

Chapter Eight

Charles Alexander Stevenson 1855-1950 - Inventor, electrical and radio engineer

Family recollections

When Charles was born the family of five girls and two boys moved to 25 Royal Terrace, a large four-storied house of Craigleith sandstone. Near the end of his life he wrote about his very happy childhood in an unpublished book.⁹² [100]

'The quiet management of the family by my father and mother and the absence of bullying words, voices raised in anger or sulking children must have been one of the reasons why our cousin Louis visited us often. There was always someone at home to give him time and attention. There was much song and music. Here too he could enjoy the superb model theatre, as well as the magic lantern, built by my father, his Uncle David. There was nothing for sale in Edinburgh, anything like it, complete with drop curtain, trap doors, side boxes and scene changing devices. We also had a "peep show" with 8 inch diameter lens and mirror.

We were at the Edinburgh Academy [101] at the same time as Louis. Only a few hundred yards to the south of Royal Terrace lay the heart of Louis' playground in his adolescent years and he shared it often with us. Every part of Holyrood and of Arthur's Seat we made our own. A map illustrates the ground we covered from the Haggis Knowe to Dunsappie Loch. Passing Dunsappie Louis always identified a non-existent cave and called it Dick Hatterick's Cave. [After the cave in Guy Mannering.] Probably he was also remembering the Grotto known to him in Italy, which he had visited with Bessy (my sister). She had arranged this whole trip in 1863 at the request of our Uncle Thomas. She went with a heavy heart because the Royal Archers Ball was just coming up and she was hoping to get engaged to Alexander James Napier.

She was very pretty and she need not have worried as he popped the question immediately on her return! These Balls given by the Royal Company of Archers were few and far between and invitations were much prized.

We could turn either to the right or left at the end of the garden in Royal Terrace and following one of the many paths laid round the Calton Hill by our grandfather Robert after the soldiers had returned from the Napoleonic wars, we would arrive in a few minutes at Waterloo Place-the east end of Princes Street. Years later Louis was to write in Samoa, remembering the family graves at the New Calton Cemetery in Edinburgh:

The tropics vanish, and meseems that I,
From Halkerside, from topmost Allermuir,
Or steep Caerketton, dreaming gaze again.
Far set in fields and woods, the town I see
Spring gallant from the shallows of her smoke,
Cragged, spired, and turreted, her virgin fort
Beflagged. About, on seaward-drooping hills,
New folds of city glitter. Last, the Forth
Wheels ample waters set with sacred isles,
And populous Fife smokes with a score of towns.

There, on the sunny frontage of a hill,
Hard by the house of kings, repose the dead,
My dead, the ready and the strong of word.
Their works, the salt-encrusted, still survive;
The sea bombards their founded towers; the night
Thrills pierced with their strong lamps. The artificers,
One after one, here in this grated cell,
Where the rain crases and the rust consumes,

Fell upon lasting silence. Continents
And continental oceans intervene;
A sea uncharted, on a lampless isle,
Environs and confines their wandering child
In vain. The voice of generations dead
Summons me, sitting distant, to arise,
My numerous footsteps nimbly to retrace,
And, all mutation over, stretch me down
In that denoted city of the dead.¹⁶

The gated cell is the only one in the cemetery to retain its original roof. Robert used the same method in its construction of 'dove-tailing' the stones into each other that he had employed in the building of the Bell Rock Lighthouse.

'In our young days the Castle would sound out the Bugle call at six o'clock in the morning and this could be clearly heard by Louis from Heriot Row. The sight of soldiers marching with their band playing swinging down from the castle to Jock's Lodge always affected us deeply and we stopped to watch them go by. With a Highland regiment the kilts would swing almost imperceptibly and on a recruiting march the music would be to some light air such as 'The girl I left behind me . . .' This would set Louis off marching alongside them admiring the action of the drummer and the strong muscles of the men.'

A railway line ran from Edinburgh to North Berwick from 1848 and the 'David Stevensons' took a house down the coast there for two or three of the summer months in the West Bay. Uncle Tom and Aunt Maggie were there also in various villas and Maggie names most of them in her diaries. Even after they took Swanston on a long lease when he was 17 years old, Louis

would turn up to his much loved old playground.

'The sands below Dirleton had the unenviable but still commonly accepted story attached to them that a man, horse and cart had been swallowd up in a quicksand. Many times I explored this territory with Louis but we never found anything but a softness due to entrapped seaweed. Louis never let slip an opportunity to impress me with a very grave face on the advisability of keeping well up onto the dry sand. Walking there with him I flicked with my walking stick a stranded sheep's jaw against his cheek. No serious damage was done but he gave me a well deserved 'round of the guns!' The only other occasion that I remember being in his really bad books took place on the banks of the Forth at Stirling where he and I were examining a beech tree on which my father, years and years before, had cut his initials D.S. and those of my mother his beloved fiancée E.M. deeply into the bark. Very stupidly I picked the centre out of the letter D. and Louis to his horror realised what I had done. It was a heinous sin in his eyes and again I was treated to some well chosen words!

The home-made 'land' boat made by my brother and myself when we were very small children is particularly successful. The hull is made out of tea-chests, etc.; the mast a clothes drying pole, two toy guns are on deck, thole pins, sails, bladders, anchor (a stone one) were got off the beach. In Louis' words 'I am a-steering of the boat', and David is at the helm. The year is 1860 and the setting the back of Anchor House, North Berwick. [102] A few years later in 1865 my father took the photo of the three of us-David, Louis and myself blowing soap bells with an ordinary cutty clay pipe.

The mouth piece was always carefully covered with red sealing wax by my mother to prevent damage to our lips. [103] The table, used to rest the soap mixture on, was the steps the maids used to hang up 'the washing' in the garden. The washing was a very large affair in our household with such a number of young girls with their spotless and bright summer dresses. Rafts, model boats, bicycles and kites were all home-made-the latter had messages sent along the string and the adjustment of the right number of bows on the tail was a special skill. On many days a joyous lot of boys would proceed along the Longskelly Beach to the Eel Burn-referred to by Louis in *Catriona* as a 'cressy burn' about a mile west of the end of North Berwick Links in the days of our boyhood. It was the ideal place to build a dam with plenty of water from a large drainage area round about Dirleton, an abundance of sand and no rocks or stones, and certainly no people anywhere in sight to disturb us. We built by heavy digging high and broad embankments and felt sure we could make a permanent diversion of the burn. Always a hopeless task as a high tide with an on-shore wind left the sand smooth and level and no sign that we had ever been there!

...We learnt to play golf from the earliest possible age and always loved the game. Davie came to championship standard with a handicap of just 4. We were members down at North Berwick and, in later years, the Old Luffness, Gullane, The Royal and Ancient at St Andrews and the Honourable Company of Edinburgh Golfers at Muirfield. Louis always despised this activity and games of robbers and pirates or just simply exploring along the coast or deep into the Lammermuirs meant much more to him. It was quite a

tough little climb for him to the top of North Berwick Law but Louis did it often and there was a memorable bright moon-light night he remembered when he wrote this poem in *Underwoods* in 1887:

A MILE AND A BITTOCK

A mile an' a bittock, a mile or twa,
 Abüne the burn, ayont the law,
 Davie an' Donal' an' Cherie an' a',
 An' the müne was shinin' clearly!

Ane went hame wi' the ither, an' then
 The ither went hame wi' the ither twa men,
 An' baith wad return him the service again,
 An' the müne was shinin' clearly!

The clocks were chappin' in house an' ha',
 Eleeven, twal an' ane an' twa;
 An' the guidman's face was turnt to the wa',
 An' the müne was shinin' clearly!

A wind got up frae affa the sea,
 It blew the stars as clear's could be,
 It blew in the een of a' o' the three,
 An' the müne was shinin' clearly!

Noo, Davie was first to get sleep in his head,
 'The best o' frien's maun twine,' he said;
 'I'm weariet, an' here I'm awa' to my bed.'
 An' the müne was shinin' clearly!

Twa o' them walkin' an' crackin' their lane,
The mornin' licht cam gray an' plain,
An' the birds they yammert on stick an' stane,
An' the mune was shinin' clearly!

O years ayont, O years awa',
My lads, ye'll mind whate'er befa'-
My lads, ye'll mind on the bield o' the law,
When the mune was shinin' clearly.

Donald was my pony. [104]

Fidra, the Lamb, Craigleith and the Bass were all left behind after the ice-age had passed by, going from west to east, and grinding and scraping away the softer material, leaving the hard rocks sticking up with precipices on their eastern and sheltered sides. The very small scratches of the ice are still visible in spite of the weathering. Louis described Fidra as 'a strange grey islet of two humps, made the more conspicuous by a piece of ruin and I mind that (as we drew close to it) the sea peeped through like a man's eye.' The eye is a hole through the main hump of the island about 29 feet in height. In Louis' day (and mine of course) the Eye used to be a marked and lovely feature of Fidra on the road leading out of Dirleton towards North Berwick and with the sea behind, it looked like a great waterfall but grown trees have now shut off this unique angle [1940]. There was of course no lighthouse in those days. At the end of the sandy Longskelly Beach away past the Eel Burn, Louis would still press on over the rocks to where there stood a small villa-right down by the sea but lost in the woods a mile below the big house known as Archerfield. It was always of great interest to him whether the villa was shuttered or not and I had no interest in

this. We crept along, heads well down right by the margin of the sea.

To the East of North Berwick Harbour lies the Black Rock. Just up from it there is still a house called Rockend that was taken for the Summer of 1860 by Louis' father and mother, my Uncle Tom and Aunt Maggie. The Rock was the scene for nursery-maids sewing, knitting and chatting while their charges played around with wooden spade and pail. To climb to the top was endlessly absorbing. Released from nursery strings a few years later we were with a crowd of boys in 'The Ladies Walk' or simply 'The Glen'. This sunless dingle of elder trees was massed over with damp dead leaves and patches of grass. A strong stream ran down the middle of it and dotted here and there were the ruins with roofless walls-the cold homes of Anchorites. To fit ourselves for life and with a special eye to acquire the art of smoking many happy hours were spent there. Here we came to 'particulars' as our mutual grandparents used to call it!

Along the East Bay still further was 'Campbell's cave' at Point Garry. This was one of the meeting places of the 'Lantern Bearers', the story of which has often been told in biographies of Louis. David and I were old enough to join in. The gulley is 7 feet deep and luckily has a stone wedge in between its sides at the top. We could with some difficulty climb across to get access to the cave. At night the passage would be impassible without the aid of our 'lanterns'.

Croquet was very fashionable, but like golf it was hated by Louis. Later, with Frances Sitwell in England, he came to love the game and was an expert at it. Croquet was often played on North Berwick Links but Louis seldom joined in.

I once played croquet on the Bass! My families and Cheynes

from Shetland going on a picnic expedition-about the year 1901!

Our new home in Melville Street, where we moved in 1870, had the usual large double drawing room found in New Town houses and the sun streamed in from early morning until late afternoon. The whole house was lighted by gas chandeliers and sidelights and except for the blazing coal fire in the drawing room it was heated by stoves and gas fires, a very up-to-date invention in those days, and a great saving of heavy labour for the servants.

At the top of the house I had a laboratory and workshop combined. A turning lathe which also worked an electric machine of my own design, a home-made spectroscope giving absolutely perfect lines, chemical apparatus for making gunpowder and fireworks, gas for explosives and lead to make bullets for catapults, and a home-invented seismograph for showing tremors in gales and earthquakes. I collected the lead from the neighbour's roof flashings that seemed to me to be unnecessarily deep! Invitations from myself to Louis when he was in the house to come upstairs to enjoy the delights of my laboratory met with a very definite negative! Nothing at all of an engineering nature was of real interest to him. My enthusiastic youthful engineering was also called into use by my sisters after 1870 when the enormous crinolines that had been fashionable were diminished by half the diameter. By cutting the steel rings and splicing them I was able to prevent unequal bulging.

Louis would come along to 45 Melville Street either alone or with our cousin Bob, Alan's son. They always walked in unannounced by the servants. Robert Alan Moubrey Stevenson was only three years older and from the day he first came into

Louis' life when Bob was nine years old and Louis seven the two had been the closest possible friends. Bob and his three sisters, who included Katherine (later Katherine de Mattos), were educated largely abroad and Bob was, like Louis, remarkably free of the strict Edinburgh social conventions of the day. He was a most lovable man and shared the same love of laughter and life as Louis. There were three beautiful paintings of his, one done when he was in Fontainebleau, another of the Bridge at Grez, and the third a river scene on the upper Thames hanging in our house.

My father had collected pictures and prints for many years both in this country and abroad and we had the superb watercolour by Turner of the Bell Rock Lighthouse, also Sam Bough's watercolour of North Unst, a lovely skating scene by Klein and many fine engravings. A marvel to Louis and Bob was a very rare engraving in silver and gold that had the picture frame on pivots so that it could be slewed up or down to produce the effect of night or day. It was by Zeuder and probably of Amsterdam, showing houses, boats and sails, people, a drawbridge and Town Hall clock in silver and gold lettering with the hands engraved in extraordinary detail.

The arrival of Bob and Louis always meant a call from them both for music. Bob had a superb tenor voice and could play the piano with a delicate touch that could really move the hearts of his audience, and my sister Mary played the harp as a perfect accompaniment to him. [105] Georgie could replace Bob on the piano and we all could sing to excellent effect. I remember the day when the clash of cymbals was heard on the street and to our delight we found two men dressed in blue with a stout pole and a dancing bear on a leash. Bob and Louis were in ecstasy over the

In winter when the ice was bearing for skaters the flag on the City Chambers was hoisted, Louis would appear at our house to borrow my steel skates and a merry party would set off. Louis could skate gracefully and well, doing little twists and twirls within a two foot compass, and this seemed to give him great pleasure, skating always backwards until in the Adirondacks in the U.S.A. after his marriage. He never could be persuaded however to practise sufficiently to become a member of the club. As he said so often to us he had 'better things to do'. Indeed he had! I read with so much pleasure now his superb poem called 'Duddingston'. The second part goes thus:

Now fancy paints that bygone day
When you were here, my fair-
The whole lake rang with rapid skates
In the windless, winter air.

You leaned to me, I leaned to you,
Our course was smooth as flight-
We steered-a heel-touch to the left,
A heel-touch to the right.

We swung our way through flying men,
Your hand lay fast in mine,
We saw the shifting crowd dispart,
The level ice-reach shine.

I swear by yon swan-travelled lake,
By yon calm hill above,
I swear had we been drowned that day
We had been drowned in love.

We had frost every year between 1879 and 1889 lasting for almost six weeks. The Secretary printed slips to members telling us if the loch at Linlithgow was bearing, and Bathgate also had a good skating loch. Louis skated at these places also on the tiny pond in the gardens outside Heriot Row; here he could practise his personal technique. The following letter went to Bob on 14th February 1877:

"A fortnights frost and I have skated every afternoon-I can't skate more; I make some progress and do some back things smaller and faster than my fellow contrymen generally, but as what they hanker after is bigness, and slowness, and ever a greater protraction of the leg, that is perhaps not much to boast of."

Duddingston Loch has the church on the north side without the manse that is there today. The pavilion has long since gone but presumably it was a refuge for skaters in winter and for boats in summer. This lovely loch lying at the foot of Arthur's Seat is a bird sanctuary, and the nesting place in the reeds for countless migrating birds. Cars can pause and people get out and refresh their city minds with the beauty of the hill and the water. For a couple of hundred years now, since the forest that grew over part of the hill and provided a close hunting ground for the kings and queens who occupied Holyrood has all vanished away, the south and east slopes of our Arthur's Seat has been covered in whin or broom and for many weeks in late spring and summer the brilliant yellow flowers can be seen for many miles down the coast. They were there in Louis' day and have spread threefold now.

With the advent of a direct railway route from Edinburgh

and before the middle of the century the Stevenson family had discovered the delights and health-giving properties of Bridge of Allan and its spa in Stirlingshire.

Maggie, Tom's wife, was writing the dates of all their visits in her diary that she kept from the time she ended Louis' *Baby Book*. A careful search by the late David Angus throughout the district has revealed the visits the other members of the family were making at the same time to various hotels and boarding houses.

David and Thomas and their families were frequently there together. Charles and Louis travelled back to Edinburgh in April 1879.

FROM A RAILWAY CARRIAGE

Faster than fairies, faster than witches,
Bridges and houses, hedges and ditches;
And charging along like troops in a battle,
All through the meadows the horses and cattle:
All of the sights of the hill and the plain
Fly as thick as driving rain;
And ever again, in the wink of an eye,
Painted stations whistle by.

Here is a child who clammers and scrambles,
All by himself and gathering brambles;
Here is a tramp who stands and gazes;
And there is the green for stringing the daisies!
Here is a cart run away in the road
Lumping along with man and load:
And here is a mill and there is a river:
Each a glimpse and gone for ever!
R.L.S.

As the train rushed on a new sight would catch Louis' interest. Everything that was seen for a few moments was photographed on Louis' mind and written down as he and I sat at the window seats of the railway carriage while we were whisked along. We were travelling between Bridge of Allan and Edinburgh. The train whistled as we went through a station. Sitting opposite me Louis would ask now and then, 'Can you get anything to rhyme with cart, Chug? Try Horse, Lump, and Screech!'

The green meadow, horses and cattle – the child alone gathering brambles – the mills and rivers and the shimmer of rain, etc, are all burned into my memory. I was with Louis hundreds of times, many of them very clear in my mind, but this journey with Louis composing and writing all the time has a special significance because of his superb combination of sight and sound turned into verse.

Louis was always very enthusiastic on the subject of the inheritance of the 'genes'.

"For that is the mark of the Scot of all classes: that he stands in an attitude towards the past unthinkable to Englishmen, and remembers and cherishes the memory of his forebears, good or bad; and there burns alive in him a sense of identity with the dead even to the twentieth generation. ... The power of ancestry on the character is not limited to the inheritance of cells. ... some Barbarossa, some old Adam of our ancestors, sleeps in all of us till the fit circumstance shall call it into action; ..."

[*Weir of Hermiston*, London, 1896, V, 3.]

He was under no misapprehension that the 'genes' and inherited characteristic all came from the male side.

MATER TRIUMPHANS

Son of my woman's body, you go, to the drum and fife,
To taste the colour of love and the other side of life-
From out of the dainty the rude, the strong from out of the
frail,
Eternally through the ages from the female comes the male.

The ten fingers and toes, and the shell-like nail on each,
The eyes blind as gems and the tongue attempting speech;
Impotent hands in my bosom, and yet they shall yield the
sword!

Drugged with slumber and milk, you wait the day of the
Lord.

Infant bridegroom, uncrowned king, unanointed priest,
Soldier, lover, explorer, I see you nuzzle the breast,
You that grope in my bosom shall load the ladies with rings,
You, that came forth through the doors, shall burst the doors
of kings.'

Charles as a child found it difficult to write easily or to express himself well. A close friendship developed between Davie and Louis who probably never knew how much Charles idolised him. Louis's ignorance of Thomas's financial dealings at the Northern Lighthouse Board and the miserable wages paid to his nephews was a serious matter for Charles whose hatred of rows of any sort was an outstanding part of his character. For the last few years of Thomas's life Charles, acting still as a paid assistant, was giving his uncle new technical innovative ideas for which he himself was never given any credit. Fortunately for the two young men Thomas's death came before his nephews'

patience had come to an end. Alan (Skerryvore) and Charles were probably the two members of the Stevenson dynasty who had a really close 'grass roots' affinity with nature, that provided the power-house for much that went into the inspiration in their work.

Marriage

Charles married Margaret Sherriff on January 19th, 1889, in St Paul's Episcopal church in York Place. [107,108] She was the daughter of Lieut.-General John Pringle Sherriff. They moved at once into 28 Douglas Crescent, facing north over the Belford Bridge, Dean Cemetery and to the sea and far shore of Fife. The house was a large double fronted stone villa with all the main rooms facing onto the cold north side of Edinburgh. It was a splendid commodious home for the family of three they were to have. Charles was a very mature young man and with absolute confidence in his own talents he started his married life in a style he meant to continue. Meta had been sent home as a child from India where her father John Sherriff served as a general in the Indian Army. She lived with her grandmother at Bairnkin, Southdean, Roxburghshire on the Scottish Borders. Presumably she was educated at a private school. She was intelligent, vivacious, loved gossip and enjoyed a gay social life after her marriage. Maggie Stevenson wrote in her Diary on 13th June 1889, when she had returned from Samoa to clear up 17 Heriot Row, that she found Meta 'pretty and pleasant.' Charles loved and spoilt her all their married life. She in turn spoilt and indulged their only son David Alan who was born on the 7th February 1891.

Frances Margaret, was born on the 21st May 1892 and five years later Evelyn Mary completed their family.

Charles was nearly 80 years old before he started to dictate to

his youngest daughter May Yeoman the memories he held of his first cousin Robert Louis Stevenson. With bad eyesight but very bright mentally, and entirely in his right mind, he could still see the photographs for his book. He made several pencilled amendments to the script as it went along. Blindness or near blindness was a terrible blow to him and his daughter suggested this venture to relieve the boredom for his very active mind. She wrote exactly as he dictated it without any alteration whatever. He laid it aside several years before his death with a note that he wished it to be brought to publication standard by a younger member of the family. It is from this book that excerpts are quoted by the present author.⁹⁷ [110] Charles died at 28 Douglas Crescent, Edinburgh, aged 96.

A professional aspect

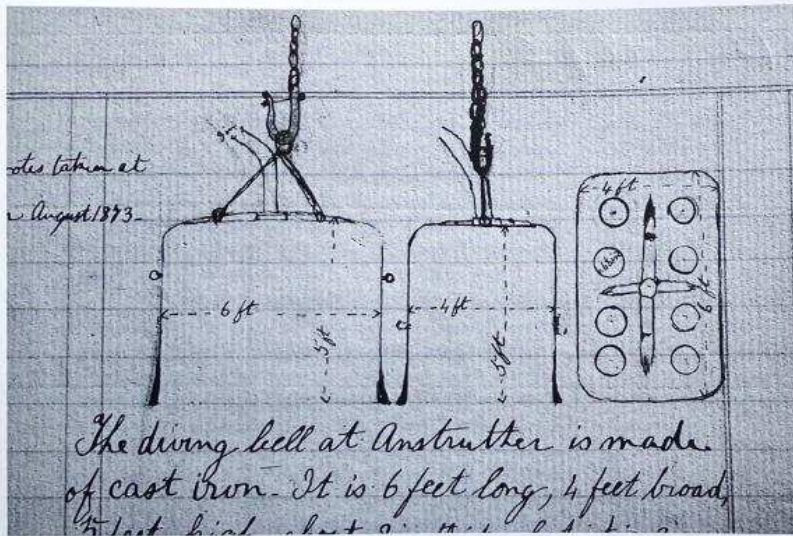
At Edinburgh University Charles followed closely in the footsteps of David A., graduating with a B.Sc. degree in 1877. He too kept the customary journal, for no less than six lighthouse inspection voyages before his 25th birthday. An entry in August 1873 describes the cast iron diving bell in use at Anstruther harbour . . . *It is 6 feet long, 4 feet broad, 5 feet high, about 2 in thick but it is 3 in thick at the bottom to make it stand steady, and weighs 5 tons and displaces 3.5 tons of water when quite filled with air that is it is less than a half its weight in the water. There are eight strong convex lenses sunk into the top of the bell each 6.5 inches in diameter, but sometimes these dont give sufficient light when the sea is discoloured and the sky dark. The air is supplied by a force pump with two cylinders 8 in diameter with a one foot stroke. Four men work the pump and gave while there were 2 men it and a few feet under water . . .*⁹⁸ [111]

Charles's avid interest in recording engineering operations

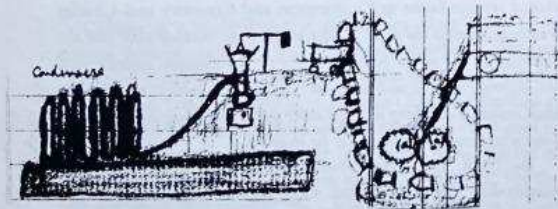
even extended to a sketch and description of the operation of Oakbank shale oilworks near Ormiston, Kirknewton, West Lothian in April 1874. [112] He wrote, *The shale, which is brought to the works straight from the pit, is in pieces about 1 ft. square x 2 in. On arriving it is put between rollers which break it up to about 3 in. square x 1 in. It is then raised to the same level & put into small carts by a series of revolving buckets like a dredge[r]. It is then rolled in the carts to the top of the furnaces where it is shot down. On being treated the oil passes off in vapour and the vapour is easily condensed (by being passed through pipes exposed to the air) on account of its latent heat being very small. It is then purified with sulphuric acid and caustic soda. Then it is put into shallow vessels where it is allowed to settle. The fineness of the oil depends on the length of time it is allowed to settle. If they wish to use it for making candles they freeze it - put it in cloth bags and squeeze with hydraulic presses so as to make it into cakes.*⁹⁹

In 1875 Charles and David A. visited London to attend an Enquiry where their father successfully opposed Sir John Coode's proposal for Peterhead harbour. On returning, they visited sewage farms at Leamington and Coventry and Charles was amazed that the dried sludge made good manure and that the water passes out of the basins into the river colourless, tasteless and inodorous and it is said with .04% of organic matter, which is less than ordinary drinking water. I don't understand how such a simple process can make sewage water fit to drink.⁹⁹

By 1888, two years after Charles had been taken into partnership, his publication with David A. of an enlarged edition of their father's book on canal and river engineering helped to establish the new partnership's authority nationally in this discipline. Its reviewer in *Nature* on 23 December 1886



[111] Charles's Sketch of diving bell at Anstruther, 1873.



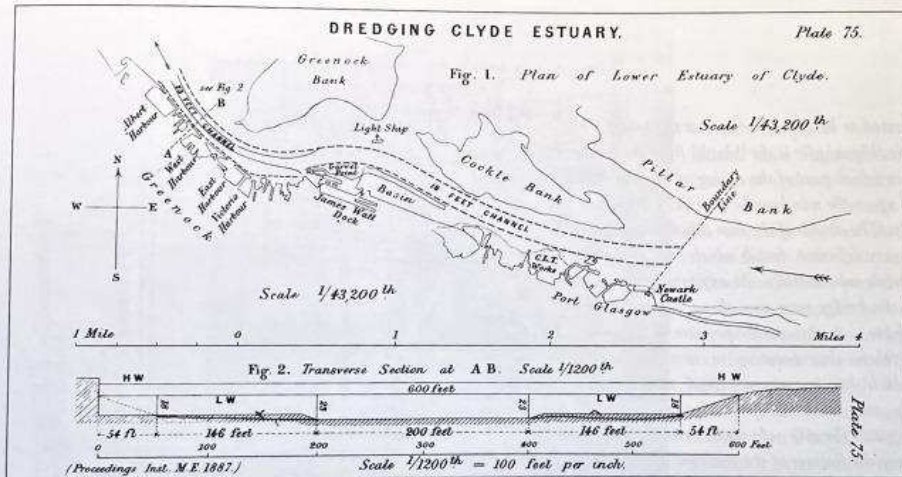
[112] Charles's Sketch of oil shale extraction at Kirknewton 1874.

considered it . . . an excellent account of the principles and practice of river engineering, to the successful practice of which its able authors have so largely contributed. During the next half century the firm, as Engineers to the Clyde Lighthouses Trust, was responsible for deepening the lower Clyde from about 16 ft. at low water to 29 ft. Charles took a particular interest in this work [113,114] and later with D. Alan devised and directed river deepening measures which enabled the largest ships to go to sea.

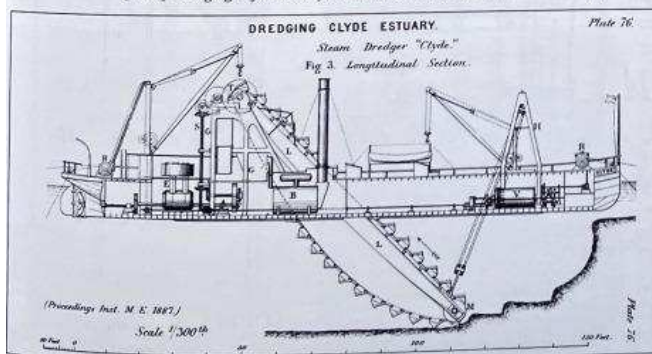
R W Johnstone, Charles's Royal Society of Edinburgh biographer who knew him very well, stated that, *Charles Stevenson was a man of great intellectual acumen, but for work of this sort he had a very special natural aptitude - a sort of instinctive grasp of how nature would work in the waves and winds and tides.*⁹⁴ His journals abound with evidence of this, for example, his entries relating to the Tay Bridge disaster:

[Undated entry, but very soon after the collapse on 28th December 1879]

Tay Bridge. Left Edinburgh at 9.30 with General Robertson arriving in Dundee at 12. Got on board the Tay steamer "Misty" which was taking out to the Tay Bridge some men to assist in the operations of raising the girders from the bed of the river. In about a quarter of an hour we reached the bridge & got the men on board



[113] Dredging Clyde Estuary. Plan and section from Charles's IMechE paper, 1887.



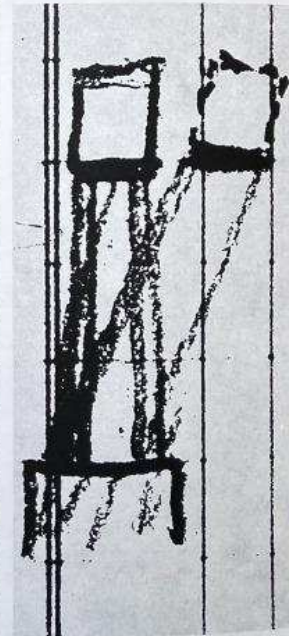
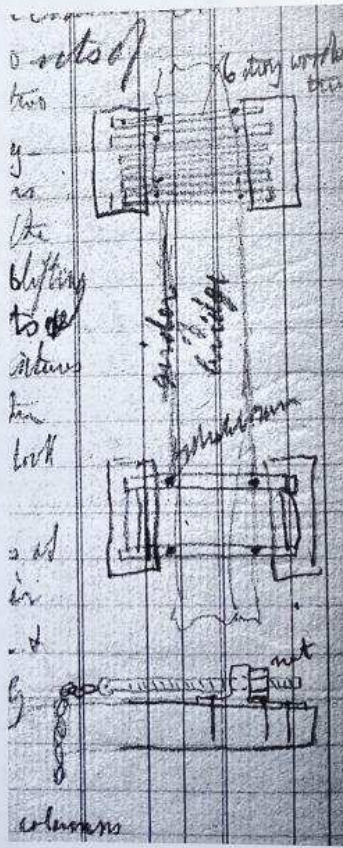
[114] Steam Dredger Clyde. From Charles's IMechE paper, 1887.

the barges which are used by the divers who are at present making chains fast to the ends of the Southmost girder of the fallen ones & otherwise preparing them for being lifted which operation of lifting is to be commenced tomorrow by raising them by means of two sets of pontoon barges, each set consisting of two joined together by very strong bracing. The bracing in the one being iron girders (with hydraulic lifting apparatus) and in the other of 6 strong wooden trusses with 6 lifting screws to be worked by means of nuts and worked by hand. There will be thus 4 fixtures at the one end of girders & 4 at the other, eight in all. (The nuts and screws dont look strong enough for their work.) [115,116]

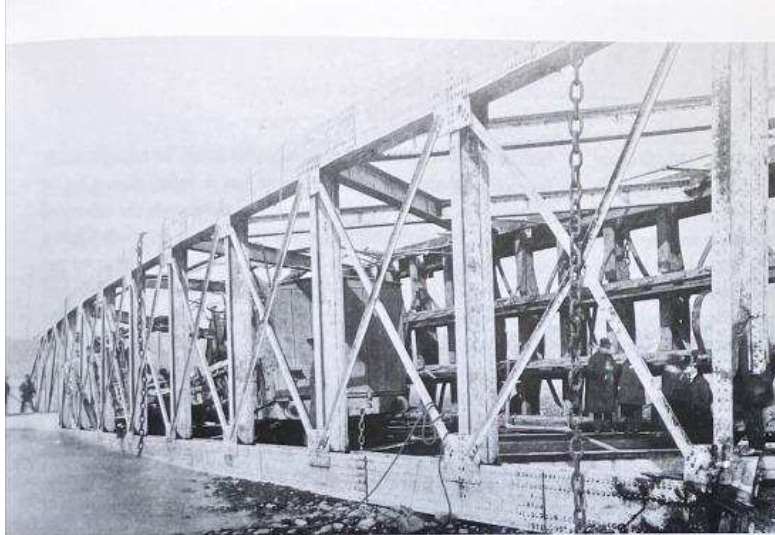
There seemed to be about 8 divers at the bridge. I landed on No. [blank] pier ie the [blank] from the south end & one in which part of the coping of the pier had been turned up on the windward side. [117] Inspected it thoroughly. The details of the iron columns appeared to me to be very defective, details which I think should have been made substantially. At any rate - It appears to me that the bridge gave way through **not having sufficient base** to withstand the pressure of the wind, the whole fabric thus wanting to come down the bracing (which by the way appeared to me to be monstrously too weak & perfectly incapable of withstanding any **thrust**) gave way & consequently at the same time the fixtures of the columns to the sockets etc, the bridge falling over thus - [115]

The greatest damage to the stonework of the piers is at the N. end which fact together with the fact that the least damage done to the **iron piers** is towards the S. end show - 1st. that the N. end was forced over by a steady push such as would be caused by the the wind & 2nd. that the S end was pulled over by a quicker force a kind of jerk in fact which points to this end having been destroyed by the fall of the more Northern portion.³⁹

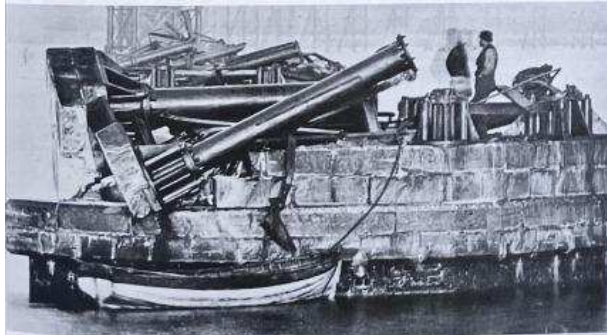
Charles's conclusions that the bridge did not have sufficient base to withstand the pressure of the wind and that the weak bracing gave way and consequently at the same time, the fixtures of the columns to the sockets, the bridge falling as indicated, accords with Martin and MacLeod's



[115] Tay Bridge - Charles's sketches, 1880.
Pontoon for lifting girders, and pier overturning



[116] *Tay Bridge - A fallen girder beached on its side after retrieval. Note lifting chains.*



[117] *Tay Bridge ruins, 1880. Note upturned coping on the windward side referred to by Charles.*

recent computer analysis of the failure⁵⁵ and Shipway's conclusions.⁵⁶ However these authorities are unconvinced by his arguments that the northern end of the navigation spans failed first, believing that the failure mechanism probably began at or close to the point where the train fell. At this point the bridge was taller and the overturning wind force would have been more likely to induce a greater uplift force on the base holding down bolts. Whilst this is a reasonable hypothesis it cannot be considered conclusive as it is based on

surmise about the uniformity of wind pressure, pier bracing strength and the resistance of the base to uplift.

An indication of Charles's work during the early years of the new partnership, from 1887-1891, is provided in the statement which accompanied his application to become a Member of the Institution of Civil Engineers in 1891. It read, *he has (along with his brother) been Engineer to the following harbour works, viz.:- Coldingham, Port Knockie, Baltinore, Broadford, Ness, Lossiemouth and Loch Ranza, which are either in progress or completed; quays at Lancaster, and the improvement of the river Lune, and dock-gates at Glasson; also the following lighthouse apparatus, etc., for Girdleness, Inchkeith, Point of Ayre and Corsewall worked by oil engines. He is also engaged in large dredging operations on the estuary of the Clyde. The aggregate expenditure on the*

above-named works will amount to about £180,000. His firm are Engineers to the projected Forth and Clyde Canal.

In lighthouse illumination, Charles applied the equiangular prism to condense a beam of light into a narrower and therefore more brilliant beam than previously. [118] D. Alan wrote of this work in 1936, *all the important and most powerful maritime lights of Scotland utilise equiangular prisms of his design instead of Fresnel's prisms or utilize his combination apparatus [with existing first order lenses] . . . these two inventions making the lights of this country shine more brightly. These great maritime lights in Scotland on his design are twenty-four in number and range from 160,000 candlepower to 1,000,000 candlepower . . . obtained from a single paraffin oil mantle burner without having recourse to the electric light which is so much more costly . . . Charles's design increased the power of the light beam by about 10% over Fresnel's prisms and his uncle Alan's alterations and did not require so large a lantern.*⁷⁷ He also improved the distinctiveness of buoy and beacon lights, at first on the lower Clyde, by utilising a small gas meter and bypass with each light to make them flash.

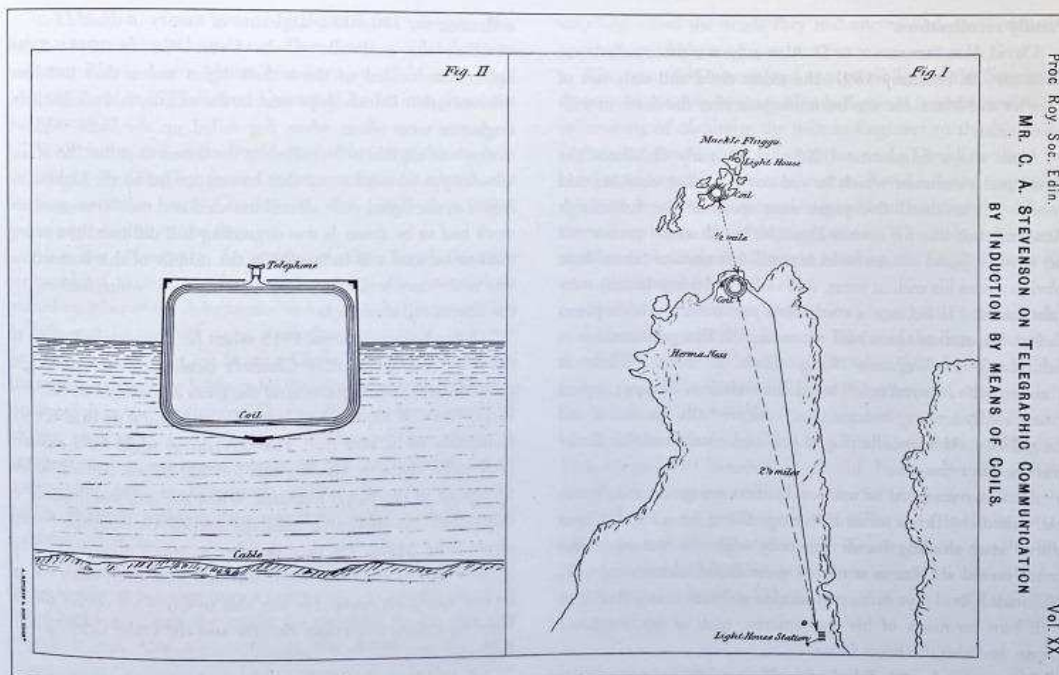
Charles was a pioneer of the development of wireless communication. In 1892 he conducted experiments in electrical induction by means of a telephone transmitter from which he received speech over a distance of two miles without wires. He is believed to have pre-dated Marconi, Heaviside, Preece and others in becoming the world's first wireless broadcaster. His apparatus did however have the drawbacks of being inconvenient to use because of the large diameter of the coil arrangements required and in having a limited range. [119]

Charles also invented the *Leader Cable* for guiding vessels by means of an electric submarine electric cable laid on the ocean

bed.⁷⁸ Ships with appropriate receivers could be brought safely up channels and along dangerous coasts in safety during fog or at night. In 1893-94 both these innovations were the subject of papers read to the Royal Society of Edinburgh, to which Charles had been elected a Fellow in 1886. He did not however get much encouragement from Lord Kelvin, who wrote, *You might just as well boil the sea.*⁷⁹ Nevertheless, the leader cable system was developed and eventually installed at several large ports in Europe and the U.S.A., the first being at Heligoland. During the war the system was also used in the North Sea off Harwich to guide vessels through mine fields.

Apart from the invention of the *Talking Beacon* which is described in more detail in the next chapter, the firm also re-established parabolic mirror glass reflectors at Toward Lighthouse, in which an incandescent mantle from an oil light producing 1100 candlepower produced a beam out to sea of 340,000 candlepower. This improvement marked a return to the catoptric system, which forms the basis of present-day lighting with the very bright electrical sources now available. Other important lighthouse service innovations by Charles included radio controlled lights and fog signals.

Charles's numerous research and development based contributions to engineering practice involving optics, electricity and radio, and their harnessing to works of maritime convenience, usefulness and safety, were in the finest tradition of his profession. Charles was the only Stevenson to become a member of the Institution of Electrical Engineers, being admitted as an Associate in 1893 and becoming a Companion in 1929. With the possible exception of Thomas, he was the most inventive member of the Stevenson engineers.



Proc. Roy. Soc. Edin.
 MR. C. A. STEVENSON ON TELEGRAPHIC COMMUNICATION
 BY INDUCTION BY MEANS OF COILS.
 Vol. XX.

[119] Speech transmission by means of inductive coils. Showing a proposed application from Unst, Shetland to Muckle Flugga lighthouse, and from underwater cable to a ship. From Charles's RSE paper 1895, XX, 196-200.