The Four Remaining Water Balance Lifts in the UK

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Abstract. In the Victorian and Edwardian eras a number of inclined water balance lifts were installed in the UK. Some of the heritage installations still survive in their water balance format and some have seen conversion to electric motors. As recent as 1991 a new one was installed in Wales and sees regular passenger service. This paper looks at the four water balance units remaining in the UK and compares the clever technologies that were used in their designs. The paper also looks at some of the converted installations which still remain including some which are important means of transport from one part of a town to another. All of the installations are different in their designs and the one thing that they have in common is that they are highly efficient when it comes to the energy they use.

1 INTRODUCTION

Two men were instrumental in the installation of inclined lifts around the UK's coastline. George Croydon Marks (Later Baron Marks of Woolwich) was the engineer and George Newnes was the financier having made his money setting up the "Country Life" series of magazines. The first installation of an inclined lift was at Scarborough in 1875 and they became synonymous with seaside towns such as Folkestone, Hastings, Torquay, Aberystwyth, Bournemouth, and Southend and so on. A few were installed inland but still in popular tourist towns such as Bridgnorth. In the early days some of the lifts were driven by water balance using the volume of water to create a weight differential between two carriages which were linked together. There are two words that have crept into use with these installations namely "lift" and "funicular" both of which are incorrectly used in this concept. They actually fall under the Cableway Installations Regulations 2004 and are "cableways" rather than lifts and the term "funicular" has become the standard way of describing an inclined system where two cabins are linked and one acts as a counterbalance to the other. In fact the term "funicular" technically means "of rope" and could apply to many things. Four water balance lifts remain in service in the UK at Lynton & Lynmouth, Folkestone Leas, Saltburn and Machynlleth. They operate in different ways and demonstrate a wealth of engineering ingenuity which is, of course, where the title engineer was derived from.

2 SALTBURN (1884)

Scarborough's popularity as a resort developed in the 1870's. At the time annual seaside holidays became a national custom. In 1875 the first inclined lift was installed and was a water balance type. It has since been modernised and is now a variable frequency type.

The success of these lifts in aiding tourists to get from the beach to their hotels above on the cliffs caused other seaside towns to consider installing one. Saltburn on Sea was one of those resorts and they ordered a gas engine, water pump and other items of engineering miscellanea from Tangye Engineering Company in Birmingham.

At the time George Croydon Marks was employed by the Tangye company which gained its status as one of leading engineering companies of the time when it assisted Brunel to launch his ship that was firmly stuck on its supports at Millwall – their marketing motto became "Brunel launched us and we launched Brunel!"

Originally Saltburn had a traditional vertical lift of timber construction. The cage could carry 20 passengers and was a traditional counterbalance type and entered service in July 1870.

The original vertical lift

The inclined lift replaced the vertical lift when it opened in June 1884. The track is 207 ft long and the rise is 120 ft. The original gauge was 3 ft 9 in but was relaid to 4 ft ¼ in in 1921. Each cabin has a rated load of 12 passengers and the triangular underframe under each cabin provides the housing for water tanks. In the 1950's the carriages were rebuilt to drawings reflecting the original design.

The original inclined lift

Upon arrival at the bottom station the lower car discharges its water which is pumped back up to the tank of the upper car. There are two water holding tanks the one at the bottom capable of holding 30,000 gallons and the one at the top 18,500 gallons.

The original pump was driven by a gas engine which was changed to a DC generator and motor in 1913 and changed again in the 1930's when it was connected to the mains electrical supply.

The lift as it looks today (2014)

The water cycle for the Saltburn Lift is as follows:

- Cycle starts with water in the top tank (18,500 gallon capacity)
- Water is transferred from the top tank to the tank under the upper carriage
- The system then overhauls with the heavier top carriage with its water lowering whilst the other car ascends
- When the water laden carriage reaches the bottom the tank under it is emptied into a holding tank (30,000 gallon capacity)
- Pumps are used to transfer the water from the lower tank to the upper tank

3 FOLKESTONE LEAS (1885)

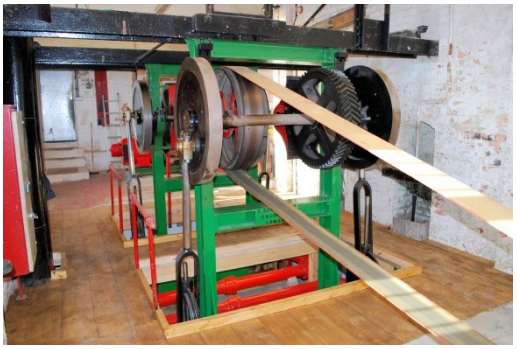
Folkestone were not to be outdone! With little room left around the harbour area the building of houses and hotels continued to the west of the town on top of the cliffs but getting down to the harbour and seafront area was a problem for residents and holidaymakers alike. Similarly, getting back up the hill was not for the old, ill or faint hearted so when the idea of a pier was mooted in the early 1880's the time was right to search for a less arduous way of navigating the cliffs. Water balance lifts had already been built in Scarborough (1875) and Saltburn (1884) and appeared to be the solution. The Scarborough Lift still survives but has been converted to electric drive and the Saltburn Lift features elsewhere in this paper. The Folkestone Lift Company was formed and a lease was agreed with the land owner, Lord Radnor.

Reginald Pope, Architect, designed the installation and local builder John Newman constructed the stations. The stations were the first in the town to be constructed using cavity walls which are now employed in the construction of most modern buildings. The lift equipment was provided by Waygood & Company and it opened for service on 21st September 1885.

The weight of water added to the top carriage was used to overcome the weight of the lower carriage and allowed the system to run. The two carriages were rated at 15 persons each and had the familiar triangular shaped water tanks mounted in the chassis.

The lift was an immediate success offering holidaymakers a comfortable ride from the new hotels on The Leas to the bathing facilities on the beach, the "switchback" and the new pier. It was, in fact, so successful that an additional lift, completed in 1890, was added. The second lift was steeper at 42° and as a result toast rack style cars were provided.

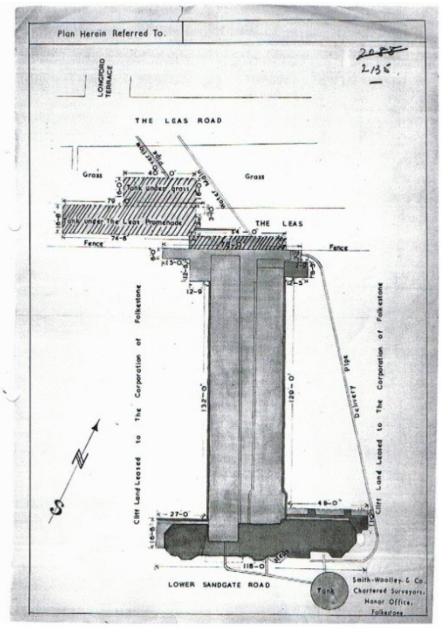
The original lift dumped its water onto the beach and proved very expensive for the owners because of the amount used. The addition of the second lift would have made matters worse and it was decided to use the water time and time again by installing a storage and pumping system. This required storage tanks at the bottom and top stations.



The pump room

In 1899 a second set of storage tanks were added to increase the amount of water that could be stored.

In about 1921 the Crossley gas engines that had driven the pumps for more than 30 years were replaced by electric motors and a band drive facility.



The lift closed during the 2nd World War and became a home guard post. A section of the pier opposite was also removed to prevent invading armies using it. The carriages were lowered to the bottom station thus rendering them useless as well. At the end of the war years of neglect and abuse by the occupying military personnel had left the lifts in a poor state of repair and unusable. It was only a concerted effort by locals that saw the lift reopen in 1947 after a protracted wait for replacement motors which were in short supply at the end of the war.

The heydays of Folkestone had passed with the introduction of overseas package holidays and the 1890 lift carried its last passengers in October 1966. The real reason for the lift being withdrawn was because it had suffered damage following a hard landing and the 1885 lift could cope with the falling numbers of passengers. The lifts insurers though had different ideas and demanded expensive, major improvements that the lift company could not afford and Folkestone Borough Council offered to put up the money in return for taking over the business. As a result the Folkestone Lift Company was forced into liquidation and the lift was absorbed into the local council. In 1974 Shepway District Council took over Folkestone Borough Council and they continued to manage the lift until 2009 when they closed it for economic reasons.

The ownership of the lease reverted to the Folkestone Estate when the lease was surrendered and they carried out a major refurbishment of the lift before looking for a new team to operate it. A group of townspeople got together to form a community interest company and they still run the lift today.

The water cycle for the Folkestone lift is similar to the Saltburn cycle as follows:

- Cycle starts with water in the top tank under the Leas
- Water is transferred from the top tank to the tank under the upper carriage
- The system then overhauls with the heavier top carriage with its water lowering whilst the other car ascends
- When the water laden carriage reaches the bottom the tank under it is emptied into a holding tank
- A couple of times a day the pumps are used to transfer the water from the lower tank to the upper tank

4 LYNTON & LYNMOUTH (1890)

The Lift at Lynton and Lynmouth is a very different design but still uses water ballast as its motive power.

The cliff railway was the second part of a scheme which involved Lynmouth Promenade, Pier and the lift itself.

The cliffs between Lynton at the top and Lynmouth at the bottom posed problems for the growing tourist industry. From the mid 1820's holiday makers began arriving at Lynmouth on paddle steamers from Bristol, Swansea and other Bristol Channel ports but a daunting hill faced those who wanted to walk up to Lynton.

Bob Jones, a local man and partner in the firm that built the esplanade recommended his sisters' son, George Marks, to be the engineering advisor on the project to build the lift.

Marks realised that due to the length of the rails (some 900 ft) rising over 500 ft vertically at an incline of 1:1.75 that he would need to consider safety carefully and particularly the braking system which would need to be far more advanced that those used on its predecessors.

He decided on four separate systems. Two friction brakes which were steel blocks which push down on the crown of the rails by hydraulic pistons and hydraulic callipers which clamp across the crown of the rails.. The system was patented by Marks and the hydraulic system used was filled with water and not oil which became unique to this lift.

The river Lyn, notable for the 1952 floods, would provide the motive power. The Lynmouth & Lynton Lift Company was formed by an Act of Parliament in 1888 which gave the company the perpetual right to extract up to 60,000 gallons of water a day from the River Lyn at the top of the hill. The water passes through a pipe under the road through the town and is held in tanks at the top of the hill adjacent to the top station

The Lynton & Lynmouth Lift in the 1950's

This lift is also different to the other water operated lifts in that space is limited and therefore the two carriages pass in a wide section in the middle of the traverse but spend the rest of their time above and below the passing point in narrower sections.

The water cycle for the Lynton & Lynmouth lift very different to Saltburn & Folkestone and operates as follows:

- Cycle starts with the bottom carriage full of water and held static by the second brake and the diamond lock at the bottom station.

The Diamond Lock

- The top carriage tank is loaded with water (700 gallon capacity)
- When the carriages are ready to move the drivers communicate with each other by bell signals
- The driver of the lower carriage releases the diamond lock and the calliper brake thus leaving the system hanging in suspense.

- The lower driver then releases some of the water from their carriage until the system overhauls
- The overspeed governor automatically applies the brake if the carriages go too fast and it is up to the drive of the lower carriage to keep the speed of the system under the governor speed by using their foot brake to control the speed.

With the water being supplied by the River Lyn and merely being made useful on its way to its discharging into the sea via the lift rather than via the valley it can be seen that the system draws no power and can therefore be deemed as extremely environmentally friendly.

5 MACHYNLLETH (1992)

The Centre for Alternative Technology was a project before its time. It was the place where the idealism of the 1960's met the real world and fought the hard won battle to convince the latter of the virtues of concepts such as sustainable energy sources, energy conservation, organic farming and materials recycling which we readily accept today.

The inclined cliff railway here opened on Saturday 6th June 1992 having been built by the enthusiasts for energy conservation.

The water cycle for this lift is, yet again, different to the other three covered in this paper and operates as follows:

- Cycle starts when the operator at the top station is commanded to fill the top carriage tank as demonstrated below with the carriage away from the station for the benefit of the photo. The water is sourced from a lake at the upper level.

Water Chute

- As the water fills the top carriage tank the drum at the top wants to overhaul which is detected by a tilt switch.
- The top car starts to roll away with the bottom car naturally ascending as their ropes, albeit separate, are wrapped around the same drum
- As the drum rotates it charges an accumulator via a hydraulic pump which is also used to maintain control of the speed
- As the upper car arrives at the bottom the accumulator is used to power the extension of the hydraulic piston which released the water from the carriage that has just arrived at the bottom station.

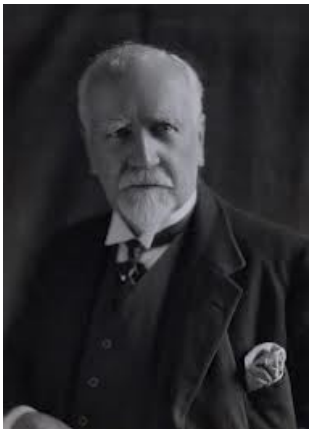
The water for the operation of the lift comes from a natural lake supplied by rainwater and the system only draws minimal power using a car battery to maintain lighting and switches at the operators console. The movement of the carriages is all down to gravity and costs nothing to operate.

Water being released at the bottom station

6 GEORGE CROYDON MARKS

George Croydon Marks was born on 6th June 1858, the eldest of eight children of which only four survived infancy and followed his father into the Arsenal at Woolwich where he undertook an apprenticeship. At school he had impressed his teachers with his academic ability and it was suggested that he attempt the Whitworth scholarship which he passed and attended Kings College in London achieving a Degree.

At a reasonably young age he became the manager of the hydraulic and lift department of the Birmingham based Tangye Brothers, a company associated with funicular lifts, and was placed in charge of the installation of the funicular at Saltburn. It was here that he met Dugald Clerk, inventor of the two stroke combustion engine, who was to become his business partner.



George Croydon Marks

In 1880 he set up in private practice in Birmingham and married Margaret Maynard a year later.

In 1882 (but some reports say 1887) at the age of 29, he set up in private practice as a consulting engineer and was soon joined by Dugald Clerk in the London based patent agency Marks Clerk which still trades today and has offices all round the world

George's mother was originally from Lynton and had maintained contact with her relatives there so once the idea of the Lynton railway became a reality George was brought in to carry out its design. In Lynton he met with George Newnes and each had a profound impact in each other's lives.

Following the opening of the Lynton and Lynmouth funicular Newnes and Marks worked together on a number of funicular installations; Saltburn, in 1892 Bridgnorth, 1893 Bristol Clifton and in 1895 Aberystwyth.

In 1906 he was elected Liberal MP for Launceston & North Cornwall

In 1910 he opened a New York office with Thomas Edison.

In 1911 he was knighted followed by a CBE in 1918. After being elected into the Houses of Parliament he crossed the floor of the house to join the labour party under the leadership of Ramsay McDonald.

In 1929 he was elevated to the peerage and became Baron Marks of Woolwich which was one of the first two Labour peerages

During his life he was a Director of two record companies, Columbia and EMI, and could be described as the Richard Branson of his time. He passed way in Bournemouth on 24th September 1938 whereupon the peerage became extinct.

7 GEORGE NEWNES

Newnes was a man of distinction; born on 13th March 1851, in Bakewell, Derbyshire he was the youngest of 6 children. The son of a congregational minister he was expected to follow his father into the ministry and he was educated in a boarding school where he received preparation for this. He had his own ideas and on leaving school he joined a London firm of accountants as a trainee and later took over their Manchester office. In 1881 he launched the journal "Tit Bits" which was to supply his future funding for some of his projects. It was the success of this magazine that brought him back to London.

In 1885 he was elected as Liberal MP for Newmarket.

The popularity of his publications enabled him to spend the winter in places such as Torquay. In 1887 he was persuaded by Thomas Hewitt, a business man from Lynton to change his plans and he wintered in Lynton and fell in love with this north Devon town. Here he funded the installation of the water balance funicular lift which still exists today.

In 1890, the same year as proposing a cliff lift at Babbacombe, he teamed up with George Croydon Marks, later Baron Marks of Woolwich, who was to be the consultant on the eventual installation at Babbacombe.

In 1895 he lost his Newmarket seat and was given a Baronetcy. In 1897 he started the now renowned journal "Country Life".

In 1900 he was elected MP for the Swansea Town seat although some reports say this was 1906.

George Newnes

He died in 1910 and was buried in Lynton. He never got to see the realisation of his proposal of a cliff lift at Babbacombe although he had his hand in on many cliff railways around the UK including Bridgnorth and Lynton & Lynmouth

8 THE HISTORY OF WATER BALANCE INCLINED LIFTS IN THE UK

The following water balanced inclined lifts were installed in the UK

Date	Location	Gauge	Length	Angle	Notes
1875	Scarborough (Spa)	4 ft 8 ½ in	284 ft	30°	Converted to electric
1878	Scarborough (Queens)	4 ft	218 ft	27°	Withdrawn 1887
1884	Saltburn	3 ft 9 in	207 ft	30°	Still in service
1885	Folkestone Leas	5 ft 10 in	164 ft	32°	Still in service
1890	Folkestone Leas (2)	5 ft	155 ft	34°	Withdrawn 1966
1890	Lynton & Lynmouth	3 ft 8 in	862 ft	30°	Still in service
1890	Laxey	5 ft	300 ft	14°	Withdrawn 1914
1892	Bridgnorth	3 ft 8 ½ in	201 ft	29°	Converted to electric
1893	Bristol	3 ft 8 in	450 ft	22°	Withdrawn 1934
1893	Folkestone (Sandgate)	5 ft 6 in	670 ft	12°	Withdrawn 1918
1896	Aberystwyth	4 ft 10 in	798 ft	27°	Converted to electric
1903	Hastings (East Hill)	5 ft	267 ft	38°	Converted to electric
1904	Folkestone (Metropole)	5 ft 6 in	96 ft	36°	Withdrawn 1940
1992	Machynlleth	5 ft 3 in	197 ft	29°	Still in service

9 CONCLUSION

14 water balance inclined lifts were installed in the UK of which only 4 remain at Saltburn, Folkestone, Lynton & Lynmouth and Machynlleth.

Whilst the 4 remaining inclined lifts have different modus operandi they all have two things in common – they use water as the prime mover and they are incredibly efficient when it comes to energy consumption.

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BIOGRAPHY

David Cooper has been in the lift industry since 1980 when he started an apprenticeship with British Railways. He has been involved with many of the rail mounted inclined lifts around the UK including Hastings East, Hastings West, Babbacombe, Scarborough Central, Scarborough South Cliff, Scarborough St Nicholas, Padstow, Lizard, Southend, Urbis Centre, Machynlleth, Bridgnorth. Internationally he has also been involved with the Angels Flight inclined lift in Los Angeles. In 2008 he appeared in the BBC programme "Flog It" as the expert showing Paul Martin over the Inclined Lift at Babbacombe in Devon. He has won awards for his involvement with inclined lifts including the Association for Consulting and Engineering Awards for the projects at Babbacombe and Hastings. He has also been involved with aerial suspended cableways and was the winning project in the Elevator World Project of the Year in 2013 for the London Emirates Airline Cable Car on which he presented a paper at the 2013 Symposium.