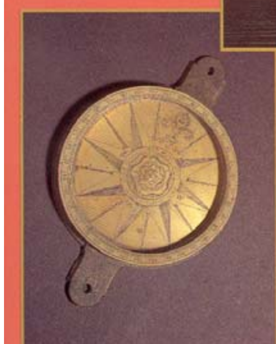

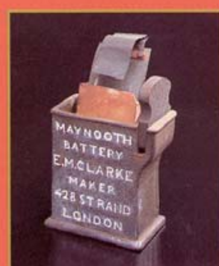

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The Scientific Apparatus of Nicholas Callan *& other Historic Instruments*

Charles Mollan
John Upton

MAYNOOTH
SAMTON

MAYNOOTH COLLEGE

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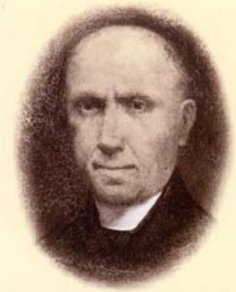
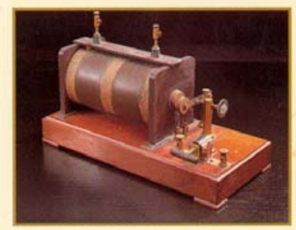
and other Historic Instruments





Charles Mollan
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CATALOGUES OF HISTORIC SCIENTIFIC INSTRUMENTS

IN IRISH COLLECTIONS

NUMBER ONE

ST PATRICK'S COLLEGE, MAYNOOTH

THE SCIENTIFIC APPARATUS OF NICHOLAS CALLAN AND OTHER HISTORIC INSTRUMENTS

by

CHARLES MOLLAN AND JOHN UPTON

ST PATRICK'S COLLEGE MAYNOOTH
and SAMTON LIMITED

1994

base, and a semi-circular silvered scale (90-0-90°). The base has a circular groove for a missing glass dome.

*This is a compact version of **035**.*

BATTERIES AND CELLS

*Under the section of the Catalogue "Electrostatic Generators and Static Electricity" (pages 107-117), the instruments listed deal with electricity which is produced by machines giving "intensity" electricity of high voltage but little power. However, for his researches, Callan required "quantity" electricity (McLaughlin 1965,61). This was supplied by batteries or cells. It was Alessandro Volta (1745-1827), the Italian scientist, who invented the electric battery, or "voltaic cell", in 1799. He found that a pile of discs, alternately silver and zinc (or copper and zinc), with absorbent materials soaked in water between each disc, produced an electric current. Entry **056** is a later version of the voltaic "pile". Previously, another Italian, Luigi Galvani (1737-1798) had thought that this electricity was released by animals (for example frogs' legs) when they came in contact with metals. Volta showed that the animal component was unnecessary. From this beginning much research was carried out to improve the reliability and power of batteries, and this work continues to-day. Indeed a current priority in this area is the development of batteries which are not too heavy, last a long time, and can be recharged quickly, to power road transport of the future in an environmentally-friendly way.*

Callan experimented with voltaic cells and made substantial improvements in them. McLaughlin (1965,64) lists contemporary and new cells investigated by Callan:

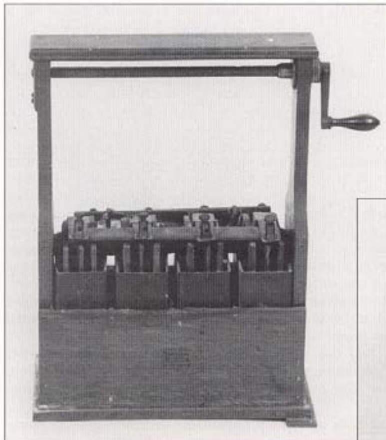
		Catalogue entry	
1836	*Wollaston's double copper*	***057***	
	Poggendorf's chromic acid	***046***	***047***
	Daniell's two fluid	***052***	
1839	*Grove's platinum*	***053***	
1843	*Bunsen's carbon*	***048***	***049***
1848	*Callan's cast iron*	***050***	
1854	*The Maynooth battery*	***055***	
1855	*Callan's single fluid*	***051***	

All these battery types are preserved in the collection, although not all would have been used by Callan. Other types of battery have been added since. Maynooth has the best collection of nineteenth century batteries in the country.

046 BICHROMATE BATTERY c1877 R.
1794 Signed: Yeates & Son, Dublin

Base diameter 119; maximum diameter 149; height 313.
A bulbous glass flask, with a cylindrical neck, has a brass sleeve on top. On this is an ebonite disc, from which is suspended one (of two) carbon plates (the second is missing), and a smaller zinc plate. The height of the plates is varied using a brass rod through a sleeve in the centre of the disc. On top of the disc are also two brass screw terminals.

This battery was invented by the German scientist Johanne Christian Poggendorf (1796-1877) (Lyall 1991,372, Williams 1982,422). The exciting liquid used was a mixture of one part of potassium bichromate, two of sulphuric acid, and ten of water (Ganot 1890,786). Such a "Bi-Chromate Bottle Battery" was offered in Yeates (1877,195-197). Although Callan experimented with this type of cell, this example and the next entry are unlikely to have been those actually used by him in his early experiments. While Yeates instruments can be difficult to date (see page 15), these were probably made after Callan's researches ceased.



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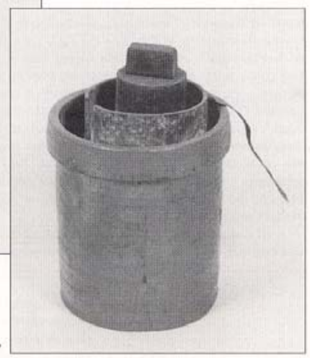

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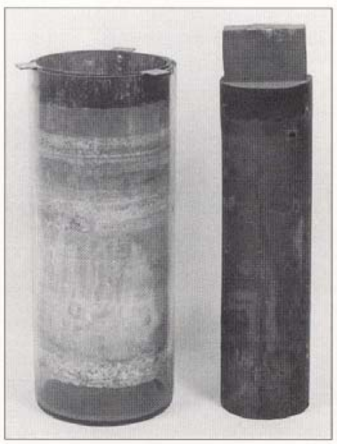

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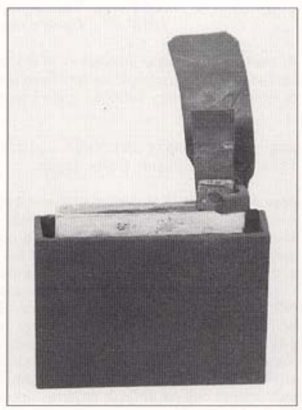

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047 BICHROMATE BATTERY c1877 R.
1771 Signed: YEATES & SON Opticians TO THE UNIVERSITY DUBLIN

Tray 274x142x15; height 375.
Four ebonite cells rest in compartments in a mahogany tray, which has extended vertical sides with a horizontal bridge joining them on top. Through the sides is an iron bar and handle, in a ratchet arrangement, for raising and lowering the plates out of the cells. Each couple consists of two graphite plates with a zinc plate between. The plates are joined together by mahogany strips. The pairs of graphite plates, and the central zinc plates, are connected by brass ribbons to brass screw terminals. Two of the graphite plates on one couple have broken off, and one of the two mahogany strip feet is missing from the tray.

This is a four-cell version of ***046****. The lifting arrangement was necessary since the zinc is attacked by the exciting liquid when the cell is on open circuit. In the single-cell version, the central zinc plate can be raised instead. A similar apparatus is offered in Yeates (1877,215&216), for use with either six Smee cells or with six Bichromate cells. The Smee cell had a sheet of platinum, or of platinised silver, between two zinc plates with dilute sulphuric acid as the exciting liquid (Ganot 1890,783).*

048 BUNSEN CELL (SMALL) c1843 R. **682-9**
1774 Unsigned

Earthenware pot maximum diameter 160; height 190.
An earthenware pot contains a hollow cylinder of amalgamated zinc, a porous pot (now missing), and a cylinder of carbon. A copper strip on the zinc cylinder was attached to the carbon of the preceding cell by means of a clamp, but this also is now missing.

*The porous pot, with its carbon cylinder, contained concentrated nitric acid. The outer vessel contained dilute sulphuric acid (Ganot 1890,782). Invented in 1843, the battery of Robert Bunsen (1811-1899) is in effect a Grove battery (****053****) in which the platinum foil is replaced by a carbon rod. Because of the good conducting properties of the carbon, the cell had a low internal resistance and was less costly than the Grove cell.*

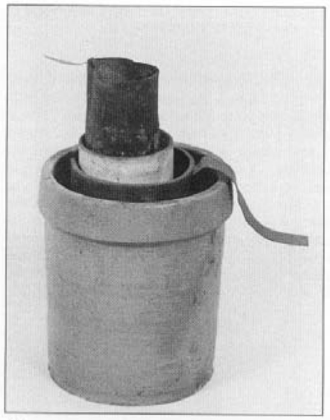
049 BUNSEN CELL (LARGE) c1843 R. **682-9**
1774 Unsigned

Outer vessel diameter 265; height 630.
This larger version of entry **048** has a glass outer cylinder, an open zinc cylinder, a porous pot, and a central carbon cylinder. Once again, the porous pots are missing. There are five glass outer vessels (two damaged) and seven large central carbon cylinders.

050 CALLAN CAST IRON BATTERY c1848 R. **690-2**
1663 Unisgned - attributed to Nicholas Callan

Outer cell 131x106x29, 141x128x35, or 161x135x43.
A cast iron cell contains a porous pot and a zinc plate. Copper strips are soldered to the cell, and to the zinc plate, to join cells in series. There are ten of these cells, seven of the smallest size, and one each of the larger sizes.

The porous pot contained dilute sulphuric acid, while the outer cell contained concentrated nitric acid. Callan found he had trouble making good contact between his thick copper leads and the carbon plate of the Bunsen battery, and that the latter gave off disagreeable fumes. He therefore substituted cast-iron for the carbon, and this also had the advantage that the cast-iron could serve as the container of the battery, dispensing with the need for another outer container. He constructed a battery with 577 of these units, probably the world's largest battery, at least twice as powerful as that constructed on Napoleon's orders for the École Polytechnique in Paris. He proved its effectiveness by electrocuting a very large turkey! According to his experiments, his cast-iron cell was fifteen times more



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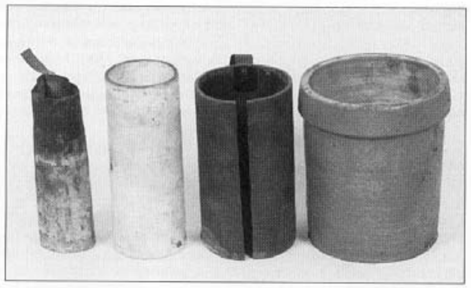

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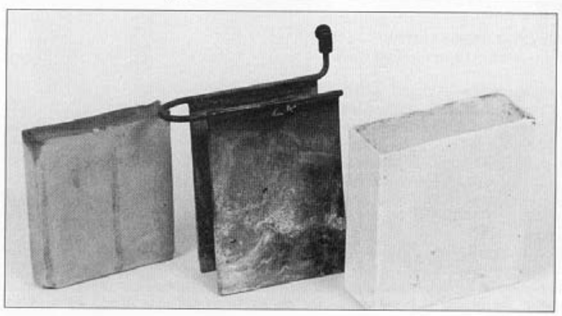

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powerful than a Wollaston ***(057)*** *of the same size, and twice that of a Grove cell* ***(053)****, which used expensive platinum for its anode. In the course of this work he found that cast-iron from his cells stood up to the weather, and he patented the process (see entry* ***380****) (McLaughlin 1965,68).*

051 CALLAN SINGLE FLUID CELL c1855 R. 697-8
4056 Unsigned - attributed to Nicholas Callan

Dimensions as for previous entry
This is identical to Callan's Cast Iron Cell **(050)**, with the omission of the porous vessel. The zinc plate was separated from the cast-iron cell by pieces of wood.

Callan invented this cell in June 1854 because he needed to produce a more economical and convenient alternative to his cast-iron battery, for the purpose of exhibiting optical experiments which required a very strong light. He experimented with different fluids and found that best results were obtained with one part of concentrated sulphuric acid to two of water. During a public demonstration in the College in September 1854, he showed that 182 of these single fluid cells, excited by one part of sulphuric acid and three of a strong solution of common salt, appeared to be superior in power to 275 of the cells using nitric acid ***(050)****. He also outlined a design for the replenishment of the exciting fluid using siphon tubes and a clockwork activated stop-cock. A graphic account of his experiments in given in Callan 1855.*

Yeates (1877,202-205) offered both "Callan's Cast-iron double Fluid Battery" and "Callan's Cast-iron Single Fluid Battery", the latter charged with: "a saturated solution of common salt in water, to which is added one-fifth of sulphuric acid".

052 DANIELL CELLS c1836 R. 674-80
1772 Unsigned - attributed to Nicholas Callan

Earthenware pot maximum diameter 160; height 190.
A glazed earthenware pot contains an open copper cylinder and a cylinder of amalgamated zinc, separated by a porous pot, the zinc being innermost. A strip of copper and a zinc tongue serve for connecting the cells in series. There are 41 outer pots, all of similar size, two of them being without a lip on top. These were also used for the small Bunsen cells **(048)**.

The liquids used included a saturated solution of copper sulphate in the earthenware pot, and a dilute solution of sulphuric acid in the porous pot. This was the first form of the "constant" battery, invented by English scientist John Daniell (1790-1845) in 1836 (Williams 1982,129). It was an improvement on the Wollaston Battery ***(057)****, which used only one fluid, and this led to "the rapid enfeeblement of the current produced". By using two fluids, as in the Daniell cell, the "action continues without material alteration for a considerable period of time" (Ganot 1890,780).*

053 GROVE BATTERY c1839 681
1793 Signed: WEDGWOOD

Outer housing 141x50x48.
A white ceramic housing contains two zinc plates on the outside of a red porous pot vessel. The zinc plates are connected by a copper U which has a brass terminal at one end.

The outer vessel was partially filled with dilute sulphuric acid (1:8) while the porous pot contained strong nitric acid and a thin platinum foil (Ganot 1906,486). The platinum foil is missing in this example.

Invented around 1839 by English scientist William Grove (1811-1896) (Gillispie 1981,V,559) this was considered to be one of the most powerful of the "two fluid" batteries, but became expensive owing to the high price of platinum (Ganot 1906,848). Platinum became really expensive only after 1902, when the Russian-born chemist Friedrich

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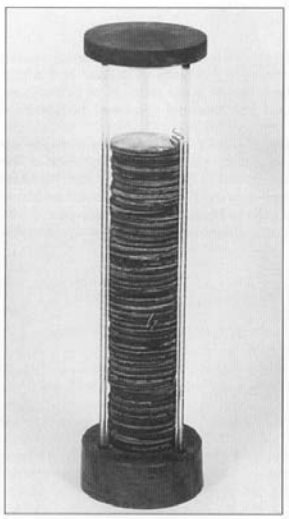

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Ostwald (1853-1932) discovered that it was an excellent catalyst for the oxidation of ammonia to nitric acid. This meant that it became essential to the manufacture of explosives, so much so that its use in photography (where it was very popular in the late nineteenth century) became prohibitive (McDonald 1982,386-393). The authors are grateful to Alison Morrison-Low for this information and reference.

054 LECLANCHÉ CELLS Late 19 C. G.
1775 Signed: LECLANCHÉ BARBIER PATENT R A L & CO LONDON

Base of vessel 112x112, height 188; total height 240.
A glass square-section vessel has a circular opening on top. Into this fits a carbon cylinder with a zinc rod in the centre. There are twenty seven of the larger vessels, most with their carbon cylinders, but only three with their central zinc rod. There are two smaller vessels (80x80x141), similarly signed, and one smaller still (76x76x134) signed: "PILE LECLANCHE BARBIER PARIS".

Invented by the French scientist Georges Leclanché (1839-1882) in 1866, this battery, in its usual form, uses a central carbon electrode, surrounded by manganese dioxide, in a porous pot, with a zinc rod for the positive terminal in a glass bottle outside the central electrode. The exciting fluid is a solution of sal-ammoniac (ammonium chloride) (Williams 1982,318, Turner 1983,199). In the Leclanché-Barbier version, as here, the zinc rod is carried in the centre, and the carbon electrode is composed of manganese peroxide and plumbago (a form of carbon) with a cast metal collar (Harris 1908,156). This was a relatively inexpensive battery, widely used, especially in door-bell circuits.

055 MAYNOOTH BATTERY c1850 R. 693-5
1664 Signed: MAYNOOTH BATTERY E.M. CLARKE MAKER 428 STRAND LONDON

Housing base 116x68, height 123; height with electrode 270.
Two. A treated cast-iron housing contains a porous pot and a zinc plate with a copper strip. A mahogany shaped piece fits a groove at the top right side.

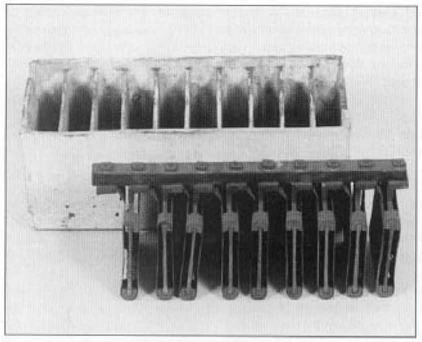
*The fluids were those of the cast-iron battery (**050**). Callan found that sheet-iron coated with an alloy of lead and tin resisted the action of acids and weathered more effectively than iron treated in other ways (Callan 1854,83). In the Maynooth Battery, the iron of the outer vessel is treated in this way. In 1859, Callan obtained sparks of about ten inches with his Great Induction Coil (**072**) using three cells of this Battery (Callan 1863,413).*

*Edward Marmaduke Clarke traded at 428 Strand from 1840-1851 (Downing 1988, 23). It is probable that this was the same Edward Clarke who traded in Dublin from 1810-1832, as Edward Marmaduke emerged in London, working for the firm of Watkins and Hill, in 1833, before setting up on his own (Morrison-Low 1989,49). For more details of E.M. Clarke, see entry **124**.*

056 VOLTAIC PILE c1836 G. 719
1725 Unsigned

Base diameter 133, height 54; overall height 522; disc diameter 78.
A red-painted oak base has three glass pillars supporting a wood disc on top. On the base stands a column of copper and zinc discs, each pair separated by circular pieces of cloth. The top and bottom discs each have a copper wire attached. The glass pillars and wood disc are modern replacements.

For information about the origin of the voltaic pile, see the introduction to this section (page 49). To actuate the pile, the cloth is moistened with acidulated water (Ganot 1890,777). McLaughlin (1955,719) records that "If the top and bottom discs - or wires connected to them - be touched simultaneously with moist fingers, there is a perceptible shock". This example of the Voltaic pile was probably used by Callan.



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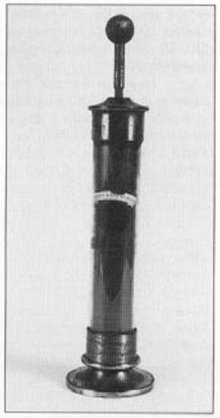

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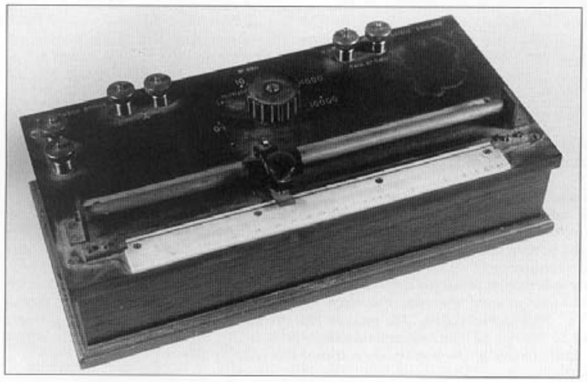

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057 WOLLASTON BATTERY c1836 R. 623-72
1770 Unsigned

Housing 360x142x141.
A ceramic vessel (there are four of these - two of them chipped) is divided into ten cells. Nine plates of thick rolled zinc and thin sheet copper are fixed to a cross frame of mahogany, and these dip into the ceramic vessel. The copper sheets are bent to surround the zinc plates without touching them. Contact is prevented by small pieces of cork.

The water in the cells was usually acidulated with 1/16 sulphuric and 1/20 nitric acid. This battery was invented by English scientist William Hyde Wollaston (1766-1828). It was an improved form of the "couronne des tasses" or "crown of cups", invented by Volta as a modification to his voltaic pile (056). An important feature was that several cells were connected together, and these could be removed from the exciting fluid when not in use (Ganot 1890,779). Callan was particularly struck by the fact that the copper was bent around the zinc, thus bringing both faces of the zinc into use. He made a twenty-cell battery with zinc plates measuring two feet by two, and a 280 cell battery with more-usual four inch plates. Using the latter he carried out a tug-of-war between a team of students and one of his electromagnets, and the electromagnet won! (McLaughlin 1965,64-66).

058 ZAMBONI DRY PILE BATTERY c1877 R. 834
1587 Signed: YEATES & SON, DUBLIN.

Base diameter 62; height 255; cylinder housing diameter 33.
A brass base supports a lower brass sleeve, holding a vertical glass cylinder, which has another brass sleeve on top (marked "+"). The upper sleeve is closed, and has a rod ending in a sphere above it. Inside the glass cylinder are the discs of the pile.

"Dry piles are remarkable for the permanence of their action, which may continue for several years...A Zamboni's pile of 2,000 couples gives neither shock nor spark, but can charge a Leyden jar and other condensers" (Ganot 1890,789).

Yeates (1877,230-231) offered: "Zamboni's Battery or Dry Pile, composed of alternate discs of tin-foil and paper coated with black oxide of manganese", either in a single tube of 1000 discs (as here) or in two tubes with 2000 discs.

BRIDGES AND RESISTANCES

A Bridge is an instrument for comparing two electrical resistances. A rheostat is a variable resistance.

059 KOHLRAUSCH POTENTIOMETER BRIDGE c1914 R.
4134 Signed: KOHLRAUSCH BRIDGE W.G. PYE & Co. CAMBRIDGE ENGLAND No.4911

Housing 340x172x75.
A mahogany housing has an ebonite top, with three sets of two brass contacts, labelled "Batt or Sec. Coil", ")(", and "Tele or Galv". There is a central ebonite knob, with a pointer to "Multiply Scale Reading" from 0.1 to 10000. On front of the ebonite plate is a brass mounted horizontal bar with a sliding sleeve, incorporating an ebonite knob to touch a wire running along a bone log scale (0-9). The slide can be clamped using a pivoted brass bar behind.

Pye (1914,52) illustrates a similar Bridge, with the description: "Kohlrausch Universal Bridge arranged for the measurement of electrolytic or solid resistance through a range of from 0.01 to 50,000 ohms. The design of this instrument is especially adapted for rapid measurement of resistance, having switches on the dial principle. The rubbing contacts of

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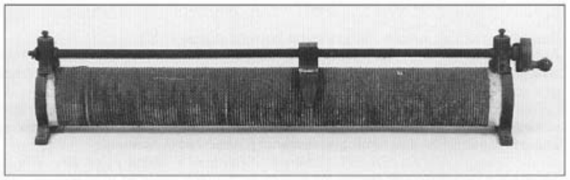

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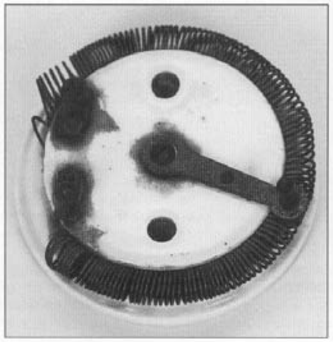

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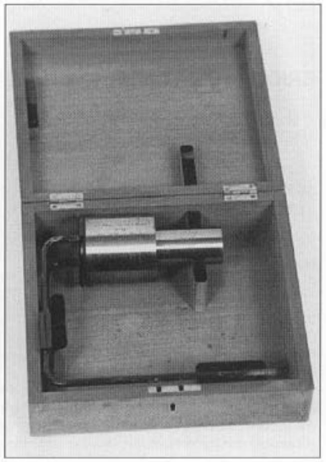

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the switches are of ample cross-section and enclosed in the case of the instrument. The slide wire is carefully selected for uniformity of cross-section and contact is made to it by an improved form of 'jockey' which enables either continuous or tapping contact to be made".

060 RHEOSTAT c1883 S.
1799 Signed: G.P.O. 502 ("8 10\83" handwritten on the base)

Base diameter 101; height 66.
A mahogany base holds a brass cylinder with a (cracked) glass top, enclosing a silver metal disc scale (0-275), which can rotate, its position being recorded by a pointer secured to the cylinder. Mounted on an ebonite arc on the base is a curved brass resistance bar, with three sections labelled "300", "G.P.O. 502", and "600". There are four holes in the bar, with two keys of brass and ebonite.

061 RHEOSTAT Late 19 early 20 C. G.
1710 Unsigned

Length 627; maximum height 148; cylinder diameter 66.
A cast-iron cylinder, on two feet, has a coil wound on an asbestos insulator. A screw-thread above the coil moves a brass contact. A wooden handle turns the screw thread.

062 RHEOSTAT Late 19 early 20 C. G.
1741 Unsigned - numbered "1241".

Diameter 86; height 38.
A white ceramic base holds two brass contacts and a wire coil in the shape of an almost complete circle. An arm, contacting the coil, is pivoted from the centre top of the base.

063 STANDARD RESISTANCE Late 19 early 20 C. G.
4335 Signed: = 1 Ohm at 15.2 Cent No.11. Elliott Bros London

Height 215; diameters of cylinders 66 & 36; diameter of wires 7; case 288x255x187.
A standard resistance coil is housed in a water-tight brass double cylinder, with a hollow centre. On top of the upper cylinder is an ebonite disc, and two stout copper wires rise in parallel out of the cylinder, bending in two right-angles. They are held by a plate and two screws, and the free ends show the remains of the mercury from the contacts in which they would have been placed.

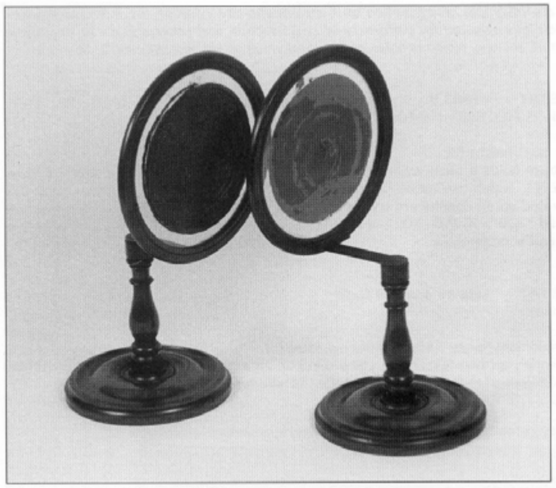
An unknown resistance is determined by comparison with such a standard resistance via a bridge.

The Elliott Brothers 1895 Catalogue (p.30) advertised standard resistances, from 0.1 to 10,000 ohms, made from platinum silver wire in nickel silver housings.

ELECTROMAGNETS AND INDUCTION COILS

"We have a priest here from Co. Louth, Dr,. Callan, the Professor of Science, and many are afraid he will blow up the College."...."But he is a very holy priest."

These are quotes, recorded in McLaughlin (1965,37), from a student at Maynooth, Lawerence Johnson, when he wrote to his folks at home on February 21 and April 9, 1855, and they seem to sum up the character of Callan very pithily. It was his coils which enabled him to produce dramatic results, like killing turkeys, and rendering unconscious a later



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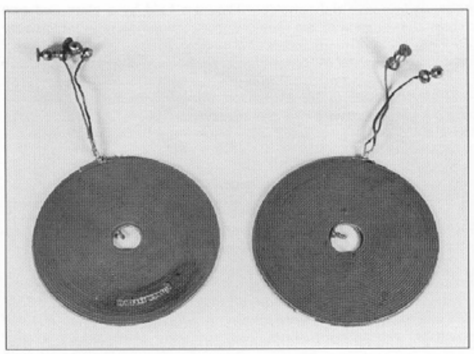

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Archbishop of Dublin, William Walsh. Callan's lasting claim to fame is as the inventor of the induction coil in 1836, and Maynooth retains original coils and other apparatus made and used by Callan in his researches. This section of the Catalogue includes Callan's primaries, secondaries and complete induction coils, and also related instruments acquired later by the Museum.

*When a soft-iron bar - the "core" - is surrounded by a coil of wire carrying a current, the core becomes magnetised, and the system is called an electromagnet. Callan, with the help of the local blacksmith, James Briody (McLaughlin 1965,58), constructed a large "horse-shoe" electromagnet (**068**), the coils being wound in different directions on each end of the bent bar, so that they had opposite polarity. When current was passed through the coils, this magnet had an impressive lifting capacity. McLaughlin (1965,70) records that Callan demonstrated the strength of his magnet by challenging a team of "robust young men" to try to separate the keeper [i.e. an iron bar held by magnetism to the poles of the magnet] when the current was on. The team lost. "Then the professor plays a little trick. He cuts the current as the team makes a mighty heave: the magnet is no longer active and the members fall in a heap on the floor, much to the amusement and applause of the on-lookers".*

*These effects were not new, although the power of his electromagnet was unsurpassed at the time. Callan's original contribution had two parts. To the coil consisting of a small number of turns of thick wire around the core - called the "primary" - he added an unconnected coil consisting of many turns of fine wire - the "secondary". He also constructed a means of interrupting the current to the primary, his "repeater" (**102**), using the escapement of an old grandfather clock. He found that, when the current was interrupted rapidly in the primary circuit using his repeater, a prodigious charge was produced in the secondary, although it was not connected to the primary. This was the world's first induction coil, completed by 1836 (McLaughlin 1965,72).*

064 APPARATUS FOR SHOWING INDUCED ELECTRIC CURRENTS 1859-1864
1589 Signed: Horatio Yeates Dublin **838-9**

Base diameter 231; height 558; coil housing diameter 308.
Each of two flat coils is supported vertically on a glass plate in a circular mahogany frame. The frame is fixed to a turned mahogany base and pillar by an oxidised brass bracket. The wires are covered with silk and insulated with a thick layer of shellac varnish. The ends of the coil are exposed at the centre and at the edge.

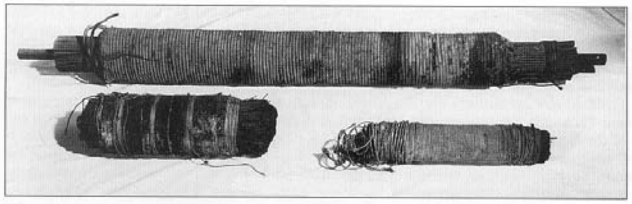
Ganot (1906,989) records that this apparatus was devised by the Italian scientist Carlo Matteucci (1811-1868), for showing the development of induced currents by the discharge of a Leyden jar (see page 85). Matteucci is best known for his work, carried out between 1836 and 1844 on animal electricity (Gillispie 1981,IX,176). However, McLaughlin (1955,838-9) reports that the apparatus was first found described in a letter of Callan's in Sturgeon's Annals of Electricity *in 1836. The coils are placed face to face, and a Leyden jar is discharged into one of them. A person holding two brass handles, connected to the other coil, receives a shock, which increases in intensity as the two coils are placed closer to each other.*

Horatio Yeates (1834-1906) traded at several Dublin addresses in the years 1859-1864, before emigrating to London, and then to South Australia (Morrison-Low 1989,42&139).

065 APPARATUS FOR SHOWING INDUCED ELECTRIC CURRENTS c1877 R.
1590 Signed: YEATES & SON, DUBLIN **838-9**

Diameters 115 & 116.
Each of two flat coils, coloured red on one side and green on the other, consists of a double strand of wire wound concentrically and joined at the centre. The wires have brass contacts at the outside ends.

This is a simpler arrangement of the previous apparatus for showing induced electric currents. Yeates (1877,318) offered "Large flat coils, to use with powerful batteries, for



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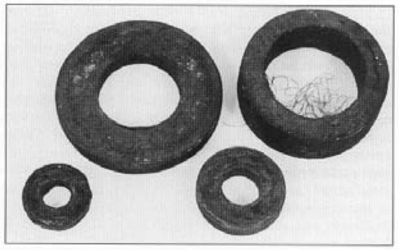

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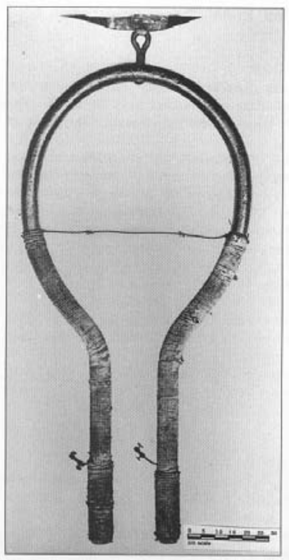

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showing attraction and repulsion of parallel currents".

066 PRIMARY COILS c1857 R.
1796 Unsigned - attributed to Nicholas Callan

Lengths 1360, 1115 & 400; maximum diameters 121, 22 & 80.
Three. The largest has a solid cylindrical iron core (with one squared end) surrounded by a bundle of wires. An insulated coil of heavy copper wire is wound around this system. The thinnest coil has a core consisting of a hollow iron tube, with a single insulated wire wound around it. The smallest has a bundle of wires as a core, with ten heavier wires in the centre. The insulated copper wire is wound around this core.

In 1838, George Henry Bachhoffner (1810-1879), the founder of the Polytechnic Institution in London, described a coil which he made with a core of insulated iron wires, and this gave better results than a coil with a solid core (Fleming 1893,11&15, Hackmann 1989,238). Callan suspended his investigations into electromagnetism in 1837 until the beginning of 1855 when, he states, "I made a long series of experiments on the various parts of the induction coil and apparatus" (Callan 1857,324). He described a coil in which a secondary circuit of insulated iron wire, rolled up tightly into a cylinder, formed not only the secondary circuit but also the core of the primary. Callan went on to describe the advantages of this arrangement over the divided core. However most of Callan's surviving coils have the Bachhoffner-type core [but using uninsulated rods], including those coils dated after 1857.

067 SECONDARY COILS c1857 R.
1796 Unsigned - attributed to Nicholas Callan

Diameters 125, 165, 290 & 330; wire diameter 0.03.
Four secondary coils consisting of insulated fine iron wire.

In 1857 Callan reported that iron wire was superior to copper wire for his secondary coils: "When the secondary coil is made of iron wire, the magnetic power it will receive from the primary current, and from the magnetic inductive force of the core, will be far greater than if it be made of copper wire" (Callan 1857,327). He discovered the advantage of using iron wire while experimenting with a coil in which the secondary coil also formed the core. In the same paper, Callan goes on to describe "an improved method of insulating the secondary coil" (pp.334-6), by drawing it through melted rosin and bees-wax. The varnish had hardened if the coil was wound at a distance of about 25 feet from the stove in which it was heated, and the wire could be insulated at a rate of 8000 feet an hour. The layers were separated by paper used in copper-plate engravings saturated with a solution of gutta-percha [a latex exuded from certain trees] in oil. These secondary coils are insulated in this way.

068 CALLAN LARGE ELECTROMAGNET 1836 R. 611
1660 Unsigned - attributed to Nicholas Callan and James Briody.

Height 1705; width 775; iron core diameter 60.
An iron bar is bent into a horse-shoe shape, with long parallel ends. Part of the curved bar, and all of the long ends, are wound with thick insulated copper wire, and the poles are double wound.

McLaughlin (1955,611) records that: "The iron core weighs 15 stone; the primary originally consisted of seven coils of copper wire, each coil containing 70 feet of wire, 1/6 inch in diameter. These coils could be connected in series or in parallel. The secondary coil contained 10,000 feet of copper wire 1/40 inch in diameter. This machine was capable of giving quite high voltages. A small model of it was exhibited in London in 1837, where it achieved great notoriety. Clarke's first medical coil, and the machines of Backhoffner, Sturgeon and others, were inspired by this model. Used as an electro magnet, the large instrument had a lifting power of several tons". Some of the primary windings and

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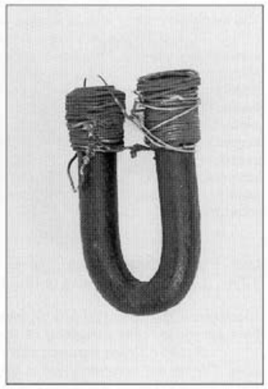

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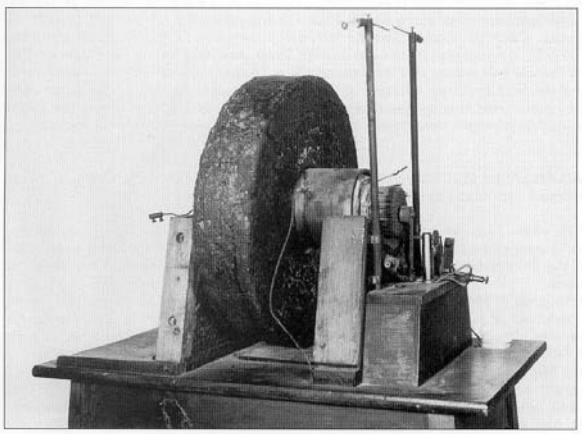

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the secondary coil are missing. The iron core was made by the Maynooth village blacksmith, James Briody.

This important instrument is the earliest preserved induction coil. The World's first induction coil, which was wound on a straight iron bar, was presented to Downside Abbey in England in May 1837 (McLaughlin 1965,72). See also entry ***096.***

069 ELECTROMAGNET c1877 R. 845.1
1722 Signed: YEATES & SON DUBLIN

Base 215x140x22; height 190; coil housing diameter 57; core & wire diameter 25&3.
A mahogany base, on four feet, has a rectangular mahogany support for a U-shaped iron bar. On each arm of the bar is a brass-bound coil of thick, insulated copper wire. The electromagnet has an iron roof-shaped keeper with a hook on top.

Yeates (1877,335) advertised a "Small Electro Magnet, horse shoe form, with stand, &c."

070 ELECTROMAGNET Mid 19 C. G.
1797 Unsigned - attributed to Nicholas Callan

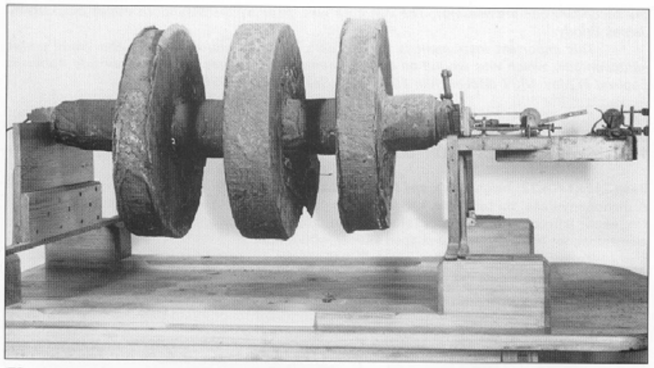
Height 225; bar diameter 36; wire diameter 2.
A rough-cast iron bar, bent in the shape of a U, has copper wire coils around each pole, the wire insulated with red windings. A hole at the base of the U-turn suggests that the electromagnet was once mounted on a base. There is an iron keeper, in the shape of a T, with a cylindrical handle.

071 CALLAN MEDIUM SIZED INDUCTION COIL c1857 R. 612
1659 Unsigned - attributed to Nicholas Callan.

Secondary coil diameter 530, width 108; ebonite cylinder diameter 155; primary coil length 380.
The primary coil of heavy copper wire, insulated with cotton thread, is wound on a bundle of annealed iron wires. The primary is insulated from the secondary by an ebonite cylinder. The secondary coil is of light iron wire insulated with melted rubber and bees-wax. The coil is fitted with a McGauley type interruptor (see below): a vertical iron bar is secured at the bottom, and has a small iron cylinder attached to the upper end, which makes or breaks contact with the core of the electromagnet. A turned brass pillar holds a screw, which makes or breaks contact with the bar. The coil is also fitted with a Rühmkorff-type commutator (**096**), consisting of a mounted ebonite cylinder which can be turned by an ebonite handle: the cylinder is fitted with two brass plates, which make alternating contact with two brass springs. There are two pillars, which hold point electrodes with glass handles. The apparatus sits on boxwood supports on a mahogany table.

Callan (1857,327-8) described his newly-made coil with a secondary of iron wire of 21,000 feet (later increased to 50,000 feet), which he demonstrated to the Dublin Meeting of the British Association for the Advancement of Science in 1857. McLaughlin (1965,73) records that Callan built "huge coils as well as medium-sized ones, and with great liberality he presented them to men of science and institutions in different parts of the world".

James William McGauley (c1806-1867), who was Professor of natural philosophy to the Board of Education in Ireland from 1836-1856, was an "independent inventor" of the "automatic hammer contact breaker", a "first-rate and now multifariously and universally employed device" (McLaughlin 1965,118). Several other people introduced similar devices at around the same time, but McGauley's description to the Liverpool Meeting of the British Association for the Advancement of Science in 1837 seems to have anticipated the others (Hackmann 1989,241). McGauley used a mercury contact-cup, but this was soon replaced and the interruptor became the well known "trembler" of the electric bell, still used today.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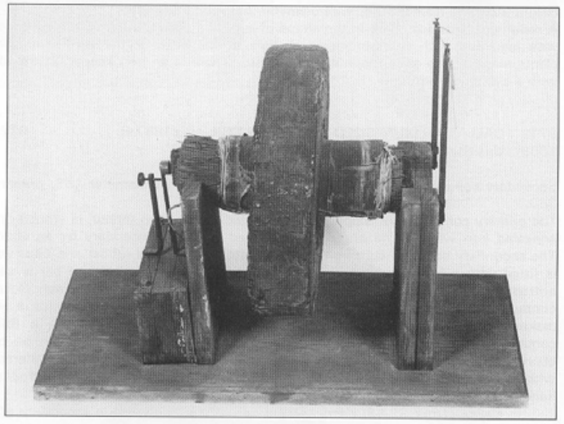
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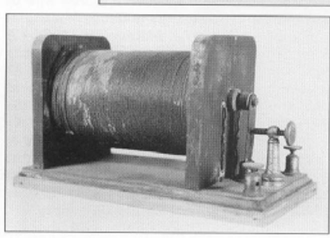
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072 CALLAN GREAT INDUCTION COIL c1859-1863 R. 613
1070 Unsigned - attributed to Nicholas Callan

Primary coil length 1090, maximum diameter 150; secondary coil diameters 530, 550 & 530, widths 90, 107 & 90.
A cylindrical bundle of annealed iron wires forms the core, about which a primary of heavy copper wire, insulated with tape, is wound in three layers. The primary coil is insulated with several layers of thin sheet gutta-percha, cemented with a paste of gutta-percha, resin and bees-wax dissolved in boiling oil. The secondary consists of three separate coils of fine iron wire, each similar to the secondary on the Medium Coil (**071**). The secondary coils are so arranged as to divide the primary into four equal parts, the planes of the coils being perpendicular to the axis. In each coil, the ends of the windings are left projecting so that they can be joined in series or in parallel. Callan used about 150,000 feet of wire in the secondary (Callan 1863,413). The contact breaker is an automatic mercury break of the type developed by Callan in 1858 (Callan 1858,255-259 - **102**), but it is now incomplete. The coil is also fitted with a Rühmkorff-type commutator (**096**), whose drum has an elliptical section. The coil is now mounted on a specially-constructed boxwood table.

*Callan (1863,413) reports that he made an induction coil "of considerable power" in 1859-60, with the secondary in three parts. In early 1863 he improved it with a new primary coil and core, and with better insulation between the primary and secondary. With these modifications, he produced sparks 15 inches in length across a point and plate arrangement (**181**) using three cells of the Maynooth battery (**055**). (To produce a 15-inch spark, a voltage of 600,000 volts is required - M. Casey, personal communication). With this coil, Callan carried out many experiments on sparking potentials and on the influence of the shape of the electrodes on the character of the spark produced. As a result of these experiments, he discovered a method of rectifying high tension alternating current, which was employed in suppressing the reverse current in early X-ray tubes (McLaughlin 1955,613). He also constructed two large condensers (**105**), which he used with the coil to reduce the spark at the break in the primary.*

Fleming (1893,20) reports Rev. Gerald Molloy as stating that the construction of this coil was started by Callan some years before his death, and that it was then left in an unfinished condition.

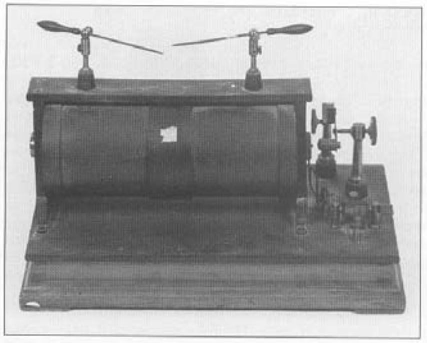
073 CALLAN SMALL-SIZED INDUCTION COIL c1857 R.
1658 Unsigned - attributed to Nicholas Callan

Secondary coil diameter 48, width 102; primary coil diameter 130, width 390.
This is similar to the medium-sized coil (see entry **071**), except that it has a core of iron wires of different diameters: thick in the centre, then very thin, then intermediate. In this case, the primary coil is covered in cloth, rather than an ebonite cylinder.

074 INDUCTION COIL 1865-1877 G.
1803 Signed: Made by Yeates & Son Dublin.

Base 288x111; height 123.
A mahogany base holds two vertical ebonite supports for a horizontal coil. The interruptor is of the McGauley type (see **071**). On the base, which is mounted on a later boxwood frame, there are two brass screw contacts.

Yeates & Son (1877,p.36) advertised a variety of induction coils, which could produce sparks of length one-eighth of an inch to five inches, all of which had built-in condensers, and all but the smallest equipped with a commutator also. They are described as having "Improved and Permanent Insulation". However, the manner of construction and the quality of the finish of this example do not seem to be of the same standard as those illustrated, so this coil may be of an earlier date.



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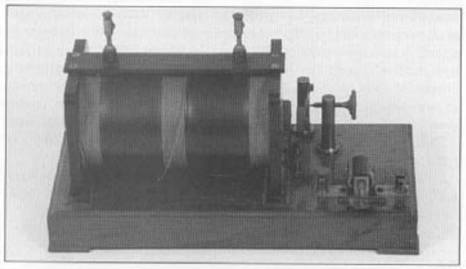

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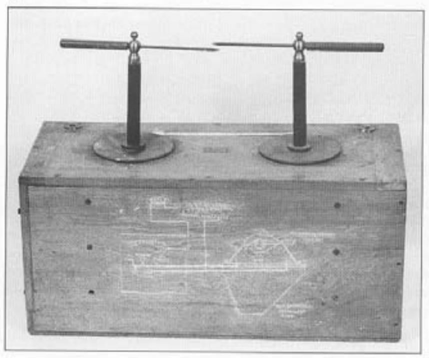

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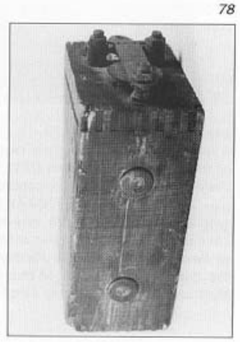


075 INDUCTION COIL c1877 R.
1811 Signed: Yeates & Son, Dublin.

Base 573x302x97; height 405; coil diameter 170.
A mahogany base, with an ebonite top, holds two tapering vertical supports, and a horizontal bridge, with the ebonite-covered horizontal coil inside this frame. At one end is a McGauley type interruptor mechanism (see **071**). Also at this end is a Rühmkorff commutator (**096**) of ebonite and brass. On the bridge above the coil are two ebonite mounts for short turned brass pillars with screw contacts. Clamped to these contacts are two pointed electrodes with turned ebonite handles.

This is probably one of the coils having "Improved and Permanent Insulation" - see previous entry.

076 INDUCTION COIL c1896 R. **751**
1593 Signed: Yeates & Son Dublin

Base 444x205x58; height 280; coil housing diameter 127.
A mahogany base, with four feet, holds two vertical ebonite supports with an ebonite bridge on top. Within this frame sits the ebonite-covered horizontal coil, with string bindings at its ends and in the centre. At one end of the base is a McGauley type interruptor (see **071**) of brass and iron, and a Rühmkorff commutator (**096**) of ebonite, copper and brass, with an ebonite turning handle (broken). Two ebonite bosses on the ebonite bar at the top of the coil support brass screw contacts.

This coil, which forms part of the gift of apparatus given to the Museum by the family of Professor A.W. Conway, was used by Marconi in his pioneering experiment at Dun Laoghaire in 1898, when he transmitted messages from a boat out in the harbour back to land (McLaughlin 1955,751) - see page 14. As a result, the Dublin Daily Express *became the first newspaper in the world to publish news received by radio - the results of the Dun Laoghaire Regatta of that year.*

077 INDUCTION COIL Post 1917 R.
Signed: SUPPLIED BY T.H. MASON 5 & 6 DAME STREET, DUBLIN.

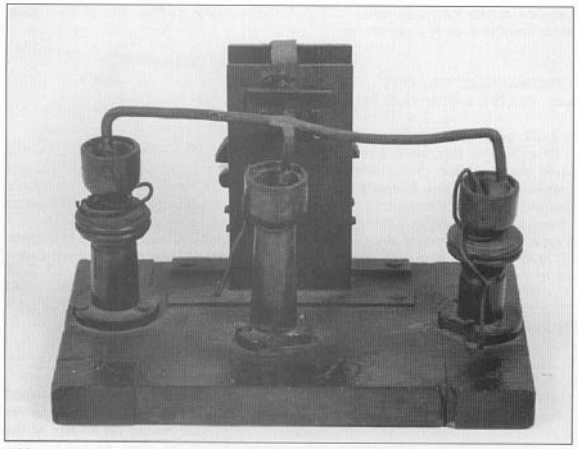
Housing 762x359x318; height 622.
A large boxwood housing conceals the coil. On top, two ebonite discs and pillars lead to brass conductors, with electrical contacts and screw clamps for ebonite-handled point electrodes. There are five brass terminals at one end, labelled "1", "2", "3", and "CONDENSER". A circuit diagram etched on front includes "DC MAIN", "PRIMARY. RESISTANCE", "END. OF. COIL 100V 200V", "200V FOR DRIVING MOTOR", and "6. LBS. MERCURY NEEDED. FOR BOWL".

Thomas H. Mason traded at this address from 1917 (Morrison-Low 1989,131).

078 INDUCTION COIL (FORD MODEL T) Patented 1914
Signed: "PATENTED APR 7, 1914 TRADE MARK K-W MADE IN U.S.A.

Housing 130x85x53.
A rough boxwood housing conceals the coil. On one end is an interuptor mechanism, with a disc connecting either to a contact on an upper brass plate, or the core of the coil. The core consists of a bundle of wires.

A card with the exhibit reads: "Callan Induction Coil: Used for producing sparks in the cylinders of the engine of a Ford Model T car, c.1920. Presented by Rev. Dr. Michael Casey, O.P., Maynooth College, 24 July 1966".



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was used as a dielectric. Ganot (1906,1062) illustrates the use of this type of interruptor with the Marconi spark gap transmitter (164). Very rapid interruptions were required to produce up to 30kV across the coil. AC motors of the type shown were also sold separately by Griffin.

102 CALLAN REPEATER 1837 R. 610
1723 Unsigned - attributed to Nicholas Callan

Base 264x157x22; height 165.
A mahogany base holds three mahogany wooden mercury cups, on turned pillars, and also the modified escapement mechanism of a large clock. A metal and ivory handle turns a cogged wheel, and the axle of a double ratchet, which engages the cogs, is connected to a horizontal copper bar. The axle, and the ends of the horizontal bar, are bent to dip into the mercury cups. On rotating the crank handle, the pinion wheel causes the bar to execute a rapid see-saw movement. This causes the end pieces to make and break contact rapidly with the mercury in the two side cups. These, and the centre cup, were connected in series in the primary circuit of the induction coil.

Using this instrument, Callan was able to achieve more than fifty interruptions per second (Casey 1982,225), and his experiments lead him to the discovery that the severity of the shock produced by an induction coil is directly related to the rate of interruption of the primary current. Callan (1857,324) records: "In April 1837 I published, in Sturgeon's 'Annals of Electricity', a description of an instrument which I devised for producing a rapid succession of electrical currents in the coil by rapidly making and breaking communications with the battery. This, as Mr. Bachhoffner says in one of his papers published in Sturgeon's 'Annals', was the first contact-breaker ever made".

103 STARTING SWITCH Early 20 C. G.
1788 Unsigned

Foot span 208; housing 171x171x95; height 219.
A black metal cage houses two horizontal coils wound on ceramic cores. A sprung switching handle on top of the cage has seven contact points. The housing has a small copper coil on top and three terminals at the side.

CONDENSERS (OR CAPACITORS) AND LEYDEN JARS

"The process called condensation of electricity *consists in increasing the capacity of a conductor by bringing near it another conductor connected with earth. The two conductors are usually thin plates or sheets of metal, placed parallel to one another, with a larger plate of non-conducting material between them" (Deschanel 1891,606). "A condenser is an apparatus for condensing a large quantity of electricity on a comparatively small surface. The form may vary considerably, but in all cases consists essentially of two insulated conductors, separated by a non-conductor, and the working depends on the action of induction" (Ganot 1890,737). Condensers are now called capacitors, and the insulating materials are called dielectrics.*

*The original condenser was the Leyden Jar (**108-111**). It consists of a glass bottle with metal foil inside and out, the foil layers being the conductors, and the glass the insulating material. The jar is charged by connecting one of the coatings (as the foil layers are called) with the ground, and the other with the source of electricity. Turner (1983,189) records that the true inventor of the jar was probably the German experimenter, Ewald Georg von Kleist (c1700-1748) in 1745. But the jar is called after the Dutch town where Pieter van Musschenbroek (1692-1761) found, in early 1746, that an enormous shock was received when a glass jar containing water was electrified. Gillispie (1981,VII,403) records that von*