WELSH HIGHLAND HERITAGE

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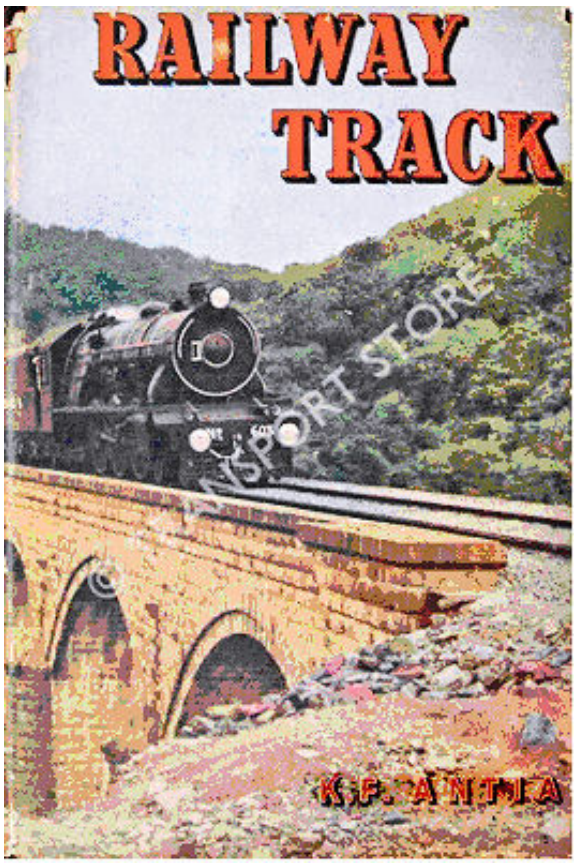
Who Was K.F. Antia?



K F Antia submitted a copy of an illustrated (but undated) paper he had written on the Festiniog and Welsh Highland Railways to Stephens' offices at Tonbridge, where it was date stamped as received on **'8 NOV 1928'**.

The "dating" of the paper - but more particularly of his photographs accompanying it - has been the subject of debate among the cognoscenti. So far as the Welsh Highland element is concerned, his description of the South Snowdon - Beddgelert section states that this is only "a couple of years old" while the WHR revenue figures used are those for calendar year 1924 - both thus suggesting it was written in 1925; the Railway Clearing House map included is dated 1928. All this means the paper was written at some time between 1925 and 1928. This does not preclude the photos having been taken earlier although that would seem unlikely. As they include a "new looking" Beddgelert station, some have claimed they date from very early in the life of the railway - despite the evidence of Antia's text.

His photograph of Portmadoc Cambrian Crossing (which is certainly in the condition prior to its renewal in November 1928) has appeared in Welsh Highland Heritage (WHH) 3, p8 (where it was dated 1928), WHH 28, p. 3 (undated, but some speculation in WHH 30, p.3 that it was early in the WHR's life) and WHH 42, p.2 (dated 1923 – which is unlikely). The photo could suggest that work on the GWR was being undertaken at the time: the fence panel to the right of the cabin removed (to give access?), the protective board removed from the front of the cabin, ballast cleared from between GWR sleepers (but was that abnormal?). If so, it might have been during works in consequence of Lt. Col. Mount's inspection (the requirement to move the north side

Richard Maund Investigates.....

WHR trap points would have involved rodding changes), or during work to remove the mechanical gong in winter 1923/4, or while the GWR were resleepering 29½ chains of their line through the site of the crossing during March and April 1925 – or, of course, at some other time during normal maintenance! It is probably not unreasonable to conclude that the photographs were taken and the paper written by spring 1925. Why it was sent to Tonbridge three years later, however, remains unexplained.

So who was Antia? Some have speculated that he might have been an apprentice with one of the main line railway companies. Unfortunately, it has been impossible to establish his date of birth but he came from an Indian Parsee (Zoroastrian) family. At the time of his Welsh visit, he was studying Civil Engineering at King's College, London, from 3 October 1923 to June 1926, when he left with a B.Sc.Eng. (Hons.).

He joined Indian Railways and went on to write *'Railway Track'*, subtitled: Design, Construction, Maintenance, and Renewal of Permanent Way with notes on signalling and bridge maintenance, first published by the New Book Company, Bombay in July 1945. Based on Indian railway practice, it went through five editions to *'Railway track Connections or Points and Crossings'* (1962). Copies of the first edition fetch £45 on the second hand market (July 2009). His other published title was *'Structural Concrete'* (1967).

He again attended King's from October 1954 for a year to obtain an M.Sc. with his thesis: 1. Fundamentals of Reinforced Concrete; 2. Railway Track Design, Construction, Maintenance, and Renewal. His career was as a respected engineer, concentrating latterly on concrete work, with Indian Railways. For their 1968/9 session he was elected President of the Institution of Engineers (India) and in 1969 the Institution created The K F Antia Memorial Prize in his memory (presumably he died in office); the prize is awarded for the best paper published in the Institution's Journal on any subject related to engineering.

My thanks to David Woodcock for raising some "debating points" about Antia's crossing photo.

The Antia Treatise

This treatise or thesis was probably written in 1924/25 when K.F. Antia was a student at Kings College London. It is interesting for being an eye witness account of the WHR & FR by a young man who was to become a significant figure in Indian Railways. The photographs have been re-scanned from the originals, which only measured about 1½" x 1" There are some errors inevitably, and yellow highlighted text shows a correction with the benefit of hindsight!

Michael Davies was in contact with the late J.A. (Arthur) Iggulden from the late 1950s, realising he was perhaps the closest person still alive who had worked with his hero, the king of light railways, Col. Holman Fred Stephens.
Arthur was still in the employ of British Railways Southern Region at the time, but following his retirement in the mid 60s, he was able to devote more time to answering queries concerning the 'Tonbridge empire' and in 1970 invited Michael to Tonbridge where he still lived. They became quite close over the next few years and Michael was able to acquire certain items thet Arthur had thoughtfully preserved on the closure of his office in 1948. Amongst these was a manilla folder, the back of which was endorsed 'Shropshire & Montgomeryshire Railway Co - Rents List Year 1938' and this folder comprised the Antia treatise which included photographs of the FR & WHR taken c1925. A single date stamp (8th Nov 1928) on the back of the folder was the only other clue to date the work.

The longest narrow gauge system in the British Isles has the advantage of passing through the best part of N. Wales as regards scenery. The whole of Snowdonia is traversed from north to south by the Welsh Highland Railway, and by the Festiniog Railway which passes through the beautiful Festiniog valley; the gauge of both is 1' 11 ½".

The two railways are a combination of a very old and a comparatively modern railway placed under the same management in 1923. The Festiniog Railway dates back to 1832 and is the first narrow gauge railway that came into existence. The Welsh Highland Railway is made up of the NWNG Ry, the P.B. & S.S.Ry and the Croesor Tramway extended from Croesor Junction in 1923

The Festiniog District is, besides Llanberis, the greatest slate producing region in the world. The slates are mainly quarried in Blaenau Festiniog about twelve miles from Cardlgan Bay and in the last century used to be brought down on pack horses to the mouth of the River Dwyryd and transferred to boats.

In 1807 William Madocks, from whom the town of Portmadoc derived its name, built the Traethmawr Embankment ¾ mile long across the estuary of the Glaslyn and reclaimed thousands of acres of land from the sea. James
Spooner, in conjunction with Mr. Madocks, projected a horse tramway from Blaenau Festiniog to Portmadoc, making use of this embankment.

The original tramway was one worked by gravity. In a length of about 13 miles the line descended approximately 700 feet, and loaded slate wagons came down to Portmadoc under their own weight, as they do to this day. The empty wagons were easily pulled up the gradient by horses.

The track was of cast iron rails 1 ½" wide and 2 ½" deep and supported on stone sleepers, mostly slate blocks, by cast iron chairs. These rails weighed 16 lbs to the yard. The gauge of the railway was 1' 11 ½". The carrying capacity of the horse drawn wagons was 2 to 3 tons and this has not varied much.

Although the idea of using locomotives on the line originated with James Spooner it was left to his son Charles to carry this into effect. In 1863 two 0-4-0 type of saddle tank engines were ordered from Messrs G. England & Co., and with their advent the rails were changed to 30 Ibs per yard.

For upwards of 30 years the line had been used for mineral traffic only, but in 1865 the railway was inspected by Government officials, and passenger traffic was sanctioned with a speed limit of 12 m.p.h.

A year later the line was extended to Duffws just beyond Blaenau Festiniog.

In 1867 the Cambrian Railways from Pwllheli to Barmouth was opened and four years later an exchange station at Minffordd was constructed. The transference of slates is made by running the narrow gauge wagons on to raised platforms alongside the standard gauge wagons .

With the advent of L & N.W.R. line to Blaenau Festiniog, a part of the slate traffic was lost to it. They also built a rival port at Deganwy.

Top - Beddgelert Siding - note Croesor chairs.
Above - Beddgelert station & bookstall

Blaenau Ffestiniog Junction on the FR

In 1868 was started the Festiniog and Blaenau Railway with a length of 3 ½ miles. It had two 0-4-2 saddle tank engines built by Manning Wardle & Co. and trains used to run through to Festiniog instead of Duffws. This railway however got into difficulties and was absorbed by Great Western Ry in 1883 and converted to the standard gauge branch from Bala. This introduced another partner in the slate traffic .

It may be of interest to note that the Festiniog Railway was subjected to a battle of gauges also, the 4' 8 ½" gauge being at one time recommended, but it came out triumphant through the fray.

As the traffic became too heavy for a single line, powers to double the track were obtained in 1869, but the company was saved this expense by the timely introduction of the Fairlie's Patent Double Boiler Locomotive. This engine although retaining perfect flexibility so necessary on a line full of sharp curves, gave a very much increased tractive power. At the same time the cast iron rails were changed to 49 Ibs steel rails and later to 50 Ibs with a length of 30'.

One of the sections of the Welsh Highland railway i.e. the North Wales Narrow Gauge Railway was constituted by the Act of 1872. The projected lines ran from Dinas on L.M.S. to S.Snowdon at the foot of the mountain, with a branch from Tryfan Junction to Bryngwyn, tapping the slate quarries roundabout. Another line was to stretch from Beddgelert (actually Llanfrothen) to Bettws-y-Coed, but this portion was never constructed.

The line from Dinas to Bryngwyn through Tryfan Jct was opened in 1877 and S.Snowdon was linked up four years later. Throughout its career it possessed only two locomotives of the 2-6-2 tank type. (During its career the NWNGR owned four locos of 0-6-4T and one of 2-6-2T)

The railway got into financial difficulties and the crisis came in 1916 when the line had to be closed down for passenger traffic.

The second factor of the Welsh Highland i.e. the Portmadoc, Beddgelert and S.Snowdon Railway owed its origin to the Croesor Tramway started in 1864 to convey slate to Portmadoc. In 1865 it was styled the Portmadoc-Croesor railway.

A part of the tramway was taken over by the PB&SSR and it was given some of the powers of the N.W.N.G.R. which had lapsed.

The P.B. & S.S.Ry never ran any trains.

In 1900 S.Snowdon and Beddgelert line was in course of construction but this work fell through due to financial loss caused by a tunnel started at both ends being out of alignment by an extraordinary distance. (Inaccurate!)

In 1922 an act was passed incorporating the N.W.N.G.Ry & P.B. & S.S.Ry now termed the Welsh Highland Hallway. The construction of the line from Croesor to S.Snowdon was entrusted to Sir Robert MacAlplne & Sons.

The Dinas-S.Snowdon line was re-opened in July 1922 and S.Snowdon was linked to Portmadoc a year later.

Carnarvon was to be the terminus of the Welsh Highland Hallway but Dinas Junction still holds this position. It is about three miles from Carnarvon and makes a junction with the London Midland and Scottish Railway. The line after running on a level for a short distance, begins to climb to the foot of Snowdon. The first station Tryfan Junction, is two miles from Dinas, and here a branch shoots off to the slate district above Bryngwyn. Rhostryfan is the only other station on this branch which has a heavy mineral traffic. The line then runs along the River Gwyrfai passing Waenfawr, Bettws Garmon and Salem on to Quellyn Lake presenting a beautiful view, and the line then passes over a girder bridge. S.Snowdon 9 ¼ miles distant was the terminus of the North Wales Narrow Gauge Railway

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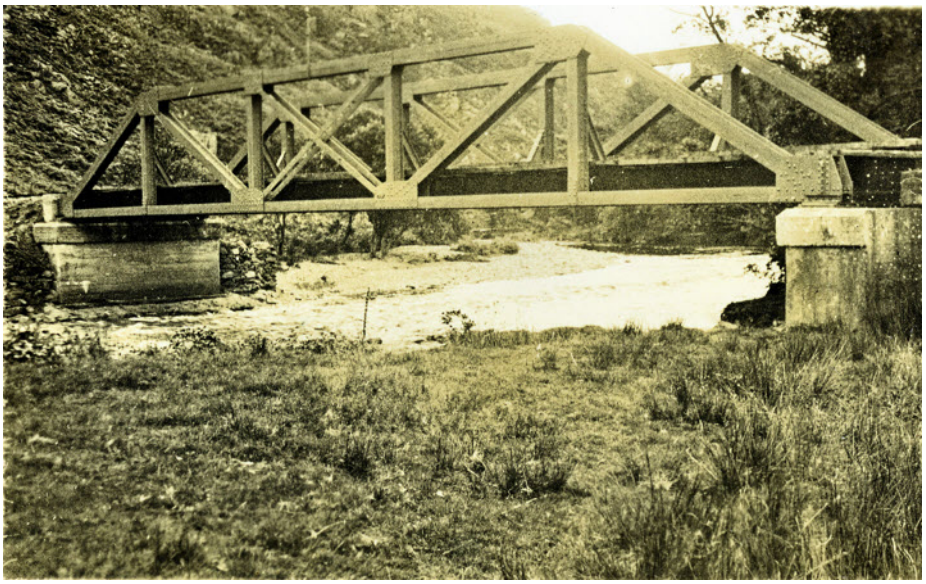
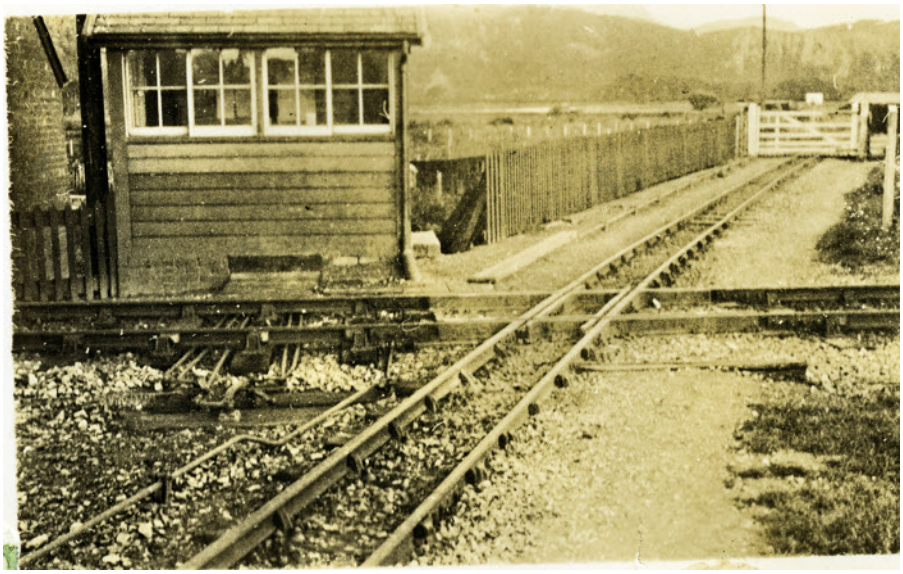
The line at this point is 650 feet above sea level, and runs on a level up to Pittshead, a mile away. One of the steepest parts of the line is then encountered to Beddgelert three miles distant. The gradient varies from 1 in 40 to 1 in 48 and a good deal of engineering has been necessary. This has been carried out by means of curves and loops which has more than doubled the distance between the two places!

Some of the sharpest curves with a radius of 3 chains are to be found here. This part of the line is only a couple of years old. Originally the gradient was 1 In 28 but it was reduced to 1 in 40 by an amendment obtained in February 1923 to make the working easier.

After passing through Beddgelert the first tunnel, 47 yds, is reached. The line then passes under a girder bridge carrying the main road to Portmadoc, and is immediately on the Glaslyn River which is spanned by a 70' span lattice girder bridge.

Bryn y Felin bridge





Croesor Crossing - see also Richard Watson's article on page 8

The railway then goes through the pass of Aberglaslyn, but the beautiful views are obscured by three tunnels the longest being 300 yds. The line for the most part runs parallel to the road and the Glaslyn River, but is on a higher level. Nantmor Station lies just beyond the longest tunnel but a high embankment with two culverts has to be passed before the halt is reached.

After crossing two roads one on a level and the other by a girder bridge the line emerges onto the plain at Hafod-y-Llyn.

The two rivers Nanmor and Dylif are crossed by 70' lattice girder bridges of the same type as that at Bryn y Felin.

At Croesor 17 3/8 miles from Dinas, a junction is made with the horse tramway started in 1864. From here the line to Portmadoc is a part of this old tramway. The longest bridge on the line 190', spans the Glaslyn River again by means of 8 spans of 24' each. The rolled steel joists 20" deep und 7 ½" wide rest on slate piers. The road runs parallel to the railway and is entirely a wooden structure and I may add, not too safe, resting on the same piers.

A cast manganese steel level crossing over the G.W.Ry being passed, the new station of Portmadoc is reached.

To the old station is a short distance through the town and over the Glaslyn River, this time by a ferro-concrete bridge, boldly named Britannia, with 5 spans.

Portmadoc Old Station, 21 ¾ miles from Dinas, adjoins the extensive wharves of the town and is the headquarters of the two railways.

The Festiniog Railway runs practically on a level along the Traethmawr Embankment with an arm of the sea on the right and swampy ground on the left. At the other end of the embankment are located the Boston Lodge works which although small have done creditable work. The scope of its work can be gauged from the fact that engines, with the exception of the boiler, have been made and erected in its shops, and that every one of the engines have been efficiently rebuilt.

A regular and unbroken climb now takes place and after passing through Minffordd, a junction with the G.W.Ry with extensive slate sidings, and Penrhyndeudraeth the average gradient becomes 1 in 80. The longest run of about 4 miles brings one to Tan-y-Bwlch 29 ¼ miles (from Dinas). The scenery about this part is very grand and its beauty is enhanced by two big loops.

The line then passes through two tunnels the first is short and the second 730 yds long. About Tan-y-Grisiau the gradient eases out to 1 in 186 but before Blaenau Festiniog is reached it changes to 1 in 88.

Blaenau Festiniog is a junction with the G.W.Ry to Bala and the L & N.W.Ry to Bettws-y-Coed, and has a number of branches to quarries, one or two round the terminus at Duffws, being on inclines. Duffws and Blaenau Festiniog are, so to say, the pulses of the railway, being the loading points for the slate traffic.

The distance between Dinas and Duffws is 35 miles.

Gradients & Curves & Superelavation

There is not a single stretch of level line on the Festiniog Railway, even the Traethmawr Embankment having a slight gradient of 1 in 1343. The ruling gradient on F.R. is 1 in 80. The steepest gradients of 1 in 40 are obtained on the Welsh Highland Railway between S.Snowdon and Beddgelert.

The Railways consist of a series of parabolic curves the sharpest of which is 1 ¾ chains lying between Penrhyn and Tan y Bwlch, whilst curves of 3 chains radius are common on the section between Beddgelert and Hafod Ruffydd.

The curves on the FR are provided with inner guard rails, but these are not found on the WHR. Superelevation sometimes reaches 3 ½" and wherever the lengths of the curves permit an elevation of ¼" per rail length from the tangent point is allowed. A straight between tangent points is a very uncommon thing, most of the curves being reversed curves.

The only straight distances lie on the Traethmawr Embankment and parts between Portmadoc New Station and Pont Croesor.

Bridges

The Welsh Highland section claims the six largest bridges. Three of them are over the Glaslyn River and all these three are of different types. The one at Beddgelert consists of a 70' lattice girder with one end resting on a pier with a 4' cattle creep. The framework is made up of rolled steel joists 10" x 8" and the main girders under the lines are 24" x 7 ½" with 5/8" thickness.

The second of the bridges over the Glaslyn is situated at Ponte Croesor and consists of 8 spans 24' each of rolled steel joists 20" x 7 ½" and ¾" web and flange. The piers are of stone.

Where the Glaslyn river enters the Port, a ferro-concrete bridge with 5 spans takes the railway as well as the high road over it. This bridge was originally of stone but was widened in concrete in 1923.

A girder bridge is situated near the south end of Quellyn Lake.

The two other bridges of importance on Welsh Highland Ry are over the Nanmor and the Dylif and are of the same type as the 70' lattice girder bridge at Beddgelert.

The deep cutting (Cutting Mawr) north of Beddgelert

The only bridge of importance on the Festiniog Section is a stone 25' 6" arch bridge over the G.W.R Station Minffordd. Here again the bridge carries a road alongside and is altogether 47' 6" wide.

There are many other smaller bridges especially on the Festiniog line. In the case of overhead bridges the clearance is 9' between the rails, and girders, the width being 10' for single line and 17' for double. Underbridges are mostly of stone with a span varying from 10' to 15' .

Culverts
The culverts consist of either 8' to 15' span stone arches or slabs of stones covering about 1 ½' openings and resting on masonry sidewalls.

Tunnels
There are altogether six tunnels, two long and four short.

The longest between Tan-y-Grisiau and Ddu-allt is 730 yds long and is 8' wide with a clearance of 9' above rails.

The other long tunnel lies just north of Nantmor and Is 300 yds long and is 12' wide with a clearance of 15'.

A 60 yds tunnel lies above Tan-y-Bwlch and 3 tunnels of 47, 37 and 17 yds length lie between Nantmor and Beddgelert.

Cuttings & Embankments
Cuttings and embankments are numerous, the Festiniog section mainly lying on a bed formed by part cutting and part filling. At formation level cuttings are 8' wide and have a slope of 4 in 1. The deepest cutting is 27'.

Most of the embankments are made up of dry masonry and a few are constructed by filling soil between two side stone walls. Wherever the embankment is on a curve, buttresses are placed on the inner as well as the outer sides. The average slope is 4 in 1 The highest embankment is 60'.

FR brake van

Mention must be made of the ¾ mile embankment in the Glaslyn estuary, built in 1807 with slate blocks and waste from quarries.

Although the rainfall is heavy no special precautions are taken for draining the lines as the steep gradients are sufficient to effect this. Only in cuttings, side channels are constructed.

Fences
On the Welsh Highland section fences consist of ordinary wire and barbed wire supported by wooden posts. On the Festiniog section stone walls are constructed and surmounted by a coping of slate on edge with two wires on top, the wires sloping outwards and being necessary to keep sheep off the track. In many places the walls are so near the lines that there is only a few Inches of clearance between them and the train.

Wooden gates are provided at short distances and cattle-guards are evident at all level crossings. These guards are said not to be very efficient, cattle having been known to pass over them.

Rails Etc
The rails used on the two railways vary in length from 33' to 24'. On the Festiniog section 30' bull head rails and 24' double head rails are used. All the rails on the Welsh Highland section are flat bottomed with lengths of 33', 30' and 24' and no chairs are used for these .

The weight per yard rail is about 50 lbs .

The chairs used on Festiniog Railway weigh 20 lbs each and have 3 holes for spikes. The older type weighed 18 lbs and were of a butterfly shape with two holes

Originally slate blocks were used for sleepers. Before the war local larch was used, and at present creosoted pine is in use.

The lengths of these are 4' 6" and sections 6" by 5". Their ordinary life is 15 years.

Points and crossings vary from 1 in 4 to 1 in 12.

On the FR the termini and main junctions are provided with big* turntables for the engines and there are numerous smaller ones for wagons. (*Clearly relative to the eyes of a young man)

Stations & Signals
The stations on the Festiniog section are better than those on the Welsh Highland section probably due to many reasons, the chief be-

The two tier embankment south of Nantmor

ing the abundance of traffic on the Festiniog line and the great economy exercised in the construction of the Welsh Highland four years after the war. Practically all the stations on the new line are sheds of corrugated Iron, all of them divided into two rooms, one for the Booking Office and the other for the Waiting Room. A Refreshment Room Is located at Portmadoc New Station.

The stations on the Festiniog section are almost all of good masonry construction. The largest station is that at Portmadoc and accommodates the General Manager's Office on the top floor. Spacious waiting rooms are provided at every station.

There are altogether 24 stations of which 16 belong to the Welsh Highland line.

No platforms exist since the type of carriages used are low.

Station yards are very well laid out, the chief ones being those of Dinas, Portmadoc (Old & New), Minffordd and Duffws.

For the transhipment of goods to the standard gauge railways the wagons are run on to platforms of such height as to bring the tops of the two wagons on the same level. This greatly facilitates the handling of slates.

The only signal cabin situated near Blaenau Festiniog is being dismantled. The whole Festiniog line is worked on the Webb-Thomson System of staff instruments for single line railways. These staff instruments are supplied by the Railway Signal Go, of Westminster.

One or two examples of the old disc type of signals are still in use.

All the points on the Welsh Highland section are worked by handlevers which are padlocked and the key fixed to the train staff.

Locomotives

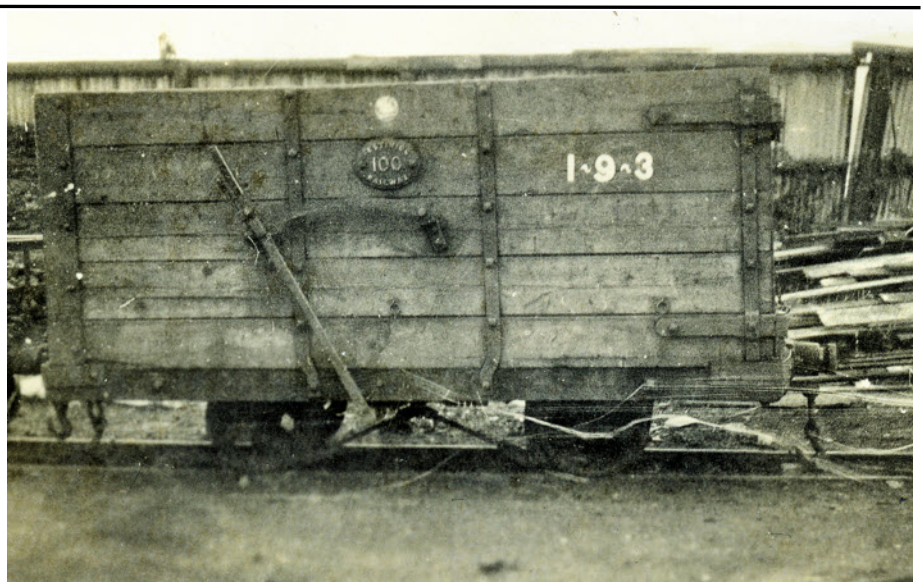
There are altogether twelve steam locomotives and two petrol engines for shunting purposes. The Festiniog Railway owns nine of the steam locos, all of which have been rebuilt, some more than once, in the Company's works at Boston Lodge.
The first four locos were built in 1863 by Messrs G England & Sons and were of the 0-4-0 saddle tank type with a weight of 8 ½ tons. Four years later two more of the same type but larger dimensions followed.

In 1869 a novel type of engine, the Fairlie patent double-boiler locomotive, was put in commission. It is interesting to note that the Fairlie locomotive was the forerunner of the Malett and Garratt locos used extensively for heavy traffic work on steep gradients.

The capacity for raising steam and tractive power are very much greater than of an ordinary engine of the same dimensions. It combines maximum power with perfect flexibility of the wheel base. It is of the0-4-0-0-4-0 type resting on two bogies. The cylinders are 8 ½" diam, 14" stroke, weight 21 tons. The steam pipe connections are of a different pattern.

Two ball joints and an elbow joint intervene between the boiler end and the cylinder end of the pipe. The length EB takes the vertical movement with B as centre and B B takes the lateral thrust with B again as centre. No packing is used at the ball joints but the joint is made steam tight by means of helical springs shown. There is not much room for the enginemen as well as coal, as the boiler runs through the cab, but due to the comparatively short runs the lack of space is not much felt.

The advent of these locomotives saved the company from the expense of doubling the track as this engine could haul easily 120 tons, nearly double the amount for the tank locos.



FR coal wagon number 100

A 0-4-4 side tank engine was ordered from the Vulcan Foundry Co. in 1872.

In 1879 and 1885 two Fairlie engines were constructed at the railway workshops.

In 1923 two locomotives from the North Wales Narrow Gauge Railway were added and a 4-6-0 American tank loco by Baldwin & Co. of Philadelphia was purchased.

The annexed table shows the chief dimensions of the locomotives in commission.

It will be of interest to note that the first locomotive built in 1865 and rebuilt in 1895 is still in use having seen above 60 years service.

Two petrol locos are us«d for shunting purposes.

Carriages & Wagons

The carriages are remarkably wide and comfortable for so narrow a gauge. The standard colour is purple, not very attractive, but necessary due to the soiling quickly of other colours in the numerous tunnels. The interior is well varnished and all the first class and some of the third are upholstered. Acetylene or electric lights are fitted to every compartment. Vacuum brakes are fitted to every carriage.

The carriages may be suitably classified into four types:-
(1) 8 wheeled bogies including composite and observation type cars.

(2) Four wheeled carriages longitudinal seats and open observation cars.

(3) Four wheeled quarrymen's cars.

(4) Bogie and four wheeled vans.

The principal dimensions are shown in the adjoining figure.

The Festiniog Railway owns 1,258 wagons of which 1,100 are open slate trucks, 120 general goods wagons and 38 timber trucks. The Welsh highland line possesses 124 general goods wagons. Among the general goods may be included the all metal gunpowder wagons for the quarries.

Ordinary lever and block brakes or strap brakes are fitted to every 6th wagon and actuated by hand.
The Festiniog line is exempted from the Board of Trade Rules of 1902 for "Prevention of Accidents" hence no brakevans are used for trains running beyond the station limits.
The general dimensions are in the adjoining table.

Traffic

The summer service on the Festiniog section consists of 6 trains each way and on the Welsh Highland 4 trains, with an additional train on both lines on market days.

The winter traffic justifies only 2 trains a day on the Welsh Highland line and the service on the Festiniog section is also curtailed.

Minffordd Station on the GWR

The timetable is so arranged for winter that only one engine can work all the trains. (Incorrect!)

Two slate trains come down to Portmadoc from Festiniog daily and due to the steady down gradient, these trains work by gravity. The empty wagons on the up journey are coupled to the passenger trains. This arrangement dispenses with a locomotive for working slate traffic. As many as 100 wagons form a slate train.
One slate train runs from Bryngwn and another from Croesor.

The chief passenger traffic consists of tourists and quarry-men and goods traffic of slate, the Festiniog district besides Llanberis, having the most extensive slate quarries in the world.

Recently traffic on the line has dwindled due to three causes

(1) Competition with the L & N.W.Ry (1879) which opened a rival port to Portmadoc, at Deganwy, and the G.W.Ry (1885).

(2) Diminished output and export of slate.

(3) Competition with motor vehicles.

The traffic of Welsh Highland Ry would, increase if the line were extended from Dinas to Carnarvon thus avoiding the uncomfortable change whilst the standard gauge lines supply a direct route.

Performance
The maximum weight carried by a Fairlie Engine up an average grade of 1 in 90 has been 190 tons.

800 has been the highest figure reached in passengers carried on a single train.

A speed of 30 miles per hour has been safely reached on this 60 cm gauge railway, although the average speed with stops is 16 m.p.h.

Pont Croesor looking upstream towards the road side of the bridge

The largest annual number of passengers has reached the figure 210,000.

Indeed all these figures apply to the Festiniog Railway as the Welsh Highland line has been in commission a very short period to give any figures. (Perhaps this comment suggest that the treatise was written in 1925?).

Staff
The staff of the two railways is about hundred.

The traffic department absorbs the greatest number having 34 men to its credit. The locomotive department has 21, the Engineering department claims 20 and 16 men are employed at the company's works at Boston Lodge.

Capital Earnings & Expenditure
The total capital of the Festiniog Railway amounts to £156,385 and the actual capital expenditure to date is £165,373. The following amounts make up the shares and stock:

The shares and stock of the Welsh Highland amount to £90,000 and loans and debentures to £84,774 of this £37,500 has been given by the Government and the rest subscribed by the various urban and rural district councils.

The total number of passengers carried during the same period was 121,747 on the Festiniog line and 50,485 on the Welsh Highland. The total goods carried was 64,694 tons (of which 53,587 tons was slate) and 19,748 tons respectively.

With the revival of trade in the quarry districts the Festiniog line would become profitable again and it is the general belief that the extension of the Welsh Highland line to Carnarvon would be instrumental in greatly increasing the traffic on that line.

Workshops
The company's workshops situated about a mile from Portmadoc would do credit to even a bigger railway.

They have been well laid out and are capable of handling every kind of repair. Every engine in service has been rebuilt here.

The works comprise two offices one for the Permanent Way Inspector and the other for the Loco Supt & Works Manager. The carpenter's shop, smithy, foundry (now out of work), machine shop, brass room, saw mills, erecting shop, carriage shed, timber stores, oil stores and general stores are arranged as shown in the plan.

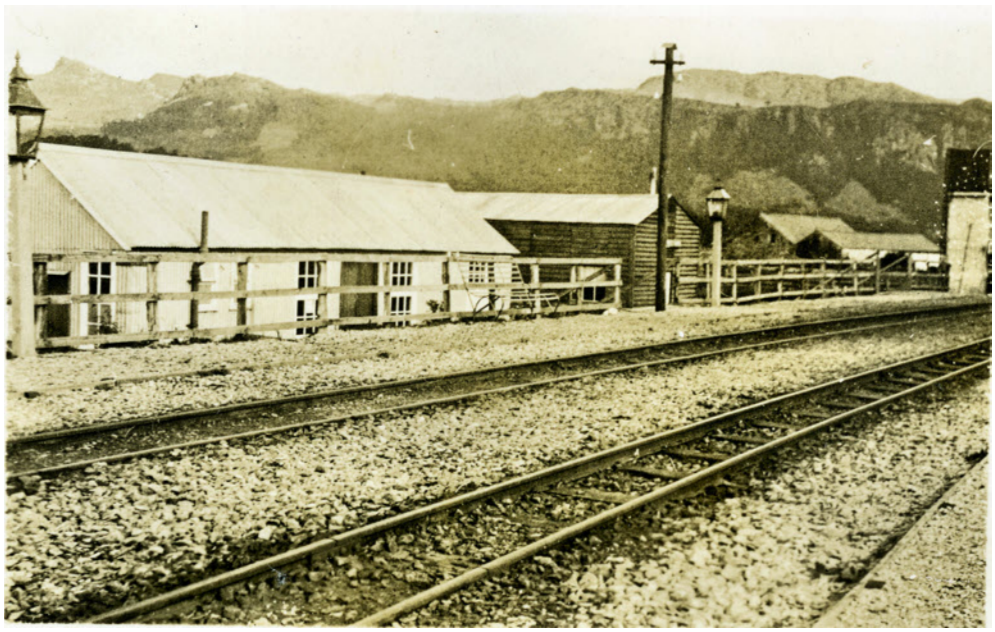
The power house consists of a Cornish boiler driving a tandem two cylinder engine. A gear wheel used to transmit power to the main shaft.

This steam engine has been replaced by a Tangye Heavy Oil Engine and the economy effected is considerable.

The advantage of substituting the oil engine for the steam engine can be gauged by comparing their respective working costs. Steam power was costing 1/2d per hour whereas the amount for the oil engine is only 3 ½ d per hour.

The machine shop contains a planing machine, a wheel turning machine, 5 ordinary screw lathes, slotting machine, shaping machine, 2 hydraulic presses, 1 screw worm wheel press and universal grinders.

Portmadoc New (1923) station



Further Light on the Cambrian Crossing

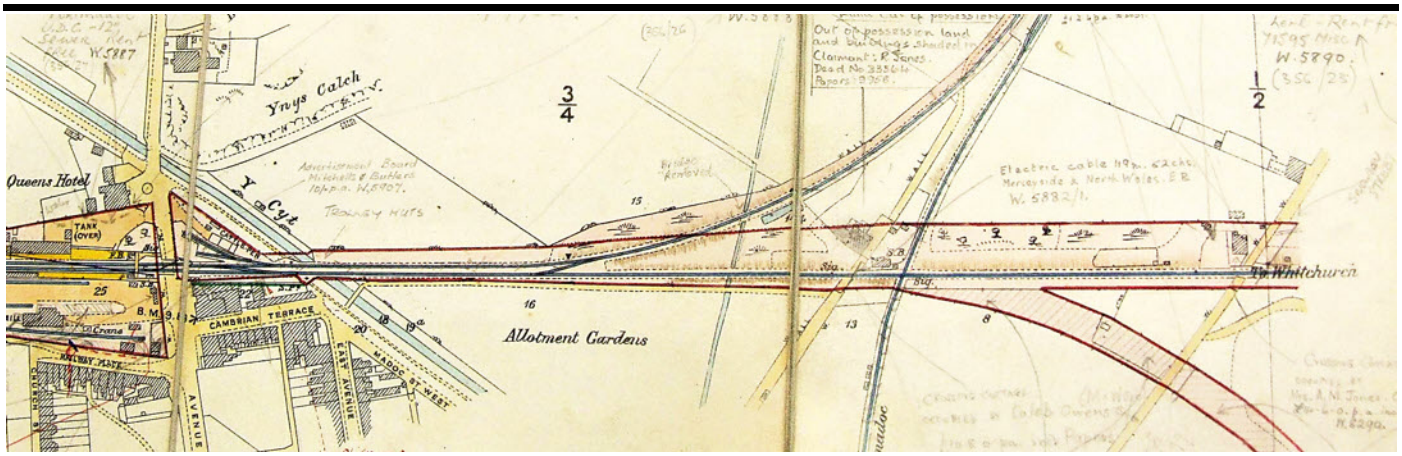


Photo 1: An extract from a 1924 G.W.R. survey of the coast section, following acquisition from Cambrian Railways. Track layouts show the WHR, Cambrian line and Beddgelert Siding, and the crossing signalbox is shown together with signalling. The formation of the incomplete s.g. harbour branch is bottom right, and part of the land in the triangle between GWR, Beddgelert Siding and WHR is marked, "Out of Possession", i.e. not G.W.R. property.

Interest in the diamond crossing over the Cambrian line continues, and it is pleasing to note that the first train crossed the new fitting over Network Rail on March 12th 2009. The train comprised FR diesel *Vale of Ffestiniog* which transferred both itself and a number of coaches from Boston Lodge to Dinas. As signalling arrangements have not yet been finalised, further stock movements have all required engineering possessions, but fortunately this situation will be resolved when the new ETRMS system is installed in February 2010.

Richard Watson shines a light on the archaeology of the Cambrian Crossing

Reverting to historical matters, I recently had the good fortune to correspond with Mr David J. Smith, a retired chartered civil engineer formerly with the Chief Civil Engineers' Department on the Western Region of British Railways. During his time there, Mr.Smith was involved in permanent way design and the laying and relaying of new and existing track. He is also the author of an excellent book, 'GWR Switch and Crossing Practice'[1 & 2]. I sent him my observations on the Cambrian Crossing and its materials of construction, and he kindly appraised them and suggested some revisions and expansion of the contents. I am grateful to him for putting me on the 'straight and narrow'.

Much of what follows is taken directly from correspondence with Mr Smith, with his kind permission. I have edited the information slightly to put the details in context.

Manganese Steel Crossing

Several references exist citing manganese steel as the material of construction. There was of course Lt-Col. Alan H. Mount's report of 1923. "The G.W.R. crossing was, he reported, cast solid, he thought of manganese steel" (Johnson, p.61) [3]. The earliest press article I have come across was in *The Railway Gazette* of October 26th 1923, reporting that "...the railway…crosses the main line…by means of a cast manganese steel crossing". *The Railway Magazine* followed suit in December 1923, using very similar wording, and C. Hamilton Ellis and Charles E. Lee did so again in the same journal in July 1941. It is interesting to note the similarity of the wording in these articles, but I offer no opinion as to how this came about! [4, 5 & 6]

The use of the word 'manganese' to describe the steel appears to suggest that this type was unusual, as it may well have been during the 1920s.

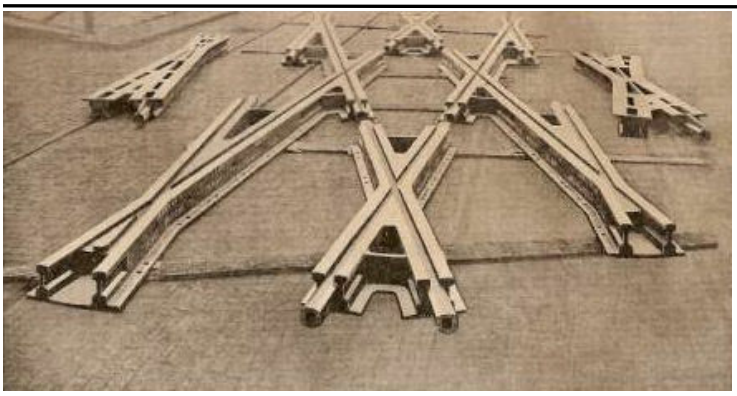
Bringing the references up to date, Peter Johnson mentions the word "manganese" in the text of his latest "Illustrated History", but not "manganese steel". [3]

The original austenitic manganese steel, containing about 1.2% carbon and 12% manganese, was invented by Sir Robert Hadfield as far back as 1882. Hadfield's steel was unique in that it combined good toughness and ductility with high work-hardening capacity. This meant an exceptionally high level of wear resistance when subjected to work hardening by shock or high impact pressure in service, making it ideal for switch and crossing work.

The "Antia Print" of c.1925

David Smith had seen references to the manganese steel crossing in the past, but had not thought them credible until he examined a copy of the "Antia" photograph. Having seen this, David points to the light colour of the crossing fitting which contrasts sharply with the darker

Photo 2: An enlargement of part of the "Antia" photograph indicating features referred to by David Smith such as; the lighter coloured, slab-sided rails on the crossing itself, consistent with it being manganese steel, and the very short WHR crossing rail stubs.



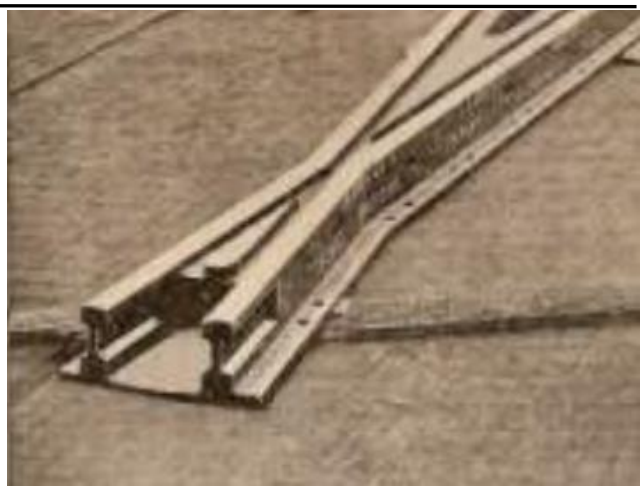


Photo 3: (Above) Illustration of a manganese steel crossing taken at Hadfields, from Cecil J Allen's book of 1915.
Photo 4: (Right) An enlargement of Photo 3. Note the transition from slab sided to bullhead section, similar to that seen in the "Antia" photograph

bullhead materials, and to the 'monolithic' rails which have a slab-sided appearance. **[Photo 2]** These features are all consistent with manganese steel. It is likely that the W.H.R. fitting was cast as a single unit by the firm of Hadfields, or perhaps Edgar Allen, both of whom were located in Sheffield.

From the historical point of view this is very interesting, as although austenitic manganese steel was first cast in 1882, railway crossings were not made in this material until 1902, i.e. some twenty years later. By about 1912 the firms mentioned were able to supply comprehensive layouts in this particular steel. From this it follows that the crossing shown in the "Antia" photograph would have been at least the second version installed since the Coast railway opened in 1867. It can be inferred that it must have been installed during the first two decades of the twentieth century, so evidently had a short service life as it was replaced again in 1928. It is reasonable to assume that the very first version, installed for the opening of the Aberystwyth & Welsh Coast Railway would have been an early form of steel, or possibly wrought iron.

A copy of an illustration in Cecil J. Allen's book [7] is provided to assist in interpreting the photograph of the Portmadoc fitting. In **Photo 3,** the crossing on the left in the laid-out piece of work has a wing rail with vertical sides, and for about 1'6" at the wing rail front, the rail assumes the standard bull head section. This would have provided a fishing surface for connecting to the adjacent closure rail of the same section. **[Enlargement, Photo 4]** The wing rail has a continuous bottom flange allowing it to be fastened down, features which can also be seen in the Portmadoc fitting laid on baulk timbers. **[Photo 2]** A bottom flange is discernible, and the fishplated joints with the cross-sleeper track are just clear of the crossing unit. The connection with the W.H.R. track is not as clear, though one fishplate is apparent. On the nearer side the W.H.R. crossing 'rails' look like foreshortened stubs, the last chair in the cross-sleepered track being very close to the crossing. The rails and chairs in the foreground are of Cambrian Railways origin, as are those in the first track panel on the far side of the crossing. The chair fastenings appear to have domed rather than square tops, implying that they were spiked down rather than coach bolted.

The real mystery is why the fitting was superseded within a relatively short time, as in a location such as this its life should have been almost indefinite. Evidently its performance was unsatisfactory in some respect, to the extent that the G.W.R.'s Oswestry Divisional Engineer decided that replacement of the unit was necessary.

The Later Crossing of c.1928 in Bridge Rail Materials [8]

The present day W.H.R. crosses Network Rail at an angle of 66°, i.e. at about 1 in 0.5 from the horizontal. Measurements taken from drawings in the Freeman Fox archive indicate (unsurprisingly) that the same angle was employed for the old crossing. The old W.H.R. track described a curve through the area but photographs show the actual crossing metals were straight and not curved. The Welsh Highland crossing of today follows a somewhat straighter alignment throughout the intersection.

Absolute right angles are avoided in flat crossings if at all possible, as they are more costly to maintain. Further, to improve riding, it is desirable that both wheels on an axle do not pass over the crossing gaps at the same time, as would be the case at 90° when the gaps would be directly opposite one another.

Standard crossings could be fabricated in all angles from 1 in 4 up to 1 in 12, and for special applications (i.e. crossings having more acute or more obtuse angles) they would be specially manufactured. However, on the G.W.R. at least, common crossings with angles smaller than 1 in 2 could not be made in the same way as standard crossings. This was because the 'v' could not be riveted effectively and the wing rails and elbows could not be bent to the required sharp angle. To counter this, the G.W.R. manufactured such crossings from bridge rail, laid on 24" x 7" longitudinal timbers formed into a frame and continuously checked throughout. Diamond crossings of this type were relatively rare in running lines but were more often found in yards and dock locations. [1 & 9]

Since it was not practicable for built-up common crossings and elbows (obtuse

Photo 5: A close-up of the post-1928 crossing in bridge rail, showing features such as (a) 1" oak packing on the longitudinal timber baulks (b) Rails and angle irons bolted down (c). Special through-bolted chairs for the bullhead transition on timber baulks.

crossings) to be made for angles of less than about 1 in 2, the G.W.R. had to adopt an alternative form of construction for its short-angle diamonds. For many years, as at Portmadoc, this consisted of bridge rails laid on timber baulks, in essence as in broad-gauge practice. **[Photos 5, 6 & 7]** A range of bridge rails to British Standard specifications was available and probably still is, since these rails had other applications, such as crane gantries where double-flanged wheels are used. However, as none of them met G.W.R. requirements they were specially rolled to order. The leading dimensions of bridge rail used by the G.W.R. were: 3 ins. high; railhead width 2½ ins.; width over bottom flanges 6ins. This gave an effective rail flange width on each side of 1¾ ins., i.e. the standard flange way in crossing work, and enabled a 3 ins. x 3 ins. angle-iron section to be laid alongside the rail on the running-face side, wherever a check rail or guard was required.

The rails and iron angles were laid on continuous oak packing of 1in. nominal thickness on 18 ins. x 7 ins. baulks. (The actual thickness was determined by the depth of the particular bull head rail section in the adjacent track panel, to ensure that the tables of the bull head and bridge rails where they meet were at the same level.) The rail flanges and iron angles were of a convenient width that could be drilled for the insertion of ⅞ ins. dia. fang bolts. Where the rails met at the nose of the crossing or at the elbow a simple mitre joint was made, with a weld on the outside face for strength. Each bridge rail stopped short 3 ft. from the end of the baulk, where a vertical cut was made, 3 ins. deep. A horizontal cut was also made at this depth from the end of the baulk, resulting in a 3 ins. step, the last 3 ft. of the baulk thus being of a reduced depth of 4 ins. Two special chairs with straight, non-keyed jaws were laid on this section of the baulk, again on oak packing, one of them close to the step, the other near the end of the baulk. The

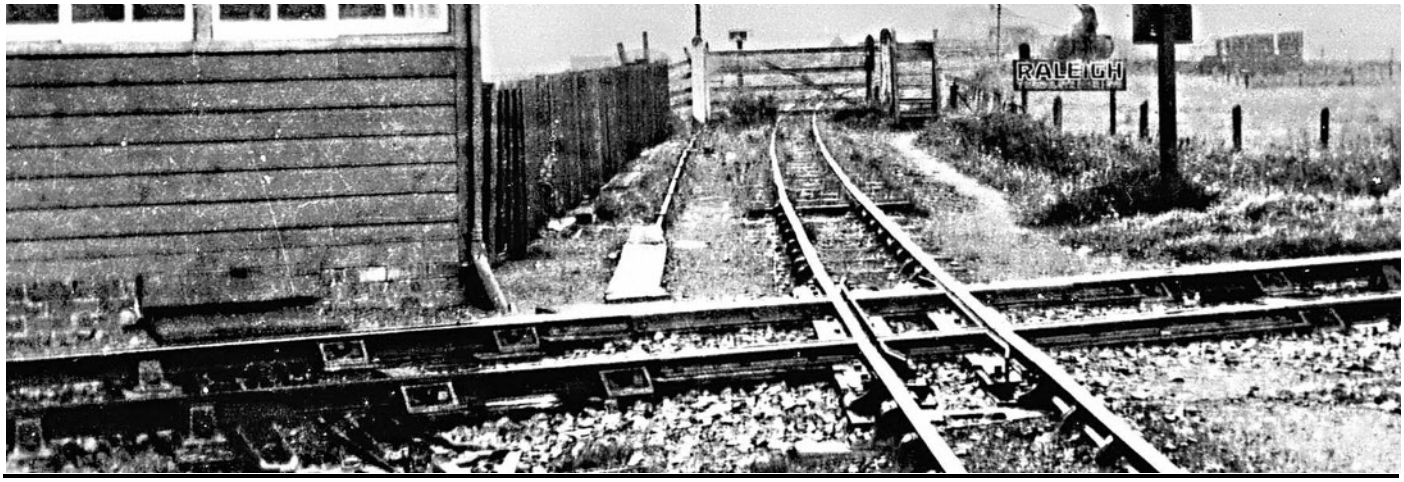
Photo 6: The transition from ex-standard gauge bullhead to W.H.R. shows a marked change in rail section. Note the higher position of the W.H.R. sleepers on the bed of ballast, and the cranked fishplates to accommodate the difference in height and cross section. The point rodding runs both north and south of the crossing; bullhead rails run under the gate to the south, so was the trap point constructed from bullhead materials?

opening in these chairs was that of the bullhead rail profile, allowing the rail to enter them with a fairly loose fit and be positioned, with a suitable expansion gap, close to the end of the bridge rail. The chairs together served the purpose of a fishplate: each had a horizontal hole on each side through which a bolt could pass, likewise through a predrilled hole in the rail web, with suitable packing pieces, to secure the rail. Near the ends of each pair of baulks a 5 ins x 5 ins. transom was let into each. These various features can be seen in the two pictures which show part of the front of the signal box. (The transoms are buried in the ballast, except that one of them is visible in the W.H.R. at the bottom of the picture - possibly 5 ins x 4 ins in this case because of its shortness; normally the transom was reduced from 5 ins. depth to 4 ins. over the last 6 ins. of its length.)

As the special chairs were specifically designed for G.W.R. bullhead rail they had to be installed on the W.H.R. approaches as well, hence the intermediate track panel with bullhead materials on each side of the crossing. Where this met the W.H.R. flat bottom track, the two rail sections were linked by means of junction fishplates in the usual manner.

Apart from its archaic appearance, the drawback to this form of flat crossing construction was that if differential wear began to occur at the joint between the bull head rail and the bridge rail there was no really satisfactory way of dealing with it. Technically, the mitred rail meetings also were not as satisfactory as the more robust built-up common crossings or elbows. A new type of flat crossing was developed by the G.W.R in 1937 which avoided these shortcomings – too late, of course, for the Welsh Highland Railway.

Photo 7: Another view of the post-1928 crossing looking north, showing the transition to flat bottom rail which extends through the gate. The trap points are out of sight and are presumed to be flat bottomed. The view is also noteworthy for the gap in the ballast, allowing the rodding to extend from the box to the south trap points. There is a clear demarcation between G.W.R. and W.H.R. property shown by the extensive weed growth on the latter!



The Intermediate Track Panels

In the W.H.R. intermediate track panels on either side of the crossing, the bull head rail, which would undoubtedly have been second hand, is of an indeterminate section but would have had a head width of 2½ ins or 2¾ ins., a total head depth a little less than 2 ins., a web depth of about 2½ ins. at most and a web thickness of ¾ in. **[Photo 6]** The W.H.R. 40 lbs. flat bottom rail would have had a head width of 1⅞ ins., a total head depth of 1⅛ ins., a web depth of 2 ins. and a web thickness of ⅜ in. Despite the dissimilarities in profile and dimensions, there would have been no practical difficulties in connecting these two sections. As the critical factors were maintaining the line and level respectively of the running faces and the rail tables, the purpose-made junction fishplates would have been cranked horizontally and vertically to achieve this, taking account of the dimensions given above. In the picture of the crossing taken from behind the signal box, the effects of this can be seen at the joint in the left-hand rail where the discontinuity of the outside rail faces is evident, and with the W.H.R. sleepers sitting higher on the ballast than those in the bull head track.

It is of interest to note that the intermediate bullhead rail panels extended further to the south of the crossing than to the north, seemingly for quite a distance beyond the gate at the northerly end of the 1923 station. **[Compare Photos 6 & 7]** As no photographs of the catch point at this location seem to survive, one can speculate that the southerly one was constructed from bullhead rather than flat bottom materials. The opposite appears to have been the case to the north of the crossing, as the bullhead stopped well short of the gate and the catch point was beyond this, i.e. on the flat bottomed section.

Crossing Finance

Richard Maund is researching archived papers at the National Library of Wales, and has found that the claim the G.W.R. was pursuing against the WHR during the Chancery proceedings of 1927-28 did not include charges for the renewal of the crossing fitment itself. The outstanding costs were finally written off in 1938 and were more to do with signalling operation and maintenance than hardware. Richard's future researches are likely to include looking at whether the costs of the renewal were met through the original (McAlpine) contract, or by the G.W.R. itself. I have to agree with him that neither option sounds likely. [8]

Recent Archaeology

As an aside, it is interesting to note that preparatory excavations for today's "Cae Pawb" crossing revealed the existence of the stone walls of the Croesor Tramway under the main line, proving 140 years too late that the Croesor was indeed the senior partner to the Aberystwyth & Welsh Coast, and not the other way round. Perhaps Robert Morgan, who was enticed by the "pound of baccy" to swear to this effect back in 1925, might have had his affidavit taken more seriously if this had been revealed at the time. Relations between the W.H.R. and G.W.R. might then have taken a very different course! [10]

References:

[1] *GWR Switch And Crossing Practice*. David J. Smith. Great Western Study Group, 2000

[2] Private correspondence with Mr. D.J. Smith

[3] Peter Johnson: *An Illustrated History of the Welsh Highland Railway* - 2nd Edition. Oxford Publishing Co. 2009

[4] Anon: *The Railway Gazette*, October 26th 1923

[5] Anon: *The Railway Magazine*, December 1923

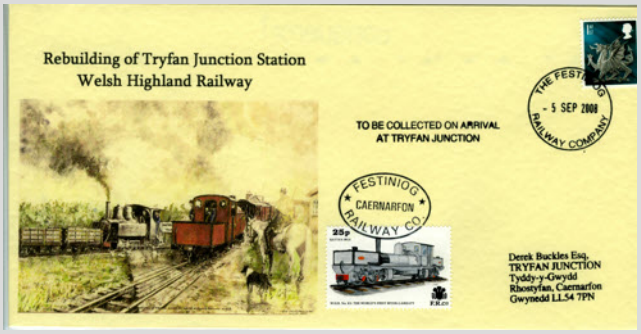
[6] C. Hamilton Ellis and Charles E. Lee: *The Welsh Highland Railway – II, The Railway Magazine*, July 1941

[7] Cecil J. Allen: *Modern British Permanent Way*, 1915

[8] Richard Maund: email correspondence

[9] Private correspondence with Edward Dorricott and Garth Tilt, Signalling Record Society

[10] J.I.C. Boyd: *Narrow Gauge Railways in South Caernarvonshire*, Revd. Ed. 1988



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Top left features the WHR Heritage Railway's 'Gladstone' coach and has been designed to coincide with Royal Mail's issue of a first class stamp featuring Prime Minister Gladstone as an 'eminent Briton'.

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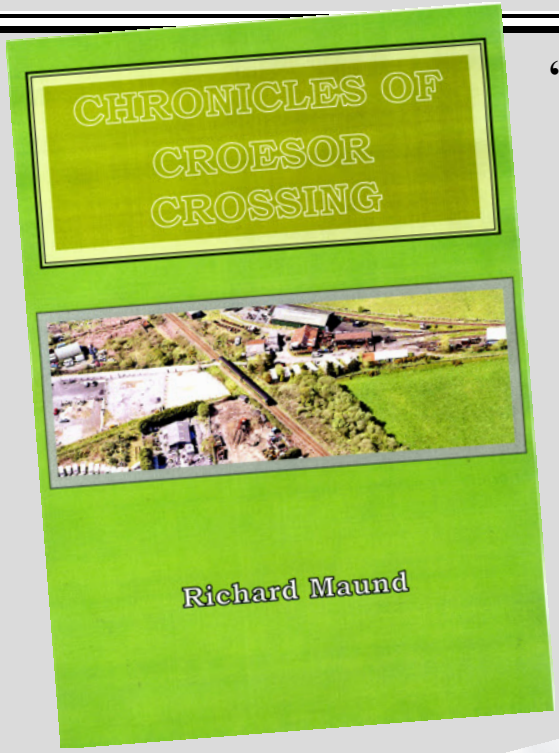

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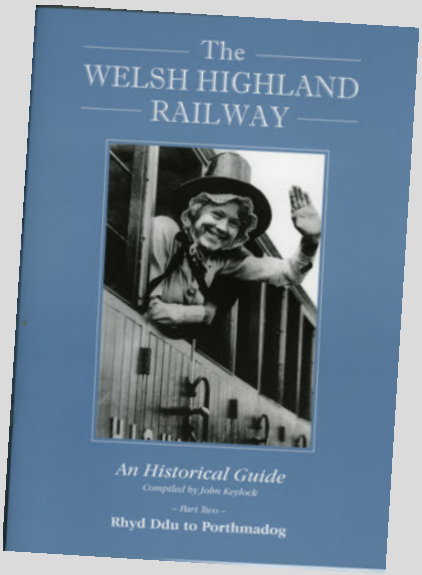

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