were Fox (the Younger) – a geologist, natural philosopher, and inventor. The main business of the firm was as ship agents, but with strong interests in copper mining, tin smelting, and foundry work, which provided the perfect environment for Fox's research into geology, electricity and magnetism. He wrote many papers for scientific journals, was a Fellow of the Royal Society, and a member of two scientific societies in America. His scientific interests and friendships stretched far beyond the Tamar.

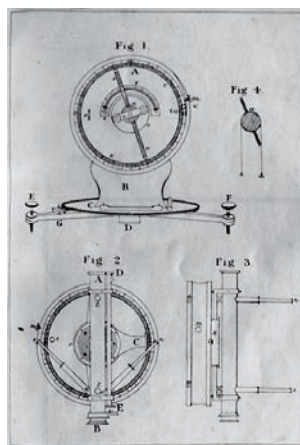


*Robert Were Fox*

Robert Were encouraged his daughters, Anna Maria (17) and Caroline (14), to take an interest in the lives and ideas of the workers in the firm's Perran Foundry, as they were constantly bringing fresh and clever suggestions to the attention of Charles Fox, the family member in charge of the foundry.

As a result, the two daughters, encouraged by their brother Barclay, proposed the formation of a society to inspire fresh ideas, and to promote an annual exhibition to demonstrate new inventions. In Robert Were's copies of the Society's early Annual Reports are unique drawings of some of his own inventions, including, in 1835, the design of his Dipping Needle.

The Cornwall Polytechnic Society was formed in 1833, the first of its kind in England.

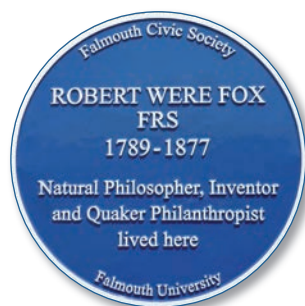


*First published design for the Dipping Needle*

In 1835 William IV bestowed Royal patronage on the new society, and in the same year the decision was taken to build a great Polytechnic Hall, where exhibitions of the arts and sciences were to be held annually.

The Poly continues to this day as an arts centre, with a remit to encourage and support artistic, creative and technological endeavour and innovation.

To recognise Robert Were Fox's scientific enterprise, a Blue Plaque has been installed by the Falmouth Civic Society at his home, Rosehill, which is now part of Falmouth University

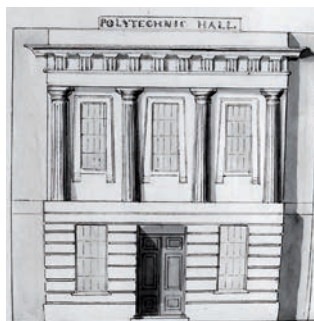


## THE POLY AND THE DIPPING NEEDLE

A little over 180 years ago, in October 1839, two ships passed off the coast of the Lizard, bound for the Antarctic. Under the command of the dashing Captain James Clark Ross, the Royal Navy's *Erebus* and *Terror* had been tasked with locating the magnetic South Pole and measuring the Earth's magnetic field in the Southern Hemisphere. To do this, both ships carried incredibly delicate magnetic instruments, known as 'dipping needles'. In the 1840s, these were some of the most sophisticated scientific machines in the world. Those on board the *Erebus* and *Terror* had been designed by Robert Were Fox, and built in Falmouth.

Throughout the 1840s, almost every British naval expedition carried similar instruments for magnetic measurements, as did very many other vessels. Today few survive. But, hidden in the Polytechnic Hall, and lately in the Falmouth Art Gallery, the Royal Cornwall Polytechnic Society has kept one of the last of these crucial devices which were so central to the development of Victorian science.

For many years the Art Gallery and Falmouth Town Council have supported the Poly very generously.



*Polytechnic Hall*

*this is where the magnetic needle lay –  
the dusty shelf of a near-forgotten  
storage space  
unused for years*

*it slept longer than ever  
the Sleeping Beauty did  
and when found astounded everyone –  
magnetism was still alive  
in its newly woken finger*

In April 2019 Dr Edward Gillin wrote to ask if the Society held any archive material relating to science in Cornwall in the 19<sup>th</sup> century. In due course he was invited to the basement of the Falmouth Art Gallery, and Robert Were Fox's dipping needle was unwrapped and displayed. Taken from its handsome case and assembled, its intricacy and beauty were revealed. Excitingly, and somewhat unbelievably, after more than 100 motionless years, the Poly's Fox needle was still magnetised, and potentially capable of taking a dip reading.



*Edward Gillin*

This discovery inspired Edward's proposal that the needle should be tested, both at home and abroad, to discover whether it remained as accurate as in its heyday. By chance, he happened to be already booked for a sea voyage half way round the world. He takes up the story:

Bringing the instrument to Robert Were Fox's original testing site, Penjerrick Garden, just outside of Falmouth, we performed our first set of magnetic observations.

With our base station at Penjerrick established, the needle travelled to Bristol, where we conducted an experiment on Isambard Kingdom Brunel's *SS Great Britain* and examined the strong disturbing influence of the ship's iron on the needle.

From Bristol, the Poly's Fox dipping needle departed on what might be her last voyage. Throughout January and February 2020 the needle followed the route of James Clark Ross's Antarctic expedition aboard HMS *Erebus* and HMS *Terror* as far as Cape Town.



*Rachel Morin and Michael Carver in Penjerrick Garden*

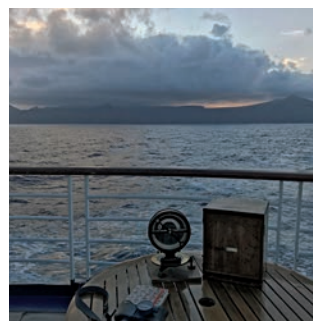


*Bristol - aboard the S.S. Great Britain*

Performing magnetic observations and measuring the Earth's magnetic dip and intensity both at sea and on land, we travelled to Cape Verde, then across the Equator into the Southern Hemisphere. We reached the island of St Helena almost 180 years to the day of Ross's arrival and then continued to Cape Town.

With the North and South Magnetic Poles being the places of greatest magnetic intensity, which would make the needle sit at 90 degrees, the Equatorial regions provided a real test of the instrument's accuracy.

Passing through the Equator, the needle gave dip measurements of almost zero degrees, showing that we were at the globe's place of least magnetic intensity. As we then sailed south, the intensity increased as we got nearer the South Pole.



*St Helena*



Professor Crosbie Smith

What impressed both my able assistant, Professor Crosbie Smith, and myself throughout the Fox needle's travels, was the extraordinary number of different ways the instrument can be used to measure magnetic dip and intensity. Fox provided the users of his device with an unprecedented package of tools for scrutinising terrestrial magnetism.

## WHAT IS A DIPPING NEEDLE?

A dipping needle is basically a magnetic compass, only instead of the needle sitting horizontally, it oscillates vertically, so as to measure the angle and intensity at which the Earth's magnetic field is acting. This is a very simple device in principle, but most of those built in the nineteenth century were delicate and travelled poorly.

On the *Erebus* in 1839 Ross took a 7-inch needle, and on the *Terror*, under Captain Crozier, a smaller 4-inch, which might be, as Edward Sabine put it, *'regarded by many persons as scarcely more than a philosophical toy ... It has, however, in Captain Crozier's hands, fully justified the expectations which Mr. Fox, from his own experiments with it, had ventured to entertain.'*

This is why the Fox needle was so important: it was robust, travelled relatively well, and was specially designed to take magnetic readings on rough seas. Fox's dipping needles were intended to help solve the most urgent scientific problem of the mid-nineteenth century: how did the earth's mysterious magnetic forces operate?



Needle with various tools

## THE MAGNETIC CRUSADE

During the 1830s and 1840s, ships were wrecked or went missing at an alarming rate, especially with the increased use of iron for hulls, largely due to unreliable compass readings caused by variations in terrestrial magnetism.

It's very likely that magnetic interference caused an error with the compass of Brunel's SS *Great Britain*, which steamed straight into Dundrum Bay on the coast of Ireland in 1846, despite the crew believing they were heading out into the Atlantic.



*SS Great Britain aground in Dundrum Bay, Ireland*

*a trickster perhaps?*

*the ancient lodestone*

*at the earth's tumbling core*

*changes position*

*moves its poles*

*only the birds are not fooled*

*need no compass*

*as they fly south or north*

*following magnetic highways of the air*

As magnetic north wandered, so compasses required adjusting in relation to charts to remain accurate. After a lobbying campaign under the leadership of Edward Sabine, a member of the RCPS, and John Herschel, the British government launched a huge surveying of the magnetic properties of the Earth in what became celebrated as the 'Magnetic Crusade'. Sending out ships to perform magnetic measurements and establishing observatories at Toronto, Tasmania, Cape Town, and St Helena, this was the largest state-funded scientific venture to date - the world's first truly global scientific survey, and Falmouth was at the absolute centre of this project.

Along with the production of charts showing terrestrial magnetic phenomena, which could help with navigation, Fox's dipping needle recorded data that had scientific implications. One of the most celebrated achievements of the magnetic surveying of the globe was the discovery that the earth's magnetism fluctuated in relation to sunspots: solar flares released electrical currents that influenced the earth's magnetism, the Aurora Borealis being a visible manifestation of this phenomenon. Fox and his dipping needle had put Falmouth and the Poly at the heart of Victorian science.

## FOX'S DIPPING NEEDLE

Almost identical to those used in Ross's expedition to the Southern Hemisphere between 1839 and 1843, the Poly's Fox type needle was built in Falmouth at some point between 1841 and 1845. It is the work of the instrument maker William George, a close associate of Fox. George had been foreman to Thomas Jordan, who had helped Fox design and build the dipping needles for the *Erebus* and *Terror*. When Jordan moved to London in the early 1840s, George took over as Fox's favoured instrument maker.

In 1841 Robert Were Fox introduced William George to Edward Sabine as a new builder of dip needles:

*'I do not know where another is to be found in whom I can feel the same confidence as it respects the more delicate parts of the instrument.'*



*The Needle*

Fox used his two subtropical gardens, at Rosehill and Penjerrick in Falmouth, to test his needles, and also as places where naval officers could go for training in how to use the instrument. Gardens were very valuable because they were relatively free of magnetic interference and allowed the integrity of a dipping needle to be ascertained. They were very sensitive instruments; even iron nails and certain types of rock could interfere with magnetic measurements, so it was essential to keep these devices as far away from buildings as possible when taking observations.



*Penjerrick Garden*

## HOW TO USE A FOX DIPPING NEEDLE

Declination, or 'deviation', is simply the difference between geographical north, as shown on any map, and the Magnetic North Pole, which has no fixed location. To calculate this, you determine where the geographical north pole is, either by the North Star or a land reference, and then compare this with the direction of a compass needle pointing to magnetic north. The difference between these, measured in degrees, is the magnetic declination. Once you know this, you can adjust your ship's compass accordingly and use your map in relation to this correction.

But the earth's magnetic field also pulls down on a magnetic needle placed horizontally: this is known as 'dip', and the force with which the needle is pulled is known as 'intensity'. Fox's needle was designed to measure these two properties. All one



*Lisbon*

had to do, was point the needle towards the magnetic north pole, measure the angle shown, giving the dip, and then apply weights to the needle to measure intensity.

*'At sea, when the manipulation of the weights causes an exposure of the needle, which, in bad weather particularly, is liable to occasion injury, the plan recommended by Mr Fox, of using deflecting magnets instead of weights, was frequently resorted to.'*



Needle back with magnet

## FOX TYPES AROUND THE WORLD

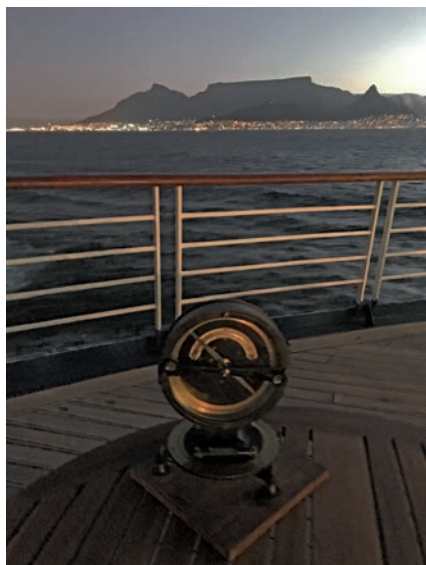
After Ross's exploration of Antarctica between 1839 and 1843, Fox dipping needles became the Royal Navy standard for on-board magnetic observations, and would be taken on a series of daring voyages of discovery around the world. In 1841 the ill-fated Niger Expedition carried one deep into central West Africa. Despite Yellow Fever and Malaria ravaging the crew and forcing the three ships to abandon the enterprise, magnetic observations continued throughout.

Captain Edward Belcher took a brand new Fox type with him aboard HMS *Samarang* in 1844. During the following six years he would use this to magnetically survey the largely uncharted seas and islands of Korea, Japan, Borneo, and the Philippines.

Onshore experiments often proved extremely risky, with Belcher's crew having to construct make-do observatories. On one occasion, on an island just off Borneo, the crew were set upon by local pirates and had to flee their temporary observatory, clutching their scientific instruments, with the iron of the pirates' spears disrupting the magnetism of the needle.

On another, with no land being found along a mangrove coast, Belcher ordered two trees to be cut down, wooden planking to be thrown across the stumps, and the Fox type mounted on the observation site amid the dense jungle.

Between 1846 and 1850 HMS *Rattlesnake* circumnavigated the globe under Captain Owen Stanley's command, employing a Fox dipping needle for measurements from Cape Town to Ceylon, Singapore, Australia's north coast, the Pacific, and the Falklands.



Cape Town

*'It had sat on his lap across the great desert, sailed in his cabin over the Atlantic, the Pacific & the Indian Oceans & been his companion in his solitary home on the borders of Siam.'*

*never separated from his 'companion'  
during 50,000 miles of travel*

*the 'darling child' sat on Captain Stanley's lap  
crossed the desert like a friendly pet dog*

*sailed with him over the world's great oceans  
comfortably ensconced in his cabin*

On an earlier voyage to the Arctic, Captain Stanley could not find magnetic intensity with the weights  
*'being so small & delicate as not to be easily handled with cold fingers.'*

However, it was Sir John Franklin's disastrous expedition to the Arctic on HMS *Erebus* and HMS *Terror* that would be best remembered. Sailing from England in May 1845, Franklin's expedition arrived late in the polar regions of northern Canada, and soon got trapped in the ice. After over two years, the starving crews abandoned their ships and tried to find their way south.

None would survive.

Franklin's expedition also carried a Fox type, but this was almost certainly left behind on HMS *Erebus*, having been a poor instrument, according to Captain James Fitzjames. In the last letters from the expedition, he lamented that his Fox was "rotten", poorly built and inaccurate. With the magnetic measurements never retrieved, we don't know whether he got it working later in the voyage.

Years later, in 1859, a rescue expedition found debris from the doomed expedition, including an abandoned magnetic dipping needle, built by Robinson of London. It would seem that, amid the ensuing calamity, magnetic observations continued until the very end: dipping needles were treasured possessions, only discarded in the very worst conditions.

But somewhere below the icy arctic waters, on *Terror* or *Erebus*, a Fox needle still rests, awaiting rediscovery.



*The needle with weights*



*we once tracked the Poles  
like celestial bloodhounds  
how lucky I was to go back*

*now I'm returned  
to my home by the sea  
my own safe haven    Falmouth*



Front cover	Norman Lister
Poetry	Caroline Carver
Text and Photography	Edward Gillin
Design	Steve Collinson
Editor	Michael Carver



**85° 47' N, 176° 9' E**

*There are four north poles but this is the true one  
unmarked, unvisited, on its bed of floating ice*

*not fixed as the Geographic Pole is, holding,  
like an Olympian charioteer, the reins of longitude together*

*not wandering like its Magnetic brother,  
considering travel options and when it will arrive in Russia*

*not a time nomad like the Geomagnetic Pole,  
counting in centillions, planning its move South*

*(the Pole of Inaccessibility sighs like an octogenarian  
whale when Geomagnetic's referred to as "True North")*

*no under its air-blanket of Northern Lights  
the Pole of Inaccessibility a Rapunzel ice-maiden*

*lies in a Shangri-La of frozen Arctic Ocean  
waiting for explorers who never come*

*although they may send messages –  
lately, a Coca-Cola can*

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