



# BRUSH CENTENARY SOUVENIR



## August 10th, 1989

*"In the beginning . . . Charles Francis Brush"*

Thomas Brush came to America and settled on Long Island in 1652, near where New York city is today. In 1630, a Church of England clergyman named Rev. George Phillips came from England to live in Boston. These pioneer settler families, after six generations, came together with the marriage of Isaac Brush and Delia Phillips, who produced nine children. The youngest was Charles Francis Brush (born March 17, 1849), the founder of our company.

Electricity (other than telephone equipment) as we now know it, was nonexistent; the science being restricted to trying to contain static charges in gases and using friction discs to make a spark jump an air gap. The famous British engineering pioneer Sir Humphrey Davy in 1802, had demonstrated a spark jumping between charcoal sticks four inches apart, but needed 2000 cells in a very large battery. Gas, oil and paraffin lamps remained the only common lighting until 1878.

Young Charles was an avid reader of all things concerning mechanics and science and tinkered with scraps of material at his family home at Walnut Hills Farm in Euclid, Ohio (population of 1,776 in 1850) overlooking Lake Erie. By the time he went to Cleveland High School in 1863 he was making from scratch, astronomic telescopes and microscopes, including grinding his own glass lenses. The first light bulb was still 15 years in the future. Your commonly held picture of inventors he was not. Charles was a stout 6 foot 2 inches, with a powerful figure, who listened and studied problems carefully, without using his physical size to impose his ideas.

Although he studied and graduated from the University of Michigan in 1867, having specialized in metals and mining, he was always experimenting with electrical equipment, seeking to find practical applications which could be sold for general use. In 1875 Charles married, and he and his wife Mary had three children, one of whom was named Charles F. Brush II, born in September, 1893.

The electric spark could produce a light but had to be continuously adjusted manually and needed large batteries to maintain the light for even short periods. Brush's solution was a dynamo just like those we used to have on bicycles, which fed the spark at a constant current with the voltage increasing depending on the number of lamps connected. In 1876 he reached an agreement with the Cleveland Telegraph Company for them to make dynamos to his design. In 1877 and 1878 he perfected and patented devices which enabled the arc light to be controlled automatically, and the elements to be fed without human attention. The element rods still needed replacement every eight hours, but this represented a big improvement over the two or three hours achieved by his competitors.

A critic (probably sponsored by a gas company) wrote at the time "The light of the voltaic arc has a brilliance and attempts were long ago made to utilize it. Its brilliancy is painfully and even dangerously intense, being liable to injure the eyes and produce headaches". Brush retorted "The same objection may be raised against the sun".

The first city lighting was in Cleveland when twelve lamps were lit on April 29, 1879 to replace 110 gas lamps, saving the city \$100 per year in gas costs (about 58 UK pounds), and providing "a more effective illumination" than previous. Thousands of spectators, many carrying smoked glass pieces to shield their eyes, witnessed this important event, but found the dire predictions unfounded.

Brush formed the Brush Electric Company in Cleveland in 1880 and was granted over 50 patents, mainly involving dynamos, carbon based compounds and lighting systems. By mid 1881, over 6000 lights had been sold across the USA, with some of the largest systems using a 38 horsepower dynamo to feed forty powerful lights, whereas competitors were struggling to keep eight lamps lit (and most were one dynamo with one lamp). However, Brush's success in lighting and the general adoption of street lighting across the US and through Europe soon reached a technical limitation. The Brush series connected lights, running at constant current, became impractical due to the available insulation materials. Each arc light required 50 volts (and passed 10 amps) so 100 lights needed 5000 volts generation from the dynamo.

Thomas Edison's competing constant voltage system, combined with his invention and patenting of the lamp bulb which is the forerunner of what we all use today, started to effect the growth of the Brush arc lighting business. What was described as the "red hot hairpin in a bottle", became the dominant lighting system as it was more practical for small rooms in every sort of building.

In London England, the Anglo American Brush Electric Company, having been capitalized with \$4 million dollars in 1879 purchased outright from Mr. Brush all the non US patent rights, enabling the British company to sell the systems exclusively into all European countries and into Russia, India, Japan, Turkey etc.

American Scientific Magazines of February 1881, praised the British Brush companies' installations at various railway stations in London, and in iron textile plants in provincial areas. The Brush Lambeth works was running a 2000 candle power electric dynamo which had given over one weeks continuous service lighting nightly, sixteen arc lights at Charing Cross Station. The Houses of Parliament, Palace yard and "even the British Admiralty has taken kindly to the Yankee invention". A development order was received for a single 80,000 candle power lamp with dynamo, that upon "flashing upon an approaching enemy a sudden glare of light, that will be a little less than blinding. An undoubtedly formidable weapon of defense!". It is hard now, to comprehend the resistance from authorities, government and military who were induced by gas companies to reject the new fangled invention. Nevertheless, within a few years Brush power lighting systems were being put into use right around the then civilised world.

Charles Brush actively involved himself in every practical part of his company's business, speaking to engineering societies and major customers, developing the hardware, making initial models and supervising installation and service personally to ensure the product worked right from the beginning. He and his companies received awards from scientific and industrial organizations, and exhibited in Europe and the USA. All the time, he tinkered privately in his home's basement laboratory in Cleveland, working 16 hour days to resolve problems and develop the next idea for increasing application and power capability.

By 1884, the first electric public street car used Brush dynamos and motors (and a third rail for electric power) in Cleveland, and America's first electric submarine "The Peacemaker" had a Brush 12 horsepower motor and storage batteries which included an early application of pasted plates developed by Charles Brush.

Brush companies developed and sold larger size of constant voltage motors and dynamos, and produced an electric arc furnace from which aluminium could be smelted in 1884, then synthetic rubies and sapphires. At his Cleveland home Brush built a 60 foot high tower with a windmill powered dynamo which powered machinery, four arc lights and over three hundred incandescent lamps in and around his very large home, running from 1888 to 1900. At this time, some of the patent protection on Brush's arc lights inventions were challenged in court, and other companies began to make inroads into that part of their business.

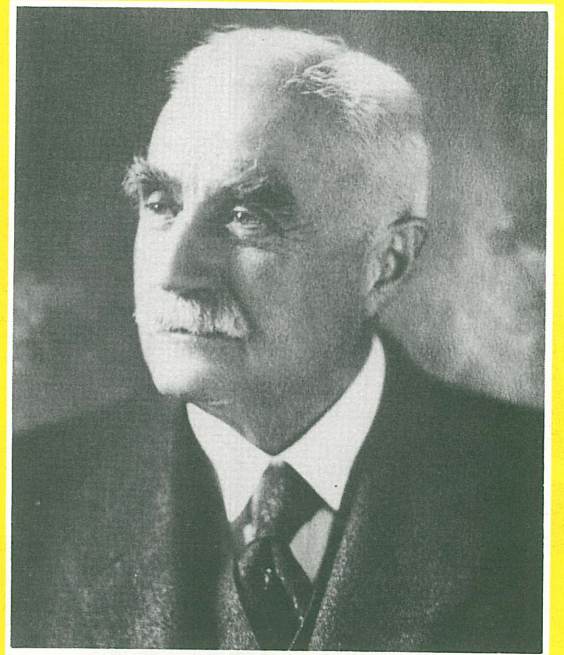
Brush Electric Company (USA) in 1889 sold it's electrical business to Thomson-Houston Company (the same one as British Thomson Houston in Rugby), and these combined companies in turn joined up in 1891 with the previous rival Edison companies to form General Electric Company with a combined workforce of about 10,000 people and a \$20 million turnover. In America, Charles Brush then 42 years old withdrew from general involvement in the electric machinery business but applied his talents to investigating other subjects. He possessed formidable curiosity, and investigated a wide range of subjects in his home workshop. He discovered the element Helium in the earth's atmosphere in 1895, and in 1905 joined with Dr. Carl Linde to form Linde Air Products (gas products and machinery to store and process gases) now a part of the worldwide Union Carbide Company. Charles Brush wrote learned papers on gravitation and the properties of metals and heat treatment of materials, collecting honors from engineering societies worldwide, using his home made equipment to demonstrate his findings. During his latter years, these activities continued. Amongst personal honours were the Franklin Medal awarded by the Franklin Institute (in 1928), a Distinguished Citizens Medal from the Cleveland Chamber of Commerce and when the French Legion of Honor appointed him a Director (both in 1929). In April 1929, Charles Brush presented his last paper entitled "The Kinetic Theory of Gravitation" to the Franklin Institute, which has become a reference work for succeeding generations of materials students and engineers.

He contracted pneumonia and died in his Cleveland home, on June 15th 1929 in his 81st year. His estate totalled \$4.5 Million dollars, a very considerable sum for those days.

Charles Brush left a legacy of many creations and ideas, which were carried forward by his successors, civil and social as well as in engineering. After studying his ancestors all his life, his book titled "A Concise Genealogy of Isaac Elbert Brush and Delia Williams Phillips his wife, and of their Descendants" was published posthumously in 1932. Having outlived his son Charles Brush II by two years, he also created and endowed the charitable Brush Foundation which makes grants toward the study and implementation of family planning and genetic research.

In Cleveland today, the Brush name lives on at the Charles F. Brush High School with about 2,500 pupils between 14 and 18 years old (and a basketball team called the ARCS) whose school motto is "Dream and Achieve". Charles Brush, who attended and addressed the schools dedication in 1927, probably extolled the personal rewards to be gained from investigation and determination. Today, he would not be at all surprised by the progress made with products which he started in his home workshop, just 113 years ago.

Derek King (Brush-Houston)



'Charles Francis Brush'

—permission of the Smithsonian Institute-Washington D.C.



Brush in 1889

### The Changing Face, or is it The Change in Pace of Brush



Brush in 1989

# THE PRESENT DAY

## *Our Chairman - Bob Hampson*

It is interesting to note that our Chairman Bob Hampson came from a farming family as did our Founder. Born in Oswestry, Shropshire he was the eldest of 2 brothers and 1 sister and for many years his brother John also worked on the Loughborough site before becoming the Managing Director of Brush Switchgear, but leaving in 1988.

Bob was educated at the Oswestry Technical College and still looks on many of the staff as having a profound influence on his career. The Principal of the College, was a personal friend of Dr. Herbert Schofield the Principal of Loughborough College and he suggested that he should consider a career in engineering with a company in Loughborough-Brush Electrical Engineering. Originally, he had thought about becoming a surveyor but the Headmaster in Oswestry, Mr A C Davis (now 83 years of age) an international authority and author on welding, changed his mind.

Therefore in 1950 having been interviewed by Messrs Platt, Padmore and Partridge he joined Brush Electrical Engineering Company as a Student Apprentice. His first six months were spent as many other apprentices in those days at the Training Centre in Regent Street with Bill Gent, Percy Clarke and Arthur North. His training then took him around all 3 site companies finishing in the Rotating Machines Design Office as a Junior Designer with David Legg, Howard Warner and John Moulding.

During his training he took a keen interest in the social activities, playing football for Brush Sports and Glenmore Rangers mainly in the inside-forward position. He also played an important part in the work of the Brush Students and Graduates Association and the East Midlands Junior section of the IEE. Academically, he studied at Loughborough College and obtained his Higher National Certificates in Electrical Engineering and his Ordinary National Certificate in Mechanical Engineering, becoming a Graduate of The Institution of Electrical Engineers.

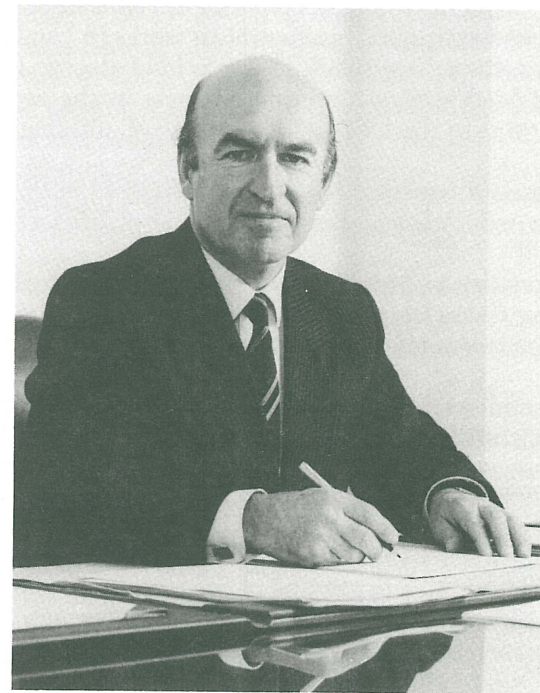
In 1955 he joined the RAF for his 2 years' National Service and went to RAF Locking near Weston-Super-Mare where he initially worked as an instructor on Ground Radar control, then moving to No1 Ground Radar Service Squadron in Glasgow where he was in charge of the servicing of underground radar systems from Peterhead to Ventnor in the Isle of Wight.

In 1957 in reply to a letter from Harry Price he came back and joined his old team at Loughborough. He spent time on both Induction, D.C. and Synchronous Machines Design before moving in 1968 to become Production Manager and Assistant Works Manager under Tony Hicks. Upon the formation of the 3 site companies in 1971 he became General Works Manager of Brush Electrical Machines and Production Director in 1974. In 1980 he moved to Wolverhampton to become Managing Director of Electric Construction before returning to Brush Electrical Machines as Managing Director in 1983. He was appointed Chairman of the 3 Loughborough site companies in January 1988 and took a place on the Hawker Siddeley Group Executive, being responsible mainly for Power Generation, Transmission and Distribution within the Hawker Siddeley Group.

Whilst he was at RAF Locking, he met his wife Natalie and they were married on 19th December 1959 and have 3 children, 2 boys and 1 girl. Bob's main hobby is golf with a handicap of 20 but also includes house renovation (he has had 5 since 1980), gardening and DIY. He is also the President of the local branch of the British Institute of Management and a Companion of The British Institute of Management. Having had such a busy schedule for many years he has great difficulty in choosing highlights, but obviously the launch of the Class 60 Locomotive and the obtaining of the Channel Tunnel Locomotive Contract have given him particular pleasure. Two other items that have given him pleasure were his experiences both with the training during his apprenticeship and the associated social life and his selection in 1982 for the General Electric Impact Training Programme which took him on a study tour of the Engineering Industries in Japan and the United States.

The greatest satisfaction he obtains from his working life is the cut and thrust of the industry together with the variety of challenges that occur each day. There is no doubt that this will continue as Brush enters its' Second Century!

*Peter Morley*



## *Charles Francis Brush Is Alive And Well*

Grandson of our founder, Charles Francis Brush III is married and has three children, Barbara, Karen, and yes, there is a Charles Francis Brush IV. With a home at the eastern end of Long Island on Shelter Island, he also maintains a business office and flat on the east side of Central Park in New York City.

Charles earned a Bachelor and Master of Arts degree at Yale University and a Doctorate at Columbia University in 1969. He was a Research Associate at the American Museum of Natural History, and currently is on the staff of Yale University's Peabody Museum. Dr. Brush has led several archeological expeditions to Mexico. On one of these, the earliest known ceramics in North America were uncovered; on another, evidence of deliberate alloying of bronze. Whilst in Chile during 1982, to investigate a volcanic crater lake lying below Inca ruins, he led a team that carried SCUBA equipment (self contained underwater breathing apparatus) 19,300 feet above sea level and set the altitude record for using compressed gas in diving. He recovered no Inca relics, but collected biological specimens that were previously unknown.

Dr. Brush is a Director and member of the Executive Committee of Brush Wellman Inc. the free world's only mine-to-finished-product Beryllium producer. As well as the pure metal, which is used in highly classified military and space applications, the company produces Beryllium alloys, used in such diverse products as computer connectors and large oil drilling collars. Brush Wellman was founded in 1921, by Charles Francis Brush II, and

now has annual sales of \$345 million dollars and 2,600 employees, with a small facility in England.

He is a Director and past President of the Explorers Club, a Director of the American Geographical Society and the Institute of Noetic Sciences, and a former Trustee of the Sierra Club Foundation, and is active in a number of other organizations.

Now 66 years old, Charlie (as he prefers to be called) remains very vigorous...last winter he camped for a week at over 19,000 feet while investigating another high altitude South American lake. During a 1983 interview, he said "We all know we are going to die, but you have to live your life as if you were going to live forever. I try to maximize all the time I have." At fifty-four, he ran and finished his first marathon in New York and since then has completed six more as a race walker. He has climbed throughout the world, including the highest mountains in North and South America, Europe and Africa, and has SCUBA dived in many exotic places. Charlie Brush also collects and enjoys drinking fine wines.

Dr. Brush has provided many important leads to information on his grandfather, and is very interested to have learned that the British offshoot of the original company, continues to prosper and meet the needs of worldwide industry.

*Derek E. King (Brush-Houston)*

