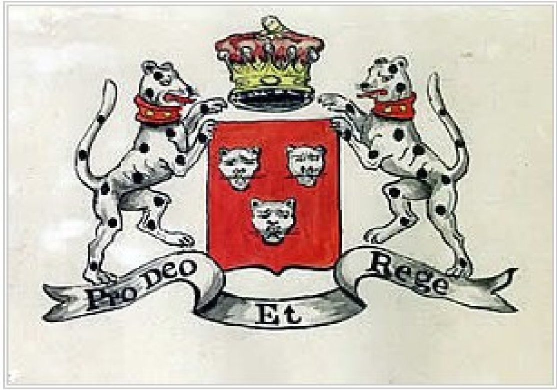
The Family Parsons, of Parsonstown, Kings County. (now, Birr Co. Offaly)



(for God and King) [P.D.]

(Birr Castle) [http://creativecommons.org/licenses/by-sa/3.0/]

A Vignette: Circa 1590, five English brothers, the Parsons, arrived in Ireland and proceeded to make their fortune. They were the nephews of Sir Geoffrey Fenton, Secretary of State to Queen Elizabeth I.

We may note two of them, Sir William (1570-1650) and his younger brother Sir Laurence (1637-98).

William settled in Co. Wexford, near New Ross. He was one of the Lord Justices of Ireland, serving from 1640 to 1643 and also served as Surveyor General of Ireland. William was known as a "land-hunter", expropriating land from owners whose titles were deemed defective.

He was created 1st Baronet of Bellamont in 1570 and a male descendant became Viscount Rosse in 1681.

The second Viscount, Richard Parsons was honoured with the Title Earl of Rosse by Charles II in 1681. However, the 2nd Earl died without a male heir in 1764 and so the title became extinct.

Through his connection with Robert Boyle (later Lord Cork) Laurence Parsons acquired the historic Myrtle Grove in Youghal, Co. Cork, *(a former home of Sir Walter Raleigh).* Laurence held several Munster-based government positions and was knighted in 1620. That same year, after 'swopping' his interest in a property near Cadamstown with Sir Robert Meredith for the latter's 1,000 acres at Birr, Kings Co., he was granted letters patent to *'the Castle, fort and Lands of Birr'.* Here he constructed a new castle on the site of the O'Carrolls 'Black Castle'.

In 1677, his descendent, Sir Laurence Parsons was created 1st Baronet of Birr, and despite temporary evacuation due to wars, successive generations of the Parsons have lived at Birr Castle since this time. The 7th Earl is now in residence.

Sir Laurence's son Richard Parsons succeeded his father in 1628 until his death without heir in 1634. The estate then passed to Sir Laurence's brother William who's descendent, yet another Laurence (1749-1807), was created Baron (1792) and then Viscount Oxmantown (1795).

In 1807 the Earldom of Rosse was recreated and granted to Laurence who became the 1st Earl of Rosse under this second creation. His nephew Lawrence Harman Parsons became the 2nd Earl, and the line has remained direct since this time.

………

We now come to the 3rd Earl, a man of principal interest:

William Parsons 3rd Earl of Rosse (b1800 d 1876)- Knight of the Order of St Patrick, President of the Royal Society, Hon Fellow of Royal Society of Edinburgh, Hon Member Institute of Civil Engineers, Member of the Imperial Academy of St Petersburg, Knight of the Legion of Honour, Astronomer, Engineer, and Naturalist.

William was the eldest male of five children and was born on the 17th of June 1800. As the eldest son and heir, he bore the title of Lord Oxmantown and on the death of his father in 1841 the Earl of Rosse.
From the honours noted above we see that William the 3rd Earl had a rich and illustrious career and is best known for his contributions to astronomy.

For two years he attended Trinity College, Dublin and then transferred to Magdalene College, Oxford, where in 1822 he graduated with first class honours in Mathematics. In 1823, like his father, he entered Parliament, representing King's County (today Co. Offaly). Following his convictions, he honourably voted in favour of Catholic Emancipation and the Reform Bill. However, William decided that the politician's life was not for him and resigned his seat in 1834. He returned to Birr Castle where he spent most of his time until his later years – and so the story of astronomy at Birr begins.

First let us define the then two types of telescopes in use for astronomy.

A Quick history of the Telescope: Possibly the earliest known useful telescope appeared in 1608 in the Netherlands, when a patent was submitted by Hans Lippershey, an eyeglass maker. Although Lippershey did not receive his patent, news of the invention soon spread across Europe. These early Refracting telescopes consisted of a convex objective lens and a concave eyepiece. Galileo improved on this design the following year and applied it to astronomy. In 1611 Johannes Kepler described how a far more useful telescope could be made with a convex objective lens and a convex eyepiece lens, figure 1. By 1655, astronomers such as Christiaan Huygens were building powerful but unwieldy 'Keplerian' telescopes with compound eyepieces.
The effectiveness of this form of telescope obviously depended on the quality of its lenses and here lay the problem in the 19th century. Lens makers had to perfect the manufacture of high-quality optical glass and find ways to avoid the smearing of colours by lenses (*chromatic aberration*). Until the early part of the twentieth century, glassmaking was more a craft than a science. Optical glass had to be very free of defects and residual colour. Ways of dealing with impurities in the sand used for glassmaking which caused tinting of the glass and the elimination of tiny bubbles or other defects which made the glass useless for lenses had yet to be found.

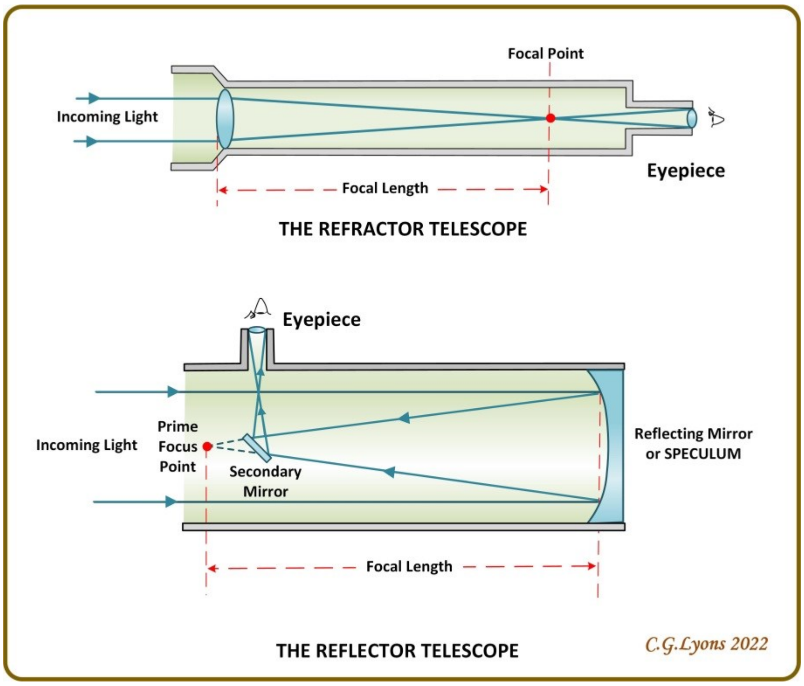


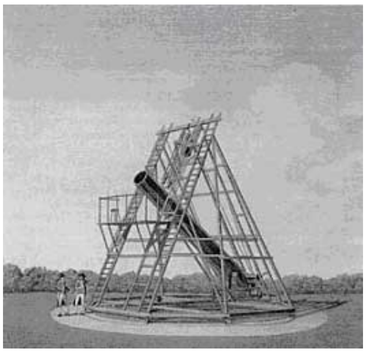
Figure 1. Schematic of Telescopes. [Author]

Because of these problems other types of telescopes had been found. As early as 1688 Isaac Newton built the first reflector telescope with a design that incorporated a small flat diagonal mirror to reflect the light to an eyepiece mounted on the side of the telescope, figure 1.

Important developments in reflecting telescopes were John Hadley's production of larger parabolic mirrors in 1721. Around this time, with help from his two brothers, he began to experiment with the grinding and polishing of metal mirrors. He used speculum, (a combination of bronze and silver used for mirrors since ancient times). By 1721, he had succeeded in making a 6-inch-diameter reflector (Newtonian) telescope with a focal length of 62 inches. Hadley managed to polish his metal mirror so that it had an approximately parabolic shape, so avoiding the distortion in previous telescopes with spherical curves. Hadley first showed off his telescope at a meeting of the Royal Society. Records from this meeting say that it was powerful enough to *"enlarge an object near two hundred times"*.

By the late 1770s, a William Herschel had built several reflectors. His most successful one had a 6-inch (15.25cm) mirror and was 7 feet (2.1m) long. He used this telescope to compile the first substantial catalogue of double stars and, in 1781, to discover the planet Uranus.

Figure 2. Herschel's 20-foot Telescope. [P.D.]



Encouraged by his success, Herschel spent the next several years perfecting an even bigger telescope. It featured a mirror nearly 19 inches (48.25cm) in diameter, encased in a tube 20 feet (6m) long, again on an altazimuth mount. (A simple two-axis mount for supporting and rotating the instrument about two perpendicular axes – one vertical and the other horizontal).

Like other early telescope mirrors, it was made mostly of copper and tin and tarnished quickly, so it had to be re-polished often. The base of the telescope could be opened, and the mirror easily removed. Another mirror was always on hand to use while the first was being polished.

In 1783, using the 20-foot reflector, Herschel began to search the night skies for the dim patches of light in the skies called nebulae.

By 1784, Herschel reported that his telescope could resolve individual stars in nebulae previously identified by the French astronomer Charles Messier and that he had also found hundreds of new nebulae.

William did his observations with the assistance of his sister Caroline. The telescope's eyepiece was mounted at the top of the tube, so Herschel observed from a platform that could be raised or lowered as needed. Caroline sat at a window in the nearby house. When William signalled by pulling a string, she would open the window and record her brother's observations as he called them down to her.

Observing was arduous. Herschel went out whenever possible, even in bitter cold. One night, while using an earlier telescope, the ink froze in its bottle and his best mirror cracked into two. Observing from the high perch was also hazardous. Caroline recorded that she and her brother were involved in a *"pretty long list of accidents which were proving nearly fatal to my brother as well as myself "*.

Herschel's 20-foot telescope was the best of his instruments. In 1785, he began to design a telescope that was twice the size and so could collect four times as much light. Its reflecting mirror was 48 inches (122cm) and the tube was 40 feet (12.2m) long. He began using this telescope in the autumn of 1789 and quickly found two more satellites of Saturn - Mimas and Enceladus. However, the long telescope tube tended to bend and the frequent need to re-polish the main mirror limited its usefulness. Herschel used this cumbersome giant only occasionally, preferring the more manageable 20-foot instrument.

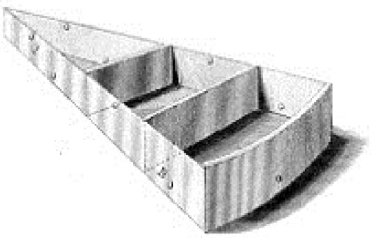
Unfortunately for William Parsons, Herschel, who died in 1822, was like many other innovators in the area and never published any details of his engineering methods in telescopes, their mounting, the casting of reflecting mirrors or of their grinding to shape and polishing. So, William, who had determined that the reflector telescope was the type for his work, was left to start from scratch. Here William's as yet untested abilities in engineering and materials science came to the fore. He designed, built, and used a number of telescopes along with his wife, the Rt Hon. Mary Parsons (née Field), who was also an accomplished blacksmith and a pioneering photographer.

William Parsons 3rd Earl of Rosse.

William started with smaller structures and after a lengthy and scientific step-by-step process, with some heart-breaking failures, found success in the manufacture of large mirrors.

All this work took place in rural Parsonstown and so furnaces had to be built and local men trained in the engineering arts of manufacture and metal casting. This was overseen by the 3rd Earl and he showed an extraordinary natural talent for engineering methods. In this he had the constant support of his remarkable wife.

During the long 'experimental' stage of his work he determined that the, then, ideal material for reflecting mirrors was a speculum metal composed of 2.14 parts copper and 1 of tin. Mirrors made with this alloy had a wonderful silvery lustre and a reflectivity of 60% but, are extremely brittle and prone to cracking whilst cooling after being cast. This fact was what tormented William for so long.



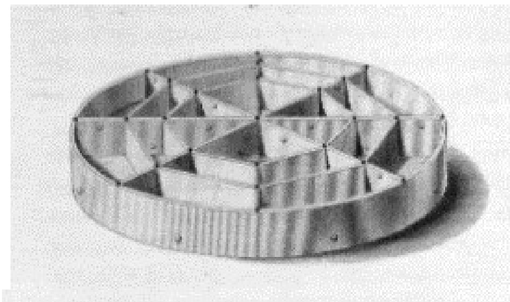
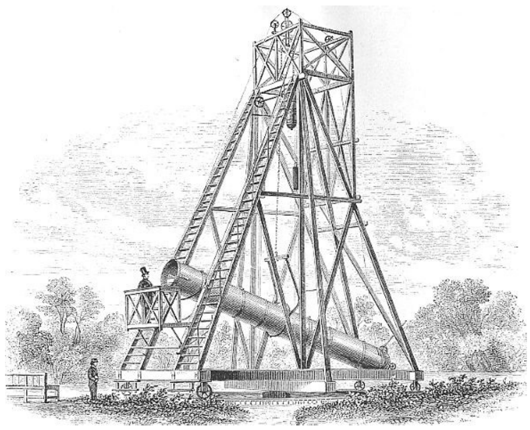


Figure 3. Various skeletal structures for Specula. [P.D.]

He spent much time devising specula composed of various sections of a cylinder overlaid with a 'tiling' of reflecting material, figure 3; none of these were successful and finally William decided on casting the speculum as a single piece.

Figure 4. The Birr 3-foot Mirror Telescope. [P.D.]



Much further work was put into the details of the mould until William arrived at the correct configuration of the mould's base and the degree of 'wetness' for the sand which made up its side. The base comprised a number of 'hoop' rings of iron with sufficiently small gaps between them to allow the escape of gases but not allow the flow-through of molten speculum metal. The rings of iron were shaped to have a convex spherical surface close to the required parabolic shape for the speculum. The mirror was thus cast reflecting surface downwards. When the molten speculum metal was poured the iron hoops forming the mould surface, due to their high thermal conductivity, bought about –

-cooling from this face upwards, thereby avoiding fissures and other casting problems. So, by the clever application of science, engineering, and trial and error, the earl devised the solution and succeeded in making the large 3-foot mirrors.

Of course, the mirror having been cast had to have its reflecting surface ground and polished to a concave parabolic shape. To accomplish this William Parsons designed and built an ingenious grinding and polishing machine as well as the steam engine to drive it. At the same time, again with lengthy experiment, he found the recipes for best combinations of grinding/polishing materials for both procedures (a model of this machine is displayed in Case 3).

Speculum metal also had the unfortunate property of tarnishing when exposed to moist air and so a mirror needed constant re-polishing to maintain its function. The Earl's creation of the grinding/polishing machine made this much a simpler task than previous manual processes (see later).

Because the specula were prone to tarnishing, at least two mirrors were required for a telescope so that when one was undergoing re-polishing the other could be fitted.

William's first great success in 1839 was his 36inch (91cm) speculum reflector telescope, figure 4, and with this he discovered the remarkable spiral shape of many objects then classed as "nebulae" - now known to be individual galaxies.

William studied and named the Crab Nebula. He also made detailed observations of the Orion Nebula. He made drawings of the nebulae, displaying another talent as an excellent draughtsman (the mind boggles at the patience and stamina needed to stand on the viewing platform in the, often, bitter cold to accomplish this task).

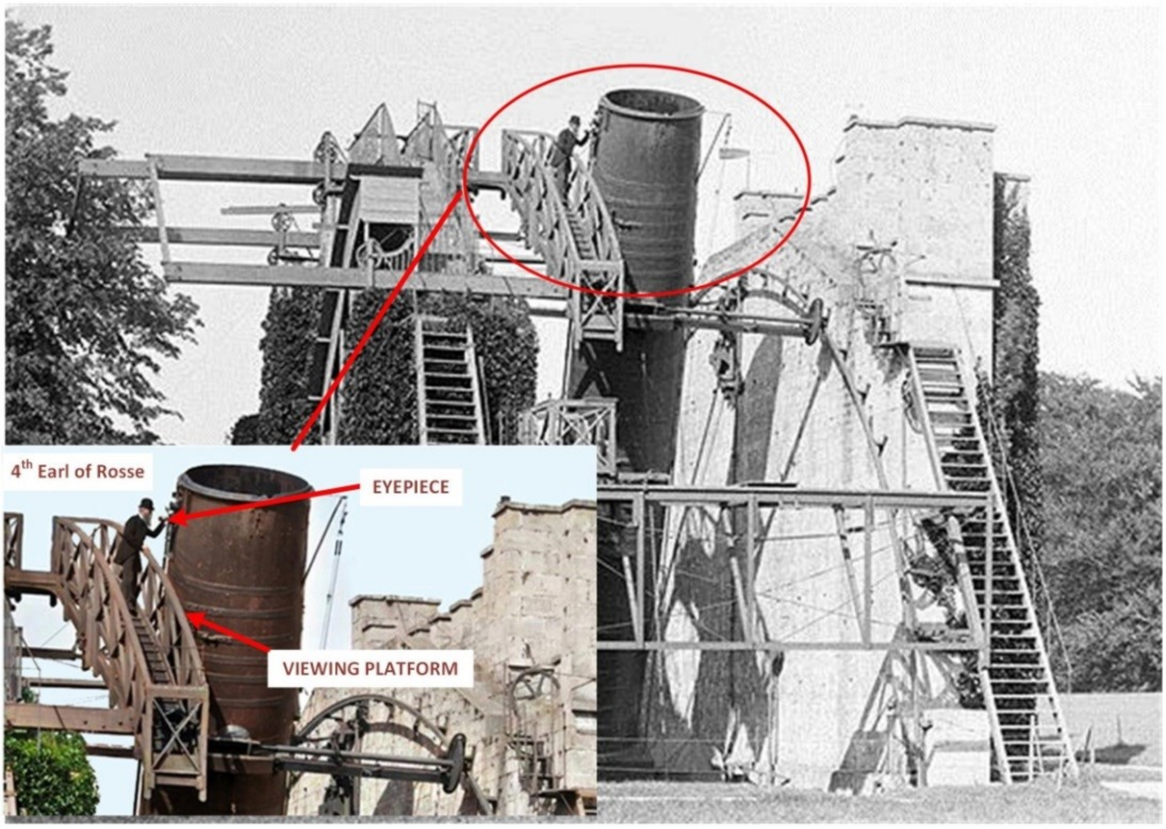


Figure 5. The Leviathan of Rosse Castle (insert shows the 4th Earl on viewing platform & the eyepiece) [P.D.]

Inspired by the results of this telescope William went on to create an even larger one and so in 1842 he began work on what came to be known as the 'Leviathan of Birr' - his 72inch (183cm) telescope.

This instrument must be considered a quite remarkable piece of Victorian engineering and for this alone William Parsons must be listed as one of "Notables" of Ireland's technological history.

Fortunately, William's hard-earned experiences with the smaller telescope, along with his engineering and materials knowledge made creation of the great telescope somewhat more straightforward. However, among the new problems which he faced was that the 6-foot mirror required 3 times more speculum metal than its 3-foot 'little brother'. This was too much metal for a single crucible and so William had to create a new small foundry at Birr. This he did with great ingenuity, setting up a system comprised of a crane, 3 crucibles, a new mould and an annealing oven, figure 6. From this image we may note two buildings, a furnace system, and an annealing oven. In the 1st building were three turf fired furnaces of 1.2 metres diameter and 1.8 metres deep above them sat iron grids some 21cm thick on which rested the crucibles while the speculum metal was slowly brought to a molten state. The 3 furnaces vented through a single square brick-built chimney. On reaching the required temperature the crucibles were raised by the crane and placed in rings swinging on trunnions about the mould and in the Earl's words, *"….and at a signal the crucibles were simultaneously inverted as rapidly as possible. The pouring was accomplished in about three seconds. If the metal was not poured rapidly, the conducting power of the iron surface* (of the moulds base) *is so great that partial solidification would take place, and the casting would be imperfect…".* [5] In about twenty minutes the speculum metal was solid throughout.

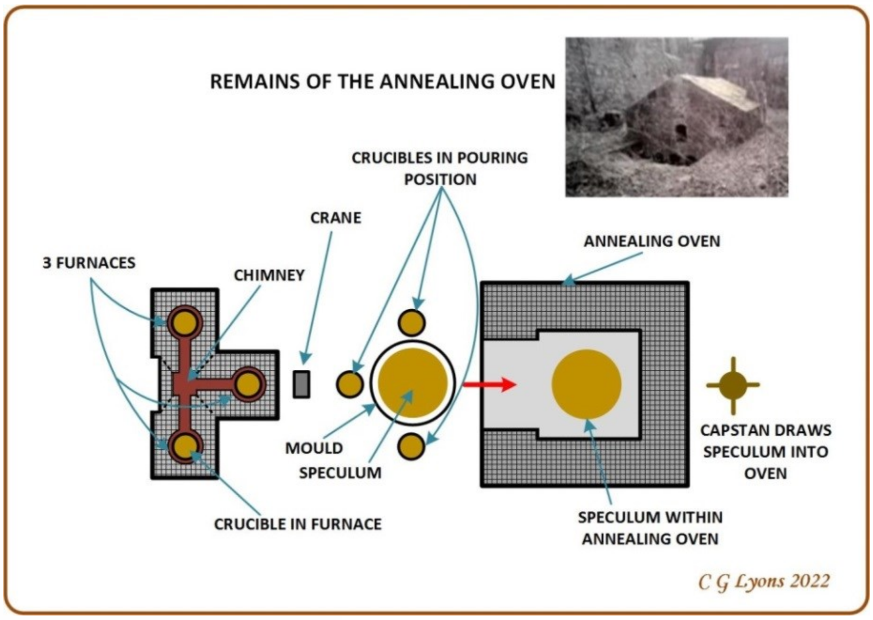


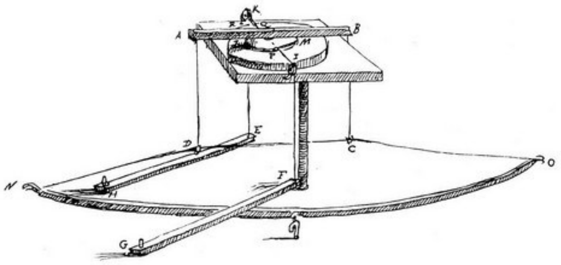
Figure 6. The Speculum Casting and Annealing System

The sand forming the sides of the mould of the mould was then removed and the speculum now enclosed by an iron ring was drawn into the annealing oven by means of a capstan. The temperature of the annealing oven was ~ 480^{0}C. All the oven's apertures were then closed; and with frequent attention the oven and the speculum were allowed to become cool over a period of about six weeks.

Various new problems vexed the project, but with step-by-step progress, after the casting of six faulty mirrors, at last two new ones were successful. So, after their grinding and polishing (see next section) being completed by 1845 the 16metre long telescope with its 4tonne mirror was ready for use, figure 5.

The 3rd Earls Grinding/Polishing Machine.

Background. The use of machinery for the polishing of optical devices goes back to the 16th century. There is evidence that Leonardo da Vinci imagined machines to grind/polish telescopes. However, there is no evidence that any of them were constructed. During the 17th century some progress in the manufacture of quality glass for telescopes and refractors lenses saw the beginning of the use of grinding machines the principles of which had been devised by Rene Descartes, Christiaan Huygens, Robert Hooke, and others.



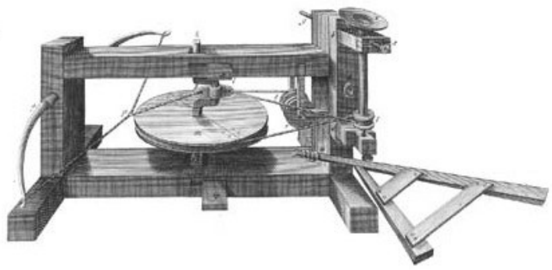


Figure 7. Lens Polishing Machines

Huygens (1683) [P.D] Anon. **Lens Machine (1670).**[P.D.]

These machines were for small lenses and as the use of Speculum mirrors for Newtonian Telescopes increased so the demand for larger and larger mirrors occurred and more sophisticated machinery was required.

We then come to William Herschel who in 1788 built a polishing machine that allowed him to 'finish' a 48inch (122 cm) speculum. Unfortunately, no description of this machine can be unearthed, and Herschel took its secrets to the grave. He did say its fabrication was necessary to replace the number of workers necessary to complete his larger mirrors (sometimes up to a dozen men). The only evidence of Herschel's polishing devices is a small polishing machine which can be seen at his museum in Bath, England, figure 8.

Figure 8. An early Herschel Mirror Polishing Machine. [P.D.]

When William Parsons successfully engineered his 3-foot mirrors they needed to be ground to a concave parabolic form and then polished. For this purpose, he then designed and built his grinding-polishing machine, the side view of which shown in figure 9. As previously stated, he also created a small steam engine to drive the machine. (What is of note is that this was a rotary engine!)

The grinding machine had a train of driven pulleys initially operated by leather drive belts. The driven speed of rotation of each axle decreases as we move from the first to the last (left to right in figure 9).

(E) is an adjustable eccentric with a variation of up to 18inches (46cm) as it is moved away from its axle centre, (J) is another such, again adjustable to 47cm.

(C.) is a water bath within which sat the revolving table (I) on which was mounted the speculum. The temperature of the water bath was maintained at 13$^{\mathrm{O}}$ C and the water filled the tank to within 2.5cm of the speculum's surface. The grinding or polishing plates hung from cables connected to one side of a lever arm (L) and from its other side hung a counterweight. The mass of this weight could be altered so controlling the precise, and repeatable, operating force acting on the grinding/polishing disc.

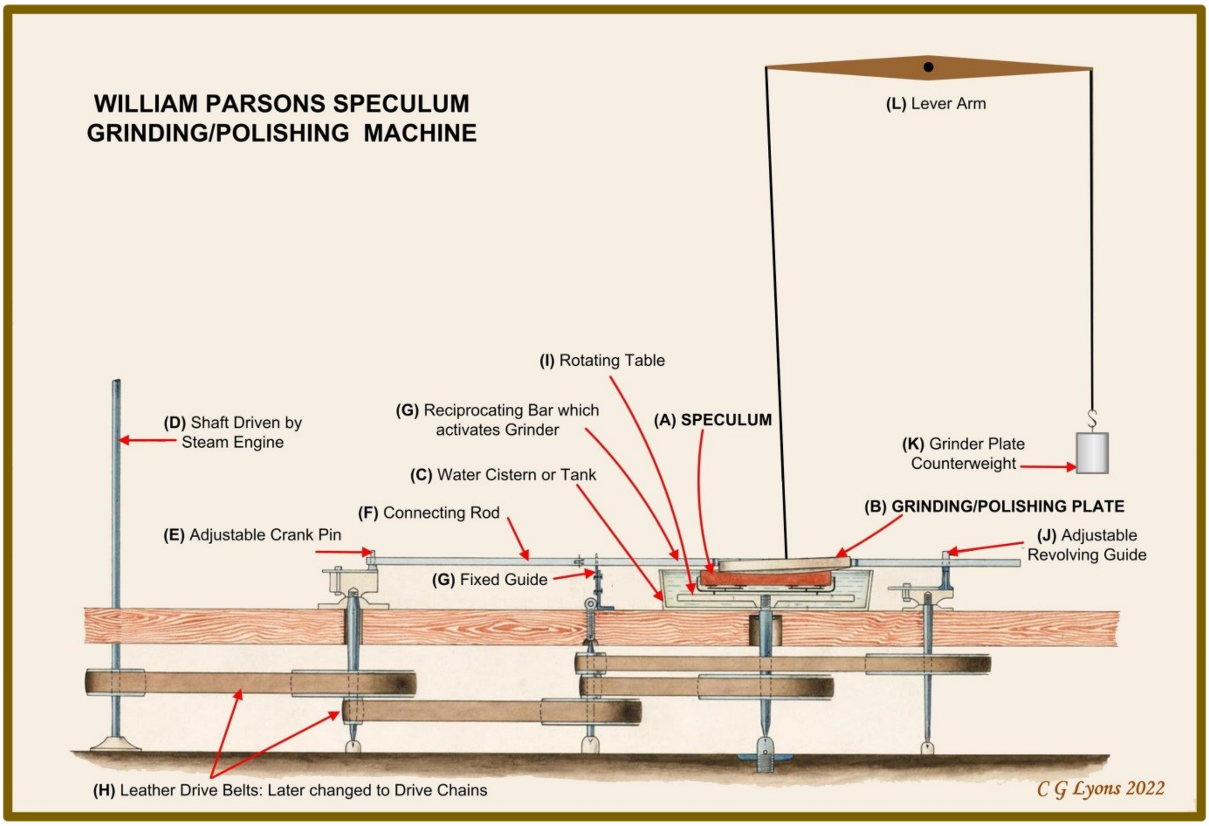


Figure 9. Side view of the Grinding/Polishing Machine

Acting through (F) the connecting rod, the effect of changing the value (E) is to vary the magnitude of the driving ring's lateral movement and changes to (J) its transverse motion. The grinding, or polishing tool, being loosely sat inside the driving ring thus moves to and fro across the speculum. So, by specific settings the eccentrics the polishing process could take the speculum through from being a convex spherical surface to a parabolic one and as grinding approached completion the speed was reduced. Figure 10 illustrates the motion of various elements of the machine

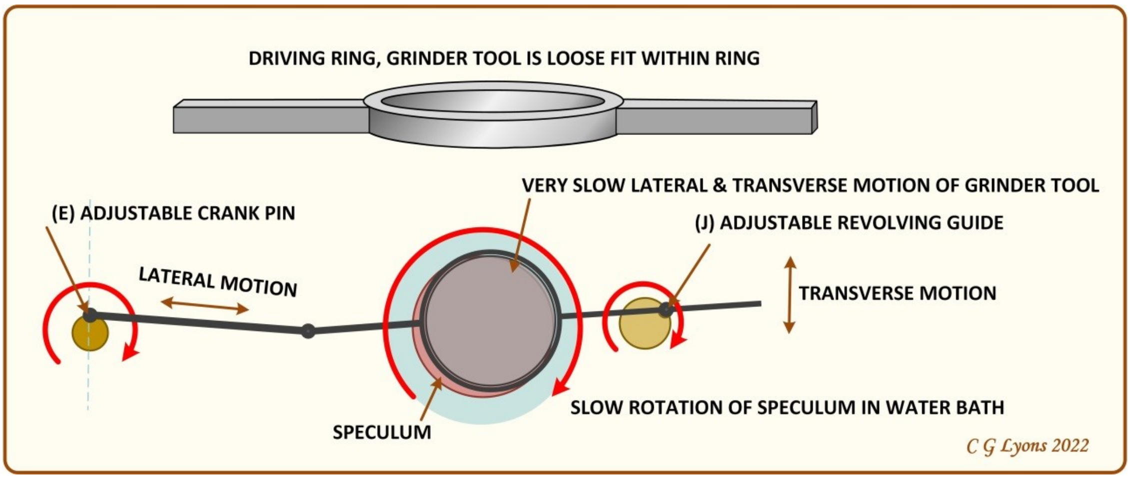


Figure 10. A view of the mechanism for Grinder/Polisher movement

The Earl applied the same scientific rigour to the development of the grinding and polishing tools. After many trials the grinding tool was eventually made with a convex spherical surface on the downwards face which was divided into small squares by having channels cut in this 'active' face. These channels acted as ducts into which the debris of grinding and 'spent' abrasive could migrate - so avoiding build-ups on the surface of the grinding tool which would damage the geometry of the speculum. For grinding, emery powder (crushed Aluminium Oxide) of different grades of abrasiveness was introduced through a central hole in the tool,

The same rigorous approach arrived at a convex shaped polishing tool whose face was subdivided by being cut with both circular and radial channels. The polisher's surface was coated with a layer of pitch 0.77-1 mm thick, then coated with a further layer made from a mixture of resin, turpentine, and wheat flour, boiled to expel moisture and to achieve the correct hardness. The gentle abrasive used for polishing was iron oxide powder (jewellers rouge) and the channels again allowed detritus to enter. The move from concave spherical to parabolic shape of the speculum was achieved at the polishing stage; here specific setting of the eccentrics, polishing force etc. caused the removal of small amounts of material at the outer radii of the speculum. Measuring gauges were used during both processes but these alone could not ensure perfection.

When it was assumed to be correct the speculum (mirror) on its platform was drawn from the machine into a tower where a watch face was mounted at a great height above it. If the image of the watch dial was clear when viewed by means of a temporary eyepiece set at the desired focal length of the speculum mirror it was deemed complete. If this was not the case the mirror was returned to the polishing machine for further work, this procedure was repeated until the mirror was judged ready for use.

When the specula of the "Leviathan" were manufactured the Earl had to create another grinding/polishing machine, its operation and the process of approaching the correct geometry of these mirrors was the same as the foregoing description.

The most important aspect of the use of the grinding/polishing machine was not that the design 'worked' but that its actions were documentable and totally repeatable. This was a first in the science of lens polishing and variants of the Earl's machine were later devised by others.

The secondary flat mirror set at the focal point and used to reflect the image to the viewer's eyepiece was made of the same material as the speculum.

When one reviews the paths taken by the 3rd Earl to achieve success in the creation of this telescope one can only marvel that an 19th century aristocrat would spend his energy in mastering the worlds of science, engineering design, engineering manufacture, train his team of workers and create a minor industrial world at his home. William was an extraordinary man and indeed one who deserves his honoured place in history.

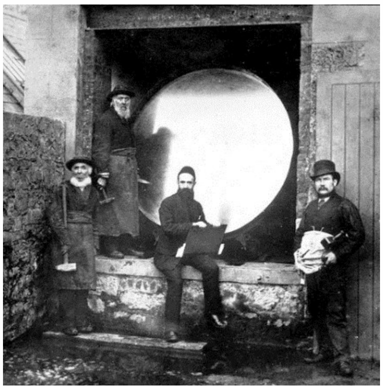


Figure 11. Some of the Earls workers with a 6-foot Speculum [P.D.]

Figure12. The 6-foot Mirror on its Travelling Carriage. [P.D.]
This mirror is displayed at the Science Museum London, the whereabouts of the 2nd mirror is unknown.

Using the Telescope:
The telescope was used primarily to observe nebulae on those rare occasions when weather conditions permitted. Parsons did call on experts for help with its construction, including the famous Irish telescope-maker Thomas Grubb.
However, the instrument was not without its drawbacks. Because of its size, a unique mounting system was constructed which restricted motion in the east-west direction. This mount was the first and last of its kind, and as can be seen from the preceding image of the Leviathan, it had an impressive fortress-like appearance. The telescope tube is suspended between two stone walls, 70 feet-long and 50 feet-high (21.4 x 15.2m). These walls protected the instrument from high winds and at their top was a movable observing platform. From here Lord Rosse and others spent many cold nights viewing and drawing the wonders of the heavens.

The year of 1845 was the beginning of a dreadful period of Irish history – An Gorta Mór- the Great Famine began; this brought a halt to astronomical observations in Birr as William and Mary Parsons spent much of their time and a great deal of the family's fortune in good works to alleviate the sufferings of the people of Parsonstown, and the county. [3]

Results: To begin with, most observations were made of the Moon and other of the planets, all of which were viewed in greater detail than ever before. However, the most important discovery made at Birr Castle was that of the spiral nature of the M51 nebula (now known as the Whirlpool Galaxy, M51).
While Lord Rosse correctly observed M51 to be "studded with stars," the debate over the true characteristics of nebulae lingered, and it was not until the 1920s that Edwin Hubble recognized some of the fuzzy objects to be galaxies like our own Milky Way.
William Rosse's drawing of the spiral 'Whirlpool' galaxy M51 is a remarkable work of nineteenth-century astronomy and when compared with modern images of the same shows the quality of his telescope and his expertise as a draughtsman. He also made detailed observations of the Orion Nebula and studied and named the Crab Nebula which he had previously sighted with the 36inch telescope.

Figure 13. Parsons Drawing of the Spiral Galaxy M51 (right) **A Modern Photographic Image**

The Leviathan telescope was the largest in the world and it was not until the 100-inch (254-cm) reflector was installed in 1917 at the Mount Wilson Observatory in California that a larger telescope was used.
The Leviathan was dismantled in 1908 but was later restored in the 1990's by the 7th Earl and can be viewed in the castle grounds at Birr, Co Offaly (see https://birrcastle.com/telescope-astronomy/) .

Along with his scientific works William Parsons served as, Lord Lieutenant of King's Co., Colonel of the County's Militia, president of the Royal Society (1848-54), and he was made a Knight of the Order of St Patrick (K.P.) in 1845. He served as Chancellor of Dublin University (1862-7) - a busy life well spent.

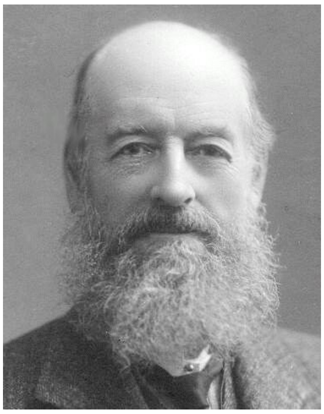
Sadly, at the age of 65 Lord Rosse's health deteriorated and in 1867 he left Birr to be near the sea and lived at 26 Longford Terrace, in Monkstown, Co, Dublin, here in the same year he died. William was buried at Birr and because he was held in such great affection by his tenants some 4,000 attended his funeral.

Perhaps we should give last words on this remarkable man to Sir Bernard Lovell who in 1968 said of him: *"…The Birr Telescope is a monument to the third Earl's skill in engineering and optics; the results he obtained with it are a remarkable tribute to his observational skill and to his insight that such a device would record more of the depths of the universe than man had yet conceived. I have before me two illustrations of the nebula in Canes Venatici—a galaxy more than ten million light years away in space. One is a drawing made by Lord Rosse as he saw it in the Birr Telescope. The other, is a photograph taken a century later by the 200inch telescope on Mount Palomar. The identity of the two is dramatic and the spiral form of the galaxy is shown with far greater clarity in the drawing. It is to the everlasting credit of Lord Rosse that he discovered the spiral structure of the nebulae, and thereby opened an avenue of exploration which today has led us into the inconceivable depths of space and time…"*

William's great interest in the natural world, and his enthusiasm for astronomy and engineering passed down to his sons, all of whom were encouraged to spend time in designing and making devices in the castle's workshops. Their early education was through home tutoring by people who also assisted the 3rd Earl in his astronomical efforts (Robert Ball and several others). All four surviving sons attended Trinity College Dublin, three of whom went on to be involved in the world of science/engineering. One, the Hon Randal Parsons became a clergyman. Another son, the Hon. Richard Clere Parsons, graduated with a B.A.I from Trinity College in 1873 and spent much of his fruitful 'engineering life' outside Ireland. He returned to these shores ca. 1870 taking a post as Engineer to the Congested Districts Board, which he held from 1893 to 1895.
The Hon. Sir Charles Algernon Parsons, in honour of whom the main building of the Department of Mechanical, Manufacturing & Biomedical Engineering at T.C.D. is named, was primarily an engineer and invented the modern steam turbine in 1884, allowing for cheap electricity which revolutionised power generation on land and sea. He founded 'C. A. Parsons and Company' in Newcastle upon Tyne, which is today a part of Siemens Energy. His engineering interests also extended to astronomy: he acquired the famous Grubb Telescope Company in 1925 and with great generosity, so to honour the Irish telescope maker, renamed it 'Sir Howard Grubb, Parsons and Co. Ltd.'

We now come to the man in the portrait in the Parsons Building in Trinity College Dublin entrance hall, the eldest son of William Parsons:

Lawrence Parsons, 4th Earl of Rosse. K.P., FRS, (1840-1908)



Sir Lawrence Parsons, the fourth Earl, was born at Birr Castle. Educated partly at home, he graduated from Trinity College, Dublin, at the age of twenty-four, and three years later, on his father's death, succeeded to the title and estates. From early manhood he took a part in public life. He received many distinctions, including an LL.D and a D.Sc. from Trinity College Dublin, where he served as Chancellor. In this capacity he helped raise funds for new engineering laboratories in the early 1900s, and personally made a substantial donation to the project.
In 1887 Lawrence became president of the Royal Dublin Society and in 1895 president of the Royal Irish Academy. He was also a fellow of the Royal Society and of the Royal Astronomical Society from 1867.

In 1879 the University of Cambridge conferred upon him the degree of LL.D., and in 1890 Lawrence received the knighthood of the Order of St. Patrick. As well as acting as Lord Lieutenant for King's County, he occupied several Government and municipal positions, and was chairman of the committee appointed by the London County Council in reference to gas-testing. In 1888, during the Dublin Meeting of the Royal Society he entertained the Members at Birr Castle, and at that Meeting contributed a paper on a "Balanced or Automatic Sluice for Weirs."

Among engineers Lawrence was known for the unswerving support he gave his brother Charles in the difficult pioneering work on the steam turbine and was a director of the Marine Steam Turbine Company formed in 1894 to construct the historic first ever turbine driven boat, Turbinia. Built as an experimental vessel in 1894, it was later became the fastest ship in the world.

In Rollo Appleyard's biography of Sir Charles Parsons are many letters to Lord Rosse relating to the steam turbine, which Charles lived to see adopted for the –
-Dreadnought, Mauretania and the Lusitania.

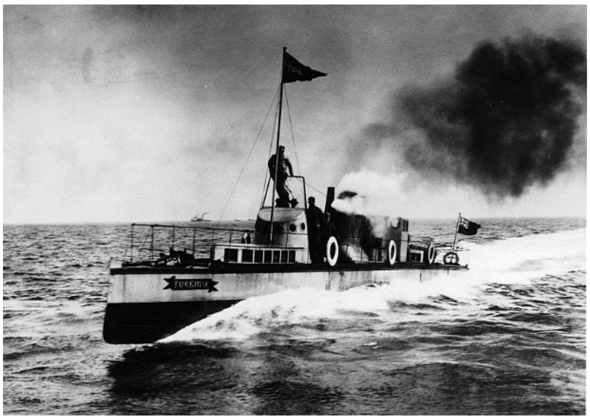


Figure 14. The Turbinia. [P.D.]

A man of wide interests, a generous employer and a philanthropist, Lord Rosse in his will left a sum of money for the upkeep of the telescopes and instruments made famous by his father.

Lawrence followed his father's footsteps and as well as his engineering interests focused on astronomy. He carried on his father's observations on nebulae, and after the design and construction of special devices made investigations on the heat radiated from the moon.

Although stated by his father to be *'totally under the dominion of the user',* Lawrence found both the 72-inch and the smaller 36-inch telescopes at Birr rather unwieldy as they had no mechanism to drive them. He solved this problem by inventing clockwork mechanisms for the purpose (see later).

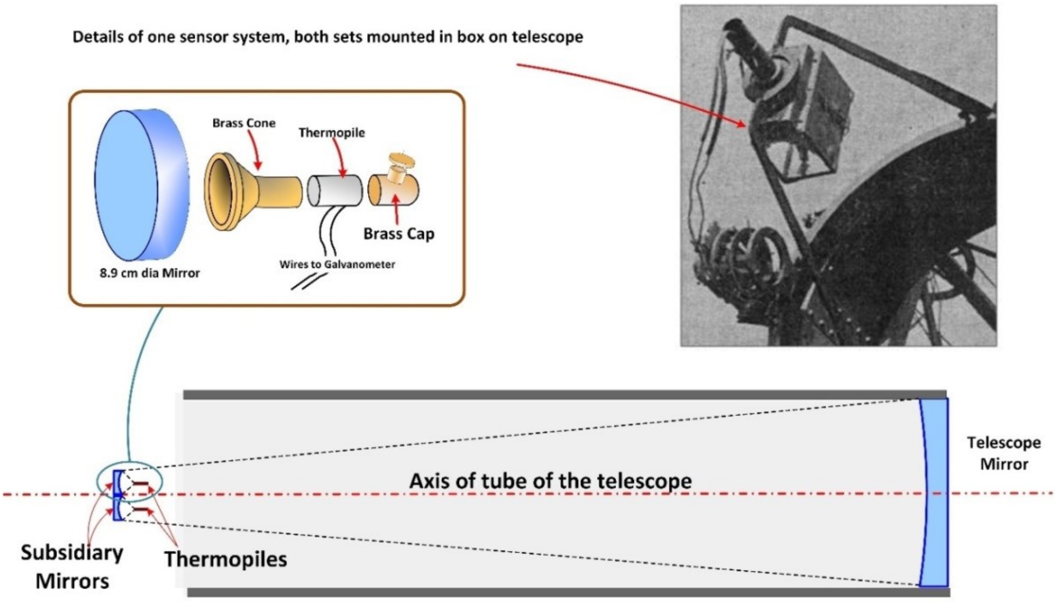


Figure 15. The 4th Earl's Lunar Heat Measuring Apparatus. [Author]

However, it is essentially for measuring the radiated heat of the moon that he is best known. For this purpose, Lawrence designed and built an instrument by which the 36-inch telescope could focus the lunar radiation on the thermopiles and so allow the production of temperature graphs. It is for these data his 'astronomical' work is best known and the accuracy of his results were only recognised long after his death.

Lunar Heat measurements: Several scientists attempted, with some success, to measure the radiant heat from the moon. However, during the period in question it was the 4th Earl who collected the most extensive data. What Lawrence did was to place a small (9cm) mirror facing the focus of the 3-foot telescope and to then position a thermopile at the focus of this subsidiary mirror, figure 15. The heat radiated from the moon was reflected from this mirror onto the sensitive joints of the thermopile and the resulting electric current was measured by means of a Thomson galvanometer.

After initial experiments he refined the system by adding another mirror and thermopile (figure 15). With this system he made measurements of lunar heat. After much work on evaluation and corrections to the data he delivered his results at a Bakerian Lecture in 1873. This is published as *"On the Radiation of Heat from the Moon, the Law of Its Absorption by our Atmosphere, and of Its Variation in Amount with Her Phases",* Phil Trans Royal Society London, Vol 163, pp 587-627. His data compare well with other's findings and after further mathematical analysis of his data, he achieved (somewhat by chance) a value close to more modern ones.

The difficulties with this work and its place in history are well described by James Lequeux, in: "*Early infrared astronomy",* Journal of Astronomical History and Heritage, Vol. 12, No. 2, p. 125-40 (2009).

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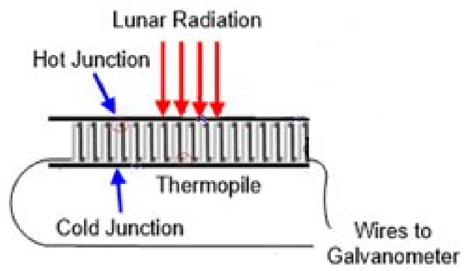
The Thermopile: In 1821 Thomas Johann Seebeck found after welding the junction between two wires of dissimilar materials that when the junction was exposed to heat it produced a voltage which is proportional to the temperature. As these wires were small in diameter the devices have a reasonably quick response and so their output voltage can be used to detect temperature variations.



This device is called a thermocouple and the thermoelectric phenomenon now known as the Seebeck Effect.
A thermopile comprises of a large number of connected thermocouples. So, thermopiles can identify thermal radiation and its variations by producing an electrical output.

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Circa1865, whilst in search of the design for a truly flat mirror to use in a telescope Lawrence also performed some preliminary work in association with the practices of the electrodeposition of copper sulphate onto silver films. However, he found it impossible to properly electroplate copper upon these silver films, as the copper would contract and detach from the underlying glass substrate. His note has been cited as one of the earliest confirmations in literature that thin films on glass substrates experience residual stresses.
This work he published in the year of his death in the paper. *"Bimetallic Mirrors Made by Electro-Deposition." Nature* **78,** 366–367 (1908).

Improving the Telescopes at Birr:

Whilst William Rosse's reflecting 6-foot telescope remained the largest in the world for over 75 years, the instrument was not without its design flaws. To accommodate such a large telescope, a unique mounting system was employed which, as said earlier, restricted motion in the east-west direction. Even the mounting of the 3-foot telescope had its problems. After working with both telescopes for some years Lawrence Parsons noted that:

"The six-foot reflector remained unequalled in aperture, and even the three-foot was in two or three cases only surpassed or even approached in size, but the mechanical appliances for working them were by no means equal in convenience to those fitted to most modern instruments, so that much time was unprofitably spent, and in some departments of the science we found it impossible to make progress. It was therefore decided, in the first place, to apply a clock-movement to the six-foot, the motion of which in Bight Ascension had up to that time been given by the hand of an attendant".

Accordingly, Lawrence set out by means of a great deal of clever engineering to improve the mountings and drive systems of the devices. The details of this work are fully described in his paper, *"On some recent improvements made in the mountings of the telescopes at Birr Castle."* Proceedings of the Royal Society of London, 29(196-199), pp. 153-62.

Along with his engineering and astronomical work Lawrence was Justice of the Peace for King's County and High Sheriff from 1867–68. He was also Lord Lieutenant of King's County and Custos Rotulorum (*Guardian of the Rolls*) of King's County from 1892 until his death

His death took place at Birr Castle on 30th August 1908, in his sixty-eighth year.

Lastly, we come to the man in whose honour the Parsons Building Trinity College Dublin is named:

Sir Charles Parsons (1854-1931) OM, KCB, FRS

Charles Algernon Parsons was born in London in 1854. . However, he spent most of his boyhood at the family home in Birr Castle. He was the youngest of the four surviving sons of the 3rd Earl of Rosse A naturally gifted student, Parsons was privately tutored by some quite prominent scientists, including the astronomer Sir Robert Ball. With encouragement from his father Charles showed his mechanical genius at an early age and in 1866, in his twelfth year, he and his brothers reportedly built a four-horsepower (3KW) steam carriage that could travel at a speed of 10 mph (16 kph). Unfortunately, this vehicle was responsible for Ireland's 1st 'car' fatality as their cousin Mary Ward fell from it and was killed.

In 1871, Charles was admitted to this University but later enrolled at St. John's College Cambridge, where, among other subjects, he studied mechanisms and applied mechanics. He graduated with a first-class honour's degree in mathematics in 1877.

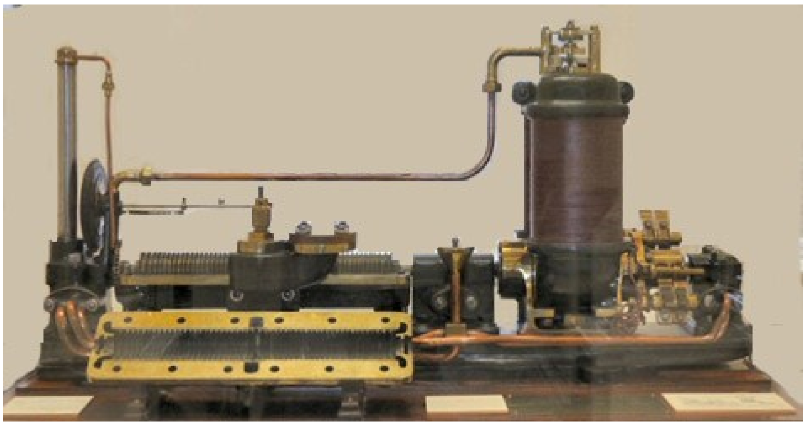

Figure 16. The T.C.D Parsons steam turbine generator (No 5). [P.D.]

Charles then, unusually for that time and someone of his background, began his engineering training as a premium apprentice at the Elswick Works of Sir William Armstrong & Co. Tyneside.
Charles later joined Kitson of Leeds where he developed a 4-cylinder high speed epicycloidal steam engine. Here he also undertook experiments on the rocket propulsion of torpedoes. In 1883 he married Katherine Bethell and at the start of 1884 he left Leeds to join in a new partnership at Clarke Chapman & Co of Gateshead, near Newcastle.
This company was not interested in his novel work on torpedoes but wished to create a steam powered engine suitable for driving shipboard dynamos. Parsons set about designing a high-speed generator and then developed a steam turbine to drive the dynamos directly. In April 1884 he filed two provisional patents specifications describing this revolutionary steam powered turbo generator and later in the year complete specifications and drawings were filed. During May 1885 the prototype was displayed at the Inventions Exhibitions London where it was awarded a silver medal.

The genius of Charles was to have the turbine operated in a series of stages. To give effect to this idea he designed a turbine consisting of a multi-bladed cylindrical rotor enclosed in a casing. Parsons knew that the effect of the steam pressure on the blades of a turbine caused a serious end-thrust on the bearings of a turbine's rotor. Charles ingeniously had the steam enter the turbine midway along the rotor causing it to flow through the sets of turbine blades equally towards each end thus negating end-load on the bearings.
During each stage, the expansion of the steam was restricted to the smallest possible extent, extracting as much kinetic energy as possible without allowing the turbine blades to turn too fast and damage the equipment. His invention was a breakthrough in both mechanical and electrical engineering and allowed electricity to be produced at much lower cost. He also cleverly designed new bearings for this high-speed machine.
All this ingenious work is well described in, W. Garrett Scaife *'The Parsons Steam Turbine'*, Scientific American, Vol. 252, No. 4 (April 1985), pp. 132-139

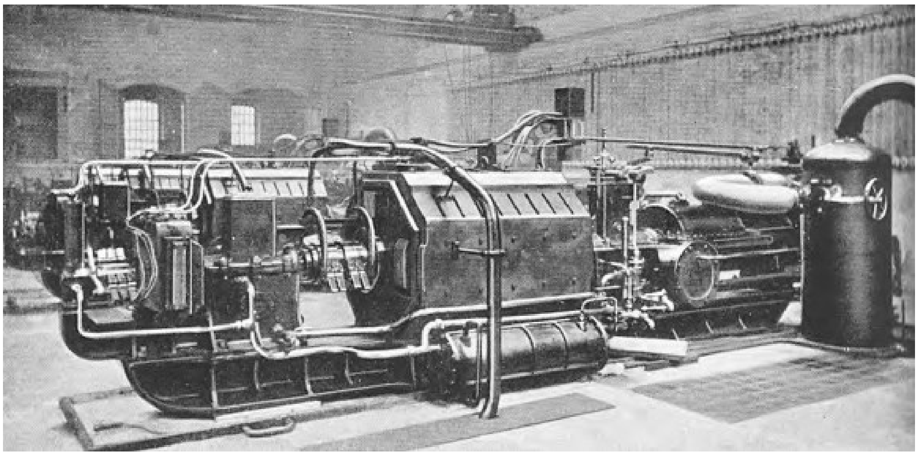

Figure 17. A 350kW axial flow machine. Installed in 1894 at Manchester Sq. Power Station London.[P.D]

Unsatisfied with his partner's efforts to develop the steam turbine in 1889 Charles Parsons founded his own company in Newcastle - **C.A. Parsons & Co.** - to manufacture turbo generators. On leaving his employer he lost access to his original patents. Charles quickly established alternative designs and by 1892 he had built a radial flow turbo-alternator with an output of 100 kW for supply to the Cambridge Electricity Company; exhausting to a condenser, it had a steam consumption comparable with the best steam engines. This machine was quickly followed with greater and greater electrical power output generators.

Charles continued to research marine propulsion, and in 1894, he applied for a patent for *"propelling a vessel by means of a steam turbine, which turbine actuates the propeller or paddle shaft directly or through gearing."*

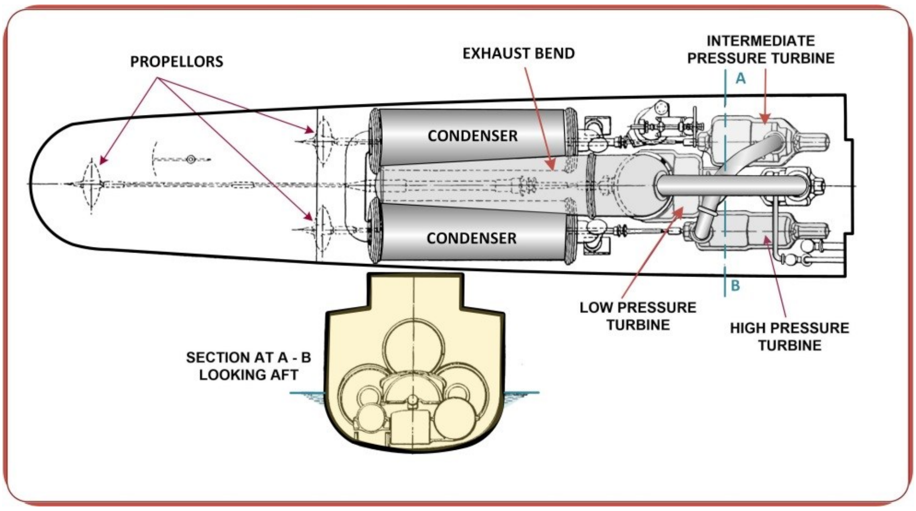

Figure 18. Turbinia's Propulsion System. [P.D.]

In 1894 Charles Parsons designed and had built a 100-foot (30.5m) long vessel, firstly called "Experimental Launch" and on its completion in 1895 the vessel entered the water without any publicity. The ship, powered by one radial flow turbine engine linked to a single shaft with a single propeller; sadly the ship yielded poor results, achieving a speed of only 20 knots - far below Charles's hopes for her.

Following this disappointment and after much research on the geometry of high-speed propellers to maximise their efficiency and minimise the effects of cavitation caused by them, Parsons was ready to make modifications. He changed the propeller system from a single shaft to three, bearing multiple propellers.

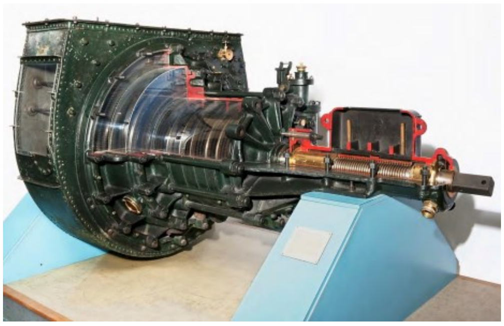

Figure 19. Turbinia's Original (1894) Radial Flow Turbine. [P.D.]

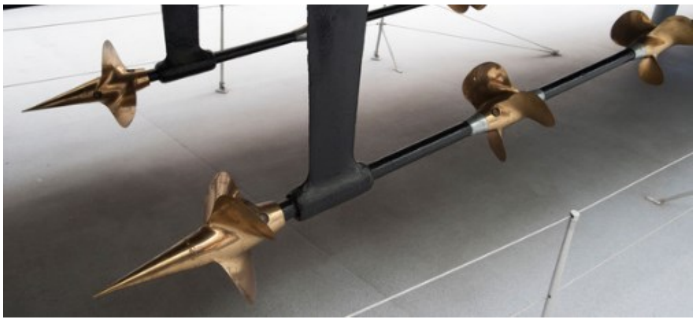

Figure 20. Turbinia's Triple Propeller Shafts. [P.D.]

In 1896 three 'parallel flow' turbines were installed, each driving a shaft bearing three identical propellers. At a steam pressure of 157 psi (1,034 MPa) the central shaft turned at 2,000 rpm and the two wing shafts at 2,230 rpm—a new standard of efficiency. The ship could travel at speeds as high as 34½ knots (64 Km/h)—an extraordinary accomplishment for that time and one making it the fastest vessel in the world.

The experimental stage was now complete and the ship - now called "Turbinia", would soon reach the public eye. In 1897 to celebrate the Queen Victoria's Diamond Jubilee a review of the Royal Navies Fleet was held at Spithead. The *Turbinia* appeared, uninvited, and greatly embarrassed the officers of the British Fleet by outmanoeuvring its ships, which could only reach maximum speeds of 27 knots (50 Km/h).

Parsons' multi-stage steam turbine quickly revolutionized marine transportation and naval warfare. Within a few years, several British destroyers were launched with Parson's turbines and turbine-powered passenger vessels were also in operation. By 1904, twenty six ships had been equipped with Parson's remarkable direct-drive turbine engines, among these were the Lusitania and Mauritania.

Figure 20. Turbinia 'charging' past the Royal Fleet. [P.D.]

Charles Parsons spent much of his free time working on new ideas and inventions. He experimented with, marine propellers, gearing, telescopes, and even dabbled in chemistry with attempts using high pressures and temperatures to crystallize carbon so to make synthetic diamonds. Among his other inventions was the Auxetophone, a device that acoustically amplified stringed musical instruments. These last two efforts were among his only failures. However, they do not detract from the truth that this gentle considerate man was an engineer of the 1st rank and a supreme and kindly businessman.

His important contributions to science were formally acknowledged when he was elected to the Royal Society in 1898, knighted in 1911 and in 1927 admitted to the Order Merit (O.M), the first engineer ever to receive this honour.

Sir Charles died on February 11, 1931, while on a cruise in the West Indies, and so passed away one of the greatest engineers of all time. A memorial service was later held at Westminster Abbey. He lies buried at Kirkwhelpington near his Northumbrian home. On death his estate was valued at £1,214,355 gross.

End Note: These vignettes presents only male members of the Parsons family. Space forbids description of the remarkable women who made their worlds possible. The interested reader is encouraged to look at material on Mary Field - Countess of Rosse, Katharine Parsons (nee) Bethell and her daughter Rachel Mary Parsons

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(This is far from a complete list of references. For further details see W.G. Scaife.)

C. G. Lyons 2022