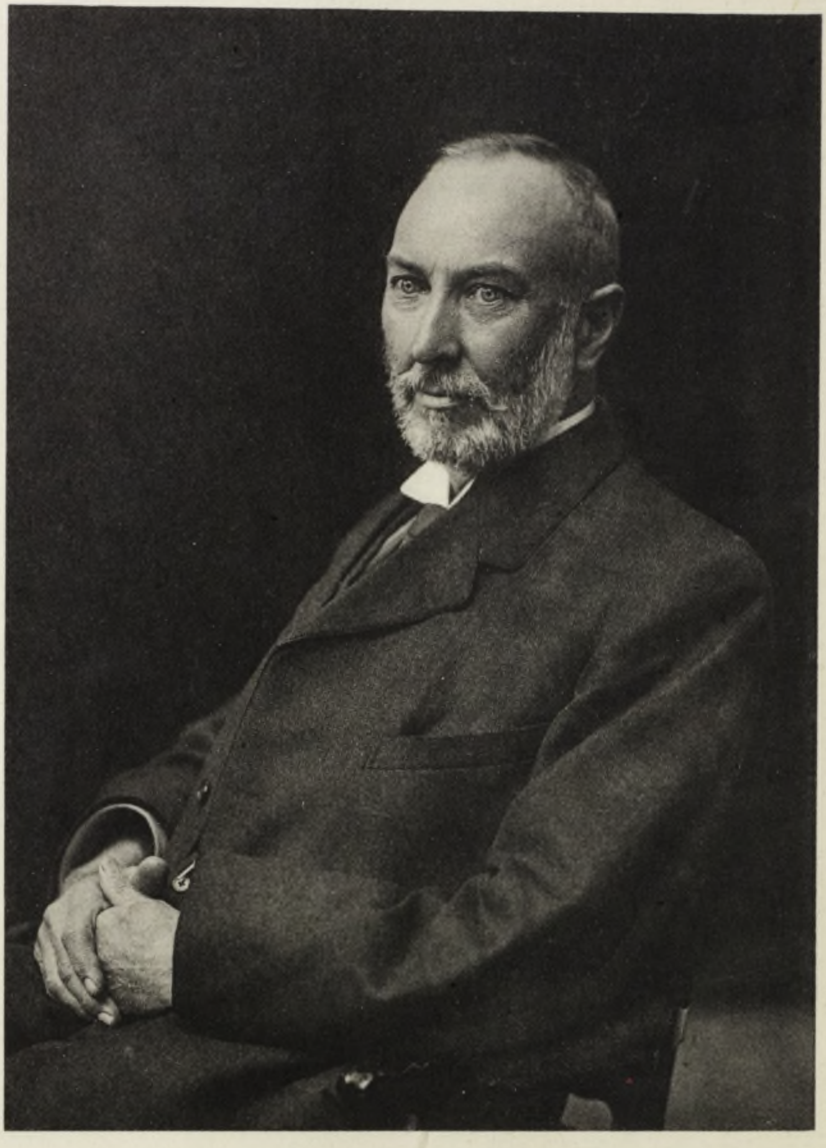

GEORGE GERALD STONEY

1863–1942

GEORGE GERALD STONEY, D.Sc., F.R.S., a lifelong friend and colleague of the honourable Sir Charles Parsons, O.M., K.C.B., F.R.S., was world famous as one of the best known pioneers of the steam turbine and high speed dynamo electric machine.

Born in Dublin on 28 November 1863, his span of life includes the entire period of the power station industry which may be said to date from 1866, when the brothers C. and S. Varley, Dr Werner von Siemens and Sir Charles Wheatstone independently and practically simultaneously discovered the principle of self excitation.

Stoney was the eldest son of Dr George Johnstone Stoney, F.R.S., and Margaret Sophia, second daughter of Robert Stoney of Birr. He had one brother, Robert Bindon Stoney, born in 1866, who was a doctor in Echuca, Australia, and three younger sisters. His relationship with Sir Bindon Blood, R.E., was through his grandmother Ann Blood of Ennis; and his uncle Bindon Blood Stoney, LL.D., F.R.S., was a civil engineer whose textbook on 'The theory of stresses in girders and similar structures' was for many years a standard work of reference.

George Gerald Stoney has recorded that he was a direct descendant of Colonel Blood, an ex-officer of the parliamentarian army who stole the Crown jewels and subsequently was rewarded by Charles II with a pardon and a pension. George Francis Fitzgerald, F.R.S., was a first cousin of George Gerald Stoney and a great-grand-uncle of the latter was Andrew Robinson Bowes Stoney, a notorious character in Newcastle-on-Tyne history.

In early childhood Stoney lived in comfortable circumstances in Dublin, being educated privately by his father and mother. He did not go to school. The father, Dr Johnstone Stoney, was a wonderful teacher and one of the most prominent physicists of Victorian times. As a result, the boy had a good grounding in mathematics, physics, mechanics, chemistry and astronomy, as well as mechanical training in the workshops and laboratory at home. He assisted his father in mounting a 12-inch reflector by Charles Burton and learned much about the technique of the silvering of mirrors—knowledge that was to stand him in good stead in later years.

Bicycling was a favourite pastime of Stoney's; in 1876 he had a wooden 'boneshaker' followed later by a series of 'penny-farthings' and other bicycles, of which he has left several good photographs illustrating the extraordinary variety of well thought out machines, including tandem bicycles and tricycles that were marketed by different makers towards the close of the nineteenth

century. In 1882 and 1883 with his father he contributed two papers on bicycles and tricycles.

Photography was another of Stoney's youthful hobbies and he had a very good quarter-plate camera with a lens giving first-class definition. Many of his negatives made in Ireland in 1887 are still in existence. They show a high degree of aptitude for choosing 'pictures' and the correct length of exposure.

In June 1882 at the age of nineteen Stoney entered Trinity College, Dublin, and at first found himself handicapped by his 'miscellaneous' education. However, he took first-class honours in mathematics and graduated in 1886 as second senior moderator and gold medallist in experimental science.

In 1884 while still attending an arts course of study he entered the engineering school, graduating B.A.I. in 1887 with three special certificates. During this period he worked in the vacations with his uncle, Bindon Blood Stoney, F.R.S., who was engineer to the Dublin Port and Harbour Board.

C. A. Parsons, who preceded Stoney at Trinity College, Dublin, in 1872, also had been educated privately, one of his tutors being Dr Johnstone Stoney, F.R.S. Through this connexion the two boys knew each other although Gerald Stoney was junior by nine years. During the time Gerald Stoney was at college, C. A. Parsons became in 1883 junior partner and chief electrical engineer at the works of Messrs Clarke, Chapman & Company at Gateshead-on-Tyne, and Gerald, having continued work with his uncle for a year after graduating, joined Parsons at Gateshead, though whether at his own request or at the invitation of Parsons, is not known. There is an open testimonial still extant dated 2 July 1888, given to Gerald by his uncle on the termination of his work at Dublin Port, in which Bindon Blood Stoney writes: 'In the various matters entrusted to him Mr Stoney has shown great aptitude for his profession, as he combines both scientific and practical knowledge, and I scarcely think I know any one on whose honourable discharge of his duties I should place greater reliance'.

Stoney's name appears in the books of Messrs Clarke, Chapman, Parsons & Company on 19 September 1888, and he was then being paid at the rate of ten shillings per week as an apprentice draughtsman.

In these circumstances he first became acquainted with the compound steam turbine, then in its infancy and limited in its application mainly to small electric lighting plants for ships. The first ship to have such an installation was the S.S. *Earl Percy* (1885), followed by the S.S. *John Ormston* (1887) and the S.S. *Tynesider* (1888), all three ships belonging to the Tyne-Tees Steam Shipping Company.

The largest turbo generators made at Gateshead were 75 kW sets but Parsons was already designing a 500 kW machine with high- and low-pressure turbines in tandem. Stoney records that he himself made the drawings in 1888 at Parsons' instruction.[1] From 75 kW to 500 kW in one leap was a big

[1] A longitudinal section through the double flow l.p. turbine was reproduced in plate 15 of Sir Alexander Richardson's book, 'The evolution of the Parsons steam turbine' (*Engineering*, 1911). An original inked general arrangement drawing on tracing paper, dated 24 January 1889 is preserved at Heaton Works.

advance and it was this attempt to 'force the pace' that precipitated the disagreement which led to Parsons' resignation and to the foundation of his own works at Heaton, Newcastle-on-Tyne, in 1889. Among others Stoney accompanied Parsons to Heaton Works where at first he was working in the shops. His name does not appear on the salary book of Messrs C. A. Parsons & Company until 23 April 1890, his remuneration being at the rate of £2, 10s. 0d. per week. Among the small band of about a dozen whom Parsons brought with him from Gateshead only two now survive. They are J. H. Armstrong and Francis Hodgkinson, both retired.

Armstrong was best known at Heaton Works for his able service in the armature winding shop of which he was for a long time foreman. Of Stoney he writes: 'I was in charge of the test house (at Gateshead) and Stoney was sent to assist me. He had just come straight over from Dublin. I quite enjoyed working with him. . . . I spent several nice evenings with him at his lodgings in Denmark Street. . . . He talked a lot about the Dublin Port and Docks, the jobs he had had, the surveying he had done, and of Trinity College. He also showed me his four bicycles, one I remember being driven by the sun and planet system. After several weeks together I was sent on outside work and lost sight of Stoney until we came together again at Heaton about October 1889.'

Francis Hodgkinson's fame in the turbine world ranks almost as high as that of Stoney. In 1895 Hodgkinson took the Parsons steam turbine to the United States of America, becoming chief turbine engineer to the Westinghouse Machine Company at Pittsburgh. Mr J. H. Armstrong writes: 'I do not think Stoney knew Hodgkinson at Gateshead for the latter went to Chile with a warship in some official capacity, but they knew one another very well at Heaton'.

In his reminiscences Stoney has recorded that 'The works were started in November 1889 with 58 men all told, including Mr Parsons and the office boy'.

For a time Stoney, who was then aged twenty-six, worked in the shops as a fitter but evidently was expected to turn his hand to anything. For example there is extant a report in Stoney's handwriting and dated 5 September 1891, on a ship lighting plant installed on George Randal, Esq.'s, S.Y. *Lady Beatrice.* Again, in 1892 Stoney was testing a unipolar dynamo. He has written of his experience as follows: 'There was one made for the Elmore Copper Company in 1892 for 6000 amps $1\frac{1}{4}$ volts at 1200 r.p.m. (belt driven). The brushes were copper foil and for lubrication and cooling a solution of soap and water was poured over them. This machine welded a $\frac{3}{4}$-inch iron bar, the biggest that has been welded by continuous current so far as I know. We ran it by a belt off the 5-inch commutator of the 12 kW shop machine. We had a job to get even a double belt to run, and tightened it again and again. Finally, it broke with a report like a pistol shot, and carried away the back door of the test house behind the unipolar. It was lucky no one was in the way! The great difficulty with unipolars was collecting the current and the large drop in voltage with load, for the drop at the brushes and the heating of them was serious. Compound

winding was difficult with very large currents. Designs were considered with a number of copper sleeves insulated from one another, to get 100 volts, but were not considered practical.'

In 1893 Stoney's previous knowledge of the silvering of mirrors led to his appointment as manager of the Searchlight Reflector Department and he also held the post of foreman of the test house, where completed turbo generators were tested under steam before dispatch. An agreement dated 24 July 1893 runs: 'C. A. Parsons & Company agree to employ and George Gerald Stoney agrees to serve the said employers for a period of five years from the date hereof in the capacity of an electrical engineer, the duties of which shall comprise the management of the mirror and testing departments, the carrying out of experiments and such other duties as in the nature of his office shall from time to time be found requisite'.

In the succeeding years Stoney ably assisted Parsons in the long struggle that lay ahead. Many records of his work, in the form of memoranda and personal reports to Mr Parsons on a great variety of subjects, both electrical and mechanical, bear witness to the diligence with which he supported his chief. The patents taken out in his name in conjunction with Mr Parsons supply the evidence of his ability as an engineer.

It is difficult to-day to appreciate the obstacles which had to be overcome. Engineers were very slow in perceiving the practical utility and great future for the compound steam turbine. Parsons strove for thirteen years (1884–1897) before any notice of his efforts was taken on the continent of Europe. It was not until 1903 at Neptune Bank[2] and Carville[3] power stations after a long uphill struggle against tremendous obstacles and difficulties that Parsons finally established the steam turbine as the most suitable prime mover of the future for large electric generating power stations and fast liners. Only then was the economic value of the steam turbine realized and its development subsequently pushed to the limit throughout Europe and America, in the face of all obstacles. Stoney had the privilege of being an active witness of this epic of engineering history.

The year 1894 was a year of notable events, some of them not without humour. For example in that year Stoney installed a 150 kW 3000 r.p.m. radial flow turbine and single phase alternator at Portsmouth. This machine was erected alongside of a 100 kW Ferranti alternator driven by a Yates and Thom steam engine. At the official opening of the new plant Ferranti machines were supplying the town and the Parsons machine was supplying the arc lamps in the power station. In the evening there was a municipal banquet and afterwards a number of the aldermen, councillors and guests visited the station. The Parsons alternator was running at a frequency slightly different from that of the external

[2] The Cunard Commission based their recommendation that steam turbines should be adopted in the *Mauretania* and *Lusitania* on trials carried out in 1904 on a Parsons 1500 kW turbo alternator at Neptune Bank power station compared with the performance of an 800 kW reciprocating steam engine driven alternator in the same power station.

[3] The 3500 kW turbo alternators installed at Carville power station in 1903 gave the *coup de grâce* to the reciprocating steam engine for electric power generation.

load, and the arc lamps thus produced a stroboscopic effect which gave the Ferranti machines the appearance of slowly revolving backwards. The well dined aldermen and others perceived this with consternation, but did not dare to comment on it!

It was intended that these generators should be capable of being run in parallel with one another, though much scepticism was expressed about the possibility of linking up slow speed 100 r.p.m. alternators with a high speed turbo generator. Actually no difficulty was experienced. This was the first time that a steam turbine was run in parallel with reciprocating engines.

Surprisingly high peripheral speeds were used in the radial flow turbines built between 1890 and 1894. Stoney described an accident to one of these as follows: 'Radial flow turbines were installed at Cambridge, Scarborough, etc., and were for an output of 150 kW, 2000 volts single phase alternators, 4800 r.p.m. The h.p. discs were of cast iron, and the final l.p. disc, which was bladed on both sides, was of mild steel boiler plate 27 inches diameter. The peripheral speed was thus 560 ft. per second. This would give a stress of about 12 tons/in^2 at the hole, not counting the load of the blades, but fortunately none knew at that time how to calculate stresses in a disc, or they would have hesitated to put over 12 tons/in^2 on 28 ton material. One of the Scarborough machines ran away on account of the armature bursting due to the binding wire going and the square on the coupling shearing off. The governor valve was leaking and thus failed to stop the turbine. The driver ran away also, but finally steam was shut off at the boiler.'

'The turbine was practically wrecked, some of the cast iron h.p. wheels burst and the l.p. disc was expanded about $\frac{1}{4}$ inch. A curious thing was that it was expanded about equally at the hole and at the rim, the former from 4 inches to 4$\frac{1}{4}$ inches and the latter from 27 inches to 27$\frac{1}{4}$ inches. Of course, all the blades had gone, and the balancing holes for passing steam through the disc were oval.'

Stoney added: 'These l.p. discs used sometimes to become slack on the spindle, they were then bored out and bushed and rarely became slack again. Truly we were brave people in those days!'

In 1894 Stoney was married to Isabella Mary, second daughter of Michael Lowes of Corbridge-on-Tyne. He was settling down in his new home at 'Oakley' in Heaton Road when the period of the development of the S.Y. *Turbinia* commenced (1894–1897) and was one of the original syndicate formed by Parsons. Stoney wrote: '*Turbinia* was started in 1894 and I well remember Mr Parsons telling me that he was forming a company to try the experiment of applying the turbine to marine propulsion. I had not much in those days but scratched up £200 and put it in. I have had some eight to ten times that out of it—I am not sure how much. Mr Parsons afterwards gave me £200 more, making my total £400.'

The turbine machinery of the *Turbinia* was designed and built at Heaton Works. A single radial flow turbine was tried at first but the hope of realizing the anticipated speed of propulsion was doomed to disappointment. This, however, was not the fault of the turbine, which was proved 'not guilty' by

means of a torsion meter, but of the propeller. The final triumph is well known.[4]

Stoney was one of the original crew of the *Turbinia* and at the time of his death was the last survivor. He has recorded how, after trials off Tyneside, Parsons would land at Wallsend and either bicycle up to Heaton Works or drive up in the works' cart, with his clothes still wet with sea water, and sign letters before going home. The rheumatism to which Parsons was subject later may be attributable to this cause.

Stoney has left several notes recording his own experiences. For example: 'We went out to make for Professor Ewing a consumption test at 12 knots. There was a nasty swell on, which seriously affected most of the crew, though Mr Parsons himself seemed proof. We went up and down the coast over the Hartley mile, and we rolled and rolled and rolled. I was taking the times and as I sat on the deck I wondered whether the mile posts would come along first or whether the sea would take its toll. The mile posts did come along, however, the sea took its toll, and I did not read the stop watch for the next five minutes.'

Or again, at the time of the wonderful run at 34½ knots at the Naval Review at Spithead in 1897: 'Shortly after, we were going quietly along towing a boat from Captain C. J. Leyland's yacht, which was our house boat. Just as we went past the bow of a battleship, a French yacht appeared. There was no time to stop, but Leyland, who was our captain, signalled full steam ahead. I promptly sat down on the deck, as the acceleration of 2500 s.h.p. on 40 tons is pretty big. We shaved the bow of the big yacht but the tow rope broke and the boat behind (in which was Leyland's Scotch skipper) went bang into the side of the French yacht. I just heard a volley of Scotch and French from the two skippers.'

In 1895, at the age of thirty-two, Stoney became chief designer in the steam turbine department. He was also appointed chief electrical designer for both high speed d.c. dynamos and alternators. It will be appreciated that with these appointments, his management of the searchlight mirror department, his experimental work and other matters which required his attention, Stoney's life during the succeeding years was a busy one.

In 1901 The Brown Boveri Company of Baden took up a licence for the manufacture of steam turbines and this caused Stoney to make trips abroad from time to time from which he gained much experience. It so happened that in 1901 Stoney was in difficulties himself, for the revolving armatures of high speed alternators were proving more and more troublesome as the size was increased. Stoney wrote: 'The first stationary armature was used at Neptune Bank in 1902. It was for a 1500 kW machine, 3 phase, 40 cycles, 6600 volts. The original armature tried in this alternator was of the revolving type, with fixed field magnets. High voltage and heavy centrifugal pressures between the windings proved fatal. The overlapping windings cut into one another and 'went up'. Something had to be done. I wanted to adopt the barrel rotor[5]

[4] It was published in *Pearson's Magazine* (vol. 6, July–December 1898) in an article by Cleveland Moffett, entitled 'The fastest vessel afloat'.

[5] i.e. rotating field magnets.

invented by C. E. L. Brown in 1901, drawings of which I had brought from Baden. Mr Parsons would not have 'any damned German invention'. I was at my wits' end what to do, and designed the abominable salient pole rotor with sliding-on pole tips, which was afterwards largely used (e.g. in a 3500 kW and a 5000 kW turbo alternator at Carville). At Mr Charles Merz' suggestion a modified form of barrel rotor was designed. The coils were wound, put into tin cases, impregnated and soldered up. They were held in place by keys. This rotor was a failure owing to the poles being too narrow. As a result, Mr Parsons *had* to adopt the 'damned German invention'.' Under the terms of the licence, particulars of the design were furnished without cost.

Again, Stoney was faced with the problem of overcoming commutator sparking in d.c. dynamos when the load changed. He wrote: 'Shifting of the brushes with load caused endless trouble. The first attempt to overcome this was to shift them automatically as the load altered. It was effected by a steam cylinder controlled by a spring and connected to the inlet branch to the turbine blading (Parsons-Stoney patent). It worked all right, but there was a time lag and furious sparking if a big load was suddenly thrown on. I wanted to try interpoles, which I had seen on the continent, but Mr Parsons would not have them, and I designed the compensating winding in the pole faces. This worked very well, but owing to the large leakage flux, to be effective it required to have at least 2·3 times the armature ampere turns, and the quantity of copper was enormous. There were heating troubles, also troubles due to coils shifting when a 'short' took place.'

In later years, after the introduction of mechanical gearing which enabled low speed dynamos to be driven by steam turbines, Stoney always referred to the high speed turbo dynamo as 'that most abominable machine'.

Stoney's remarks on the introduction of 'stalloy' for armature core plates are of interest. He wrote: 'About 1903 Sir William Barrett tested a lot of alloys (made by Mr Robert Hadfield) for conductivity and permeability. He read a paper to the Institution of Electrical Engineers about this investigation. I saw it and I saw that two, a silicon and an aluminium alloy, had important properties (low hysteresis and low conductivity). I wrote to Barrett a letter which he put into the discussion on the paper, and Hadfield asked me to go to Sheffield, which I did. I did not see him there but one of his men, who said that the stuff could not be made, could not be worked, could not be rolled, etc. They would do nothing. I then saw Jenkins of Sankeys, who were our suppliers of armature and transformer core plates. They would do nothing. I did not want to go to the Germans but a man from the Bismarkhütte of Berlin called and I told him about it. He asked me to lend him Barrett's paper, which I did, and like a man he returned it. Three months after they quoted us for the stuff, and we bought it from them for a long time. Then Sankeys took it up and made it under the name of Stalloy!'

Some idea of the value which Parsons put upon Stoney's work can be gained from an agreement signed in December 1904. In it Parsons wrote: 'Confirming what I have mentioned to you verbally, I beg to say that I propose to open a

special account with you in our books, and to credit it with five thousand pounds which during your service with the firm will bear interest at four and a half per cent per annum. This interest you will be at the liberty to draw half yearly or yearly. If you continue in the service of the firm for ten years from this time, the capital will be yours and the interest will cease, and you may draw the capital, or, by arrangement with the firm, continue it.'

Additions to the sum were made in 1907 and 1910. Further evidence of Stoney's ability as an engineer is supplied by his Cantor lectures to the Royal Society of Arts in 1909. These are a very ably written account of the state of the art of building steam turbines and high speed electric generators at that time.

Between 1904 and 1907 Parsons was preoccupied with three main problems, the 5000 kW turbo alternators at Carville power station, the 37,000 s.h.p. turbines for the *Mauretania* and *Lusitania*, and the 25,000 s.h.p. turbines for the first all big gun battleship, H.M.S. *Dreadnought*. From 1901 up to the beginning of this period he had spent much time with his 'vacuum augmentor' for high vacuum surface condensing plant, and with his axial flow air compressor. Pressure of work prevented him from devoting his energies to each problem as he would have liked, and he relied on Stoney to relieve the burden on his shoulders by conducting Heaton Works on the managerial as well as on the technical side. Stoney was doing research at the same time himself, for in the records at Heaton Works there is a reprint from the *Proceedings of the Royal Society* (A. vol. 82) of a memoir entitled 'The tension of metallic films deposited by electrolysis', communicated by C. A. Parsons in January 1909. In 1910 Stoney had become technical manager of the entire Heaton Works—Parsons reserved the title of 'chief engineer' for himself—and in the following year he was elected to the Fellowship of the Royal Society.

The reader will gather from the foregoing account how deeply Stoney's fortunes and career had become bound up with the development of Heaton Works. After the great struggle, Parsons had brought his enterprise into comparatively calm waters, and Stoney had risen from the ranks to the post of second in command. He was then aged forty-seven and his future appeared to be assured. Yet during this period there arose difficulties which increased as time went on and led ultimately to his resignation in 1912.

This most regrettable turn of events may be attributed to the following causes. Ever since the foundation of Heaton Works in 1889 Parsons had looked upon his works as his experimental workshop. When the time came (from 1895 onwards) that licences to manufacture steam turbines were granted to other companies in England and abroad, he regarded his works as a place where experiments could be carried on continuously so that improvements could be made and passed on to the licensees. As regards orders for Heaton Works, his only desire seemed to be to secure enough work to keep his workshops busy and sufficient profit to finance the development and experimental work. He never tried to create a monopoly or to corner the market.

On the other hand, it became clear to the management that if Heaton Works

were to continue, it was essential that they should no longer be regarded as an experimental shop, but should be reorganized on business lines, free from interference with the standardized turbine plant which had to be available for tenders for new work. J. H. Barker, at one time general manager at Heaton Works, wrote[6] apropos of Parsons' wilfulness: 'Had he had his way he would never have made two machines alike, each succeeding one would have been improved. I forestalled him once when, catching him in a complacent mood, I obtained his permission to have cast two turbine cylinders for 1500–2000 kW sets as well as four cyclinders for 1000–1500 kW sets so that he could not subsequently alter the design. I had the satisfaction of seeing them absorbed immediately for Manchester and Sheffield.'

Parsons' way of settling these controversies was simply to challenge: 'Who is paymaster here?' What was required, however, was the reorganization of the staff and the defining of departmental provinces, because besides Stoney there were other energetic and able men employed in the works, who felt themselves thwarted and were not content merely to do what they were told. Stoney's organizing power proved to be not so great as his ability as an engineer, but had he held on for a few more years all might have been well, for ultimately the matter settled itself because its urgency brooked no further delay. Unfortunately, his temperament would not allow him to compose these differences on administrative matters or to carry on in spite of them. In a moment of extreme vexation he departed (30 June 1912).

During the twenty-four years between 1888 and 1912 Stoney had seen steam turbine installations develop in size from 32 kW to 25,000 kW on land and from 2300 s.h.p. to 74,000 s.h.p. at sea.[7]

The last known report written by Stoney before his resignation is dated 12 May 1912. It describes the experiments which he had been conducting on the single collar pivoted pad thrust bearing invented by Michell. Stoney wrote: 'Bearing metal thrust blocks carried from 600 lbs. to 1100 lbs. per square inch before they seized. White metal thrust blocks were also tried and one carried 1900 lbs. per square inch before it began to smoke, and on easing to 1400 lbs. per square inch ran all right—neither the shaft nor thrust blocks being appreciably worn or torn. Another one carried 2100 lbs. per square inch with no signs of seizing or wear: in fact, the blocks were hardly marked. In my opinion therefore it is safe to calculate on about 500 lbs. per square inch for white metal thrust blocks under such conditions.'

Stoney recorded that after he left, he realized that he must find some employment temporarily that had to do with steam turbines, for his whole career had been occupied with them and he could not immediately turn his hand to something else. At the same time his loyalty to Sir Charles Parsons (as Parsons had become in 1911) prevented him from going over whole-heartedly to a competitor. He decided to take up consulting work and commenced by acting as adviser on turbine matters to Messrs Richardsons, Westgarth at Hartlepool,

[6] *Heaton Works Journal*, 3, 313 (1938–1941).

[7] *Mauretania* had two independent installations, each of 37,000 s.h.p. on two shafts.

who at that time were licensees of Heaton Works. He also acted as consultant to a company known as Wetcarbonizing Ltd., who were operating a peat factory at Dumfries.

When the Great War commenced in 1914 Stoney gave his services as joint secretary of the Tyneside Irish Battalions, four of which were raised in the district. He also served on Lord Fisher's board of invention and research, and later on the Lancashire anti-submarine committee. In 1915 he became a member of the Newcastle-on-Tyne Education Committee, continuing this work until 1917 when he accepted the chair of Mechanical Engineering in the College of Technology at Manchester, in succession to Professor A. B. Field.

During his period of office there he published several papers mainly on steam turbines and was a member of the original committee appointed by The Institution of Mechanical Engineers to report on 'What experiments relating to the subject of 'The action of steam passing through nozzles and steam turbines' could with advantage be undertaken', the subsequent research being carried out at Manchester.[8] In 1920 Professor Stoney was appointed reporter for this work. In the same year he was made an honorary D.Sc. of Durham University, a distinction of which he was very proud.

Two years before, Stoney had been elected a member of the Council of King's College in the same university and continued to be a member until his death. He took a keen interest in the affairs of the college and especially in the Faculty of Applied Science. He was a valued member of the Research Committee and also of the Electrical Engineering Committee and of the John H. Holmes Memorial Lectures Committee.

Happily there had been reconciliation between Stoney and Sir Charles Parsons, and during his stay at Manchester Stoney was in continuous correspondence with his old firm, supplying technical information and receiving practical data in return. During vacations and also at other times he was frequently a visitor at Heaton Works and always took a keen interest in the progress that he saw had been made in modern steam turbine design. His interest in the electrical side seemed to have largely subsided, it was generally turbines and condensing plant that held his attention. He was delighted when any one from Heaton Works, who happened to be in the Manchester district, came to see him.

From about the year 1916, to the adversity with which Stoney had been confronted and which he had faced with fortitude, there was added the tragedy of his wife's long illness, for Mrs Stoney gradually had become a helpless invalid. During his nine years at Manchester Stoney had been obliged to leave her at Oakley, his home in Heaton. As, in spite of all aid, her malady developed, her husband was obliged more and more to absent himself from Manchester at week-ends and at other times, to return home. Sir Charles Parsons, who became aware of this sad situation, then showed that kindness of heart which so endeared him to those who knew him well. He invited Stoney to return to Heaton Works and to accept the position of Director of Research. In 1926

[8] The tests were carried out at the Dickinson St. power station of the Manchester Corporation.

Stoney relinquished his professorship for this purpose, and recommenced at Heaton Works on 23 August of that year.

In his first report made to the directors on 29 September Stoney discussed the general theory of exhaust losses in condensing turbines and showed how model experiments must be carried out with the same Reynolds number. This led to the construction of standard apparatus for model tests and was a valuable contribution to modern progress. With great energy Stoney carried out experimental work in steam turbines, condensing plant, high speed pumps and fans and other subjects.

In addition to his other duties Stoney gave much advice on the reorganization of the searchlight mirror department which during the period 1914–1918 had become the largest of its kind in the world. His knowledge of optics also enabled him to advise on the research work of Sir Howard Grubb, Parsons & Company at the adjacent premises at Walkergate, a business which Sir Charles had brought from St Albans in 1926.

Mrs Stoney died in January 1930 and is commemorated by the 'Isabella Stoney Prize' which her husband endowed at the Manchester College of Technology. On 31 March of the same year Stoney retired, but he did not lose interest in Heaton Works and nothing pleased him more than an invitation to walk round the shops and to discuss matters of turbine design. Even at his age (67) he was sought after by other manufacturers to take a position as steam turbine expert, but he remained loyal and would have none of it.

Sir Charles Parsons died on 11 February 1931 and in 1937 Stoney wrote the second Parsons Memorial Lecture, which he delivered before the Institution of Electrical Engineers on 25 November. The story he then told covered not only the development of steam turbines, condensing plant, turbo fans and compressors, electrical machinery, searchlight mirrors and other products characteristic of the present activities of Heaton Works, but also ranged over the manufacture of arc-lamps, unipolar dynamos, clock energy meters and other apparatus to which Sir Charles devoted his energies in his younger days.

In 1937 the Optical Works (Sir Howard Grubb, Parsons & Company) received an order from The Imperial Tobacco Company at Bristol for a heliostat and mirrors to be arranged on a roof so that their board room, badly situated owing to the growth of the factory, should be illuminated by sunlight whenever it was available. For this purpose a large instrument was built, based on a tiny model that had been made by Dr Johnstone Stoney, and which had been preserved by his son. The installation proved a success, to the delight of the latter.[9]

Stoney retained until the end his connexion with the International Electrotechnical Commission, having been appointed a delegate of the British National Committee to attend the meetings of the Advisory Committee of the Commission on Steam Turbines. He attended their meetings at Bellagio, Berlin, London, Stockholm, Oslo, the Hague and other places. At Berlin in 1930 he also attended the second World Power Conference and the meetings of the

[9] *The Engineer*, **164**, 319 (1937).

International Committee on the Properties of Steam. On that occasion it seemed that in Germany he was held in even greater respect, as 'the father of the steam turbine', than Sir Charles Parsons himself. Certainly at the A.E.G. Works where Stoney was especially invited to lunch, the directors received him with the deepest awe. He carried off the situation with aplomb.

On one of his journeys abroad, Stoney travelled back from Amsterdam by air and was photographed sitting in the aeroplane by a press reporter of a well known society paper. The photograph duly appeared, and, much to Stoney's amusement, the caption read 'Lord . . . becomes air minded!'

Stoney's work on the International Committee on the Properties of Steam was very painstaking and valuable, and he also continued work on the turbine committee of the British Standards Institution. He retained his interest in the meetings of the Newcastle-on-Tyne Branch of the Institution of Mechanical Engineers and of the North-East Coast Institution of Engineers & Shipbuilders. He was also a member of the Newcastle Antiquarian Society, and of the Pen and Palette Club. The former gave him much opportunity for country rambles with his car and camera, for he was greatly interested in ancient Britain and in Roman Britain, the counties of Northumberland and Durham providing wide scope for research in these subjects. He also remained president of the Cyclists' Touring Club in the same counties.

During the latter part of his retirement Stoney was requested by a foreign company to advise them on peat manufacture, his knowledge of which evidently had become known abroad, but he felt that he was too old to undertake the journey and with regret, declined.

Stoney's disposition was kindly, sympathetic and humorous, but at times his Irish temperament showed itself. In controversy or under criticism he was inclined to be scornful but did not seem to realize the irritation that this caused, sometimes even in ordinary conversation. For example, always an ardent motorist, he was one of the first to run a Ford. One day some one was contrasting his own car of more ambitious pretensions and Stoney asked him if he had ever driven it under really severe conditions, such as on a very steep hill or on a rough unpaved track. He replied that he did not think that it was fair to a good car to treat it thus, whereupon Stoney retorted 'Oh, I've no use for a car that won't go anywhere!' a rejoinder which was apt but somewhat nettling.

Often, if some one made a statement to him Stoney would say that his experience of life had made him a confirmed sceptic, and here again he sometimes caused ill-feeling. Of politics he said: 'Whichever party is in power, I'm agin 'em'.

Nevertheless, Stoney made and retained many friends. He held the respect of all for his scientific attainments, his loyalty to his old firm and his devotion during his wife's long illness. Some years before his own decease he had given instructions that he was to be laid beside Mrs Stoney in the cemetery at Corbridge-on-Tyne. He was troubled with bronchitis in the winter of 1940 and this left him with a weakened heart. He told his friends that he did not think he would live to see the end of the war, a prediction that unhappily came true for on 15 May 1942 in his seventy-ninth year he died at Oakley after a short

illness. Thus there came to an end a long and useful career, maintained through adversity in both business and private life. Dr Stoney left no heir.

This account has been prepared largely from information supplied by Dr Stoney himself during his lifetime and from the author's personal knowledge. Acknowledgments are made with thanks to Trinity College, University of Dublin; Messrs Clarke, Chapman & Co. Limited; Mr J. H. Armstrong; Manchester College of Technology; King's College, University of Durham; Newcastle-on-Tyne Education Committee; and to Messrs C. A. Parsons & Company Limited for access to Dr Stoney's files and records written when an employee of Heaton Works.

ROBERT DOWSON

BIBLIOGRAPHY

CONTRIBUTIONS TO SCIENTIFIC AND TECHNICAL LITERATURE

(With Dr JOHNSTONE STONEY.) Gearing for bicycles and tricycles. *Royal Dublin Society*, 1882.

(With Dr JOHNSTONE STONEY.) The energy expended in propelling a bicycle. *Royal Dublin Society*, 1883.

Experimental method of determining moments of inertia. *Royal Dublin Society*, 1886.

Quantity of oxygen in the atmosphere compared with that in the earth's crust. *Phil. Mag.*, June 1889.

(With Sir CHARLES PARSONS.) Trials of steam turbines for driving dynamos. *Institution of Mechanical Engineers*, 1901.

The continental practice in electric light stations. *Institution of Civil Engineers, Newcastle Students' Association*, 1901.

The use of large blocks in harbour and other marine works. *Institution of Civil Engineers, Newcastle Students' Association*, 1902.

Chairman's address. *Newcastle Branch of the Institution of Electrical Engineers*, 1904.

(With Sir CHARLES PARSONS and C. P. MARTIN.) The steam turbine as applied to electrical engineering. *Institution of Electrical Engineers*, 1904.

Presidential address. Recent advances in engineering. *Institution of Civil Engineers, Students' Association*, 1904.

(With Sir CHARLES PARSONS.) The steam turbine. *Institution of Civil Engineers*, 1905.

(With A. H. LAW.) High speed electrical machinery. *Institution of Electrical Engineers*, 1908.

Tension of metallic films deposited by electrolysis. *Proc. Roy. Soc. A*, **82** (1909).

Steam turbines. Royal Society of Arts. (Cantor lectures.) 1909.

High speed bearings. *North East-Coast Institution of Engineers and Shipbuilders*, 1914.

The effect of vacuum in steam turbines. *Institution of Mechanical Engineers*, 1914.

Turbine design. *Engineering*, 13 February 1914.

The effect of vacuum in steam turbines. *Engineering*, 19 November 1915.

Address to the engineering section. *British Association* (*Newcastle*), 1916.

Divergence of steam nozzles. *Engineering*, 7 December 1917.

Stresses in turbine blading. *Engineering*, 26 April 1918.

High speed turbine gears. *Manchester Association of Engineers*, 1919.

(With S. LEES.) Manufacturing interchangeable articles to limit gauges. *Engineering*, 22 March 1919.

(With T. PETRIE.) Production of sound under water. *Engineering*, 29 October 1920.

The Callendar equations for steam. *B.E.A.M.A. Journal*, October 1921.
Recent advances in steam turbine design. *Electrician*, 24 June 1921.
Pressure distribution in steam turbines. *Engineering*, 4 March 1921.
(With N. ELCE.) Flow of air and steam in nozzles. *Engineering*, 2 December 1921.
(With R. O. BOSWELL and J. MASSEY.) Thickness and resistance of oil films in high speed bearings. *Engineering*, 3 March 1922.
(With T. PETRIE.) Physics of the steam turbine. *Dictionary of Applied Physics*, 1922.
Proportioning of impulse blades and nozzles. *Engineering*, 3 October 1924.
Failure of materials in engineering. *Engineering*, 12 August 1925.
The economic speed for turbo alternators in power stations. *Engineering*, 10 October 1930.
An appreciation of the late Hon. Sir Charles Parsons. *Engineering*, 20 February 1931.
The development of the steam turbine. *Electrical Times*, 24 September 1931.
Standards of efficiency for steam turbines. *Engineering*, 25 September 1931.
Some reminiscences. *Heaton Works Journal*, **1**, no. 4, 135 (December 1933).
The development of the bicycle. *Heaton Works Journal*, **1**, no. 5, 230 (June 1934).
Scientific activities of the late Hon. Sir Charles Parsons. Second Parsons Memorial lecture. *Institution of Electrical Engineers*, 25 November 1937.
The development of the tricycle and tandem bicycle. *Heaton Works Journal*, **3**, no. 18, 568 (December 1941).