AST Trust
Advancing Steam Traction

NEWSLETTER No. 25 - SEP 2024

Trust Chairman John Hind Addressing the WATTRAIN Conference, on the subject of "Bure Valley Railway and ASTT Trials of Alternative Fuels" (see report on page 14)

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Editor's Note: Please can contributions for ASTT Newsletter 26 be sent to advancedsteamtrust@gmail.com by 1st January 2025.

CHAIRMAN'S PIECE
John Hind

Just as the political parties are approaching the conference season, so are we. Chris has been sending out the Conference Flyer giving advance notice and by the time you get this newsletter, you will have had the latest update. The first day is going to focus on 'alternative fuels'.

I sent a press release to Steam Railway and am expecting that there will be an item on it in their News Section. The next edition is published 12/9/2024, so we are hoping that will boost numbers at the conference. As far as we know, this will be the first conference in the UK open to all enthusiasts, that focuses on alternative fuels and brings together in one place a chance to understand what has been learnt, the alternatives to coal and the advantages and disadvantages of each.

Places are limited, so don't delay in booking.

Charities Commission – appeal for help

In the last newsletter, I asked for help with applying for help in applying. Hendrik Kapitein has offered help to Chris, but we are still open for any other offers. This is a long-term task and to some extent, it is on the back burner, but it would be good to progress it.

This involves completion of an application showing that we meet a number of the criteria. If anyone is willing to help Chris and Hendrik, contact me john.hind@advanced-steam.org

MEMBERSHIP MATTERS
Chris Newman

Committee Members

ASTT's management committee :

John Hind	Chairman & Trustee	Jamie Keyte	Trustee
Hendrik Kaptein	Secretary & Trustee	Alex Powell	Trustee
Chris Newman	Treasurer & Trustee	Grant Soden	Ex-officio
Mike Stockbridge	Ex-officio		

New Members

We welcome three new members who have joined since our No 24 Newsletter of May 2024:

- **Alex Masters** from Cornwall. Alex is a project engineer working for the MoD in Falmouth. He has a Master's degree in Mechanical Engineering and is a member of the Institution of Mechanical Engineers. He has also been Chairman of the Robey Trust at Tavistok, Devon, since 2016.
- **Douglas Scott** from Boat of Garten in Scotland. Doug is a retired marine engineer who worked in the oil and gas industry. He now volunteers on the Strathspey Railway where he drove *Flying Scotsman* on its recent visit to that railway (thankfully not on the day of its unfortunate accident!}
- **Martin Young** from Dunstable. Martin is a retired railway engineer. He served a five-year apprenticeship with BR at its Ashford Works, moving in 1981 to the Drawing Offices of the (then) BR Railway Technical Centre in Derby, and thence to BREL Head Office as a Principal Draughtsman. From 1987, he worked on the Channel Tunnel Project until its completion in 1994. Since then, he worked as Engineering Manager on the Athens and Istanbul Metro Projects; as Engineering Manager on the Jubilee Line Extension / TPWS / Northern Line Upgrade; as Contract Engineer on HS1, and as Rail Systems Engineer on Crossrail and HS2. Martin is the author of the article in this Newsletter about "The Suspension Systems of Steam Locomotives and the mechanisms required to adjust them".

Membership Numbers

The current breakdown of paid-up membership is as follows:

Full Members:	39	UK members:	77	Age ranges	
Associate Members:	68*	EU:	17	Over 60	Approx. 50%
Student Members:	9	USA:	9	30 to 60	Approx. 36%
		Australasia:	10	Under 30	Approx. 14%
Total Membership:	116	Asia & Africa:	3	Av. age	Approx. 57
** this figure includes two recent re-enrolments*					

PUBLICATIONS PAGE
Chris Newman

Book Sales

Two new titles have been added to ASTT's book sales page since the last Newsletter:

"**Physiology of the Locomotive Boiler – Part 1**", by Adrian Tester.

"**Selection of Papers by L.D. Porta– Volume 4, Locomotive Boiler Water**", by Martyn Bane

Details of Adrian Tester's long-awaited new book can be found on our website at http://advanced-steam.org/sales-2/physiology-of-the-locomotive-boiler-vol1/. It fills no less than 583 pages between its hard covers, and sells for £48.00 + postage (less 10% discount to ASTT members).

Thanks to a significant extent to Adrian's book being added to our catalogue in July, we have sold a total of 54 books since May – these being as follows:

Publisher	Author	Title	Sales since N/L 24	Total Sales
ASTT	L.D. Porta	Porta's Papers Vol 1	5	148
	L.D. Porta	Porta's Papers Vol 2	5	140
	L.D. Porta	Porta's Papers Vol 3	5	102
ASTT (continued)	C. Newman (Editor)	Porta's Centenary Compendium Vol 1	3	85
	C. Newman (Editor)	Porta's Centenary Compendium Vol 2	4	39
	Ian Gaylor	Lyn Design Calculations	0	110
	David Wardale	5AT FDCs	2	220
	David Wardale	Reminiscences of a Trainspotter	4	40
	Alan Fozard	5AT Feasibility Study	2	45
Camden*	*David Wardale*	*The Red Devil and Other Tales from the Age of Steam*	*0*	*260*
	Phil Girdlestone	*Here be Dragons*	*0*	*33*
	Jos Koopmans	*The Fire Burns Better …*	*0*	*11*
	L.D. Porta	*Advanced Steam Design*	*0*	*5*
Crimson Lake	Adrian Tester	Physiology of the Loco Boiler – Part 1	23	23
	Adrian Tester	A Defence of the MR/LMS 4F 0-6-0	0	42
	Adrian Tester	Introduction to Large Lap Valves	1	20
		Total sales	54	1326
* Camden is now selling these titles in digital format, so they have been withdrawn from sale from ASTT's website.				

Martyn Bane's 513-page book on "**Locomotive Boiler Water** covering **Water Treatment, Feedwater Heating and Boiler Water Behaviour**" was released too late to feature on the above sales listing, but it may be hoped that its sales will boost the figures for the next Newsletter. It introduces a new feature to ASTT's in-house publications in that it is offered in both soft and hard cover options. These are priced at £40 (plus postage) for the soft cover version and £48 (plus postage) for the hard cover. A 20% discount on these prices will be offered to ASTT members as usual.

Martyn's book contains several papers by authors other than Porta, however the majority of its papers (12 in all) are authored by Porta which justifies the book being designated as "Volume 4" in our series of papers by him. For more details about the book, see the copy of the newly released webpage appended to this report.

In addition to the above, another new ASTT publication is in the pipeline – viz: **"A Selection of Papers by L.D. Porta - Volume 5"**. It is hope that this will be released before the end of the year. It will cover a wide variety of topics including:

Paper title	Date	Pgs
1 - Steam Locomotive development in Argentina (the "Manchester paper")	1969	48
2 - Progress on Steam Loco Technology carried out in Argentina since 1969	1976	10
3 - Fundamental Principles of Steam Locomotive Modernization	1998	9
4 - The Exhaust of Locomotives (1957) - covering Kylpor and Lempor theories**	1957	60
5 - Theory of the Lempor Ejector**	1974	16
6 - Calculations for a Lempor Ejector for a 2-10-0 locomotive	1974	5
7 - A New Conception of the Compound Locomotive	1976	9
8 - The Steam Cycle in the case of a 3-cyl compound 2-10-0	undated	7
9 - Some Notes on the Design of Mallet Locomotives	1977	5
10 - Notes on the Design of Garratt Locomotives	1977	8
11 - Some notes on Large Steam Pipe Connections occurring in separable locomotives	1978	5
12 - Porta - Some Loose Notes on the Separable Locomotive - Third Generation Steam	1978	8
13 - A system for coupling Mallet engine units and its extension to other Articulates	1977	8
14 - A Mechanical Anti-Slipping Device for Steam, Electric or Diesel Locomotives	1977	7
15 - Modernization of ex-Baldwin 2-6-2T locos Emerald tourist railway Australia	1995	14
16 - Cario - An Advanced Axlebox Scheme for 21st Century Steam Locomotives	2000	9
17 - Steam Locomotive: Running with Closed Regulator	1977	5
18 - The Fischer Knuckle Pin in Advanced Steam Locomotive Engineering	1986	6
19 - Notes on the Optimum Value of Lead in Steam Locomotives	1977	15
20 - Modifications to the 8C locos of the FCGR *(not yet transcribed)*	1957	*15*
21 - On the Performance of the British Standard Class 8 No 71000 Steam Locomotive	1977	20
Total page count	approx	289

Anticipated price £27.00 less 20% discount to members

** Porta's "**Exhaust of Locomotives**" (1957 paper) covers the theory of both the Kylpor and Lempor ejectors, going into considerable mathematical detail. I'm grateful to Martin Johnson and David Fryer (both members of ASTT) for their invaluable contributions, not only in reviewing Porta's paper but also for the footnotes and addenda that they have permitted me to add to the transcription to help readers to better understand Porta's theories and their limitations.

Porta's later (and perhaps better known) "**Theory of the Lempor Ejector**" builds on his 1957 paper and explains why he came to adopt the Lempor in preference to the Kylpor. The two papers complement one another and should be read together.

Book sales provide a valuable source of income to ASTT which helps to fund activities, not least our Revolution project. **Members are urged to support our endeavours by purchasing books from us.**

Note: We'd like to expand our book selection, so we welcome any suggestions for additional titles that we might be able to sell, or new texts that we might publish under ASTT's logo.

Selection of Papers

by

L.D. Porta

Volume 4

- Special Edition -

Locomotive Boiler Water

covering

Water Treatment, Feedwater Heating and Boiler Water Behaviour

including papers by

Ing. Livio Dante Porta, Martyn Bane, Nigel Day, Shaun McMahon, Joachim Robrade, William Richardson and Friedrich Witte

Compiled and Edited by

Martyn Bane

On behalf of the Advanced Steam Traction Trust

Selection of Papers by L.D. Porta (and others) – Volume 4
Locomotive Boiler Water covering

Water Treatment, Feedwater Heating and Boiler Water Behaviour

[Note – this book is available in both hard and soft covers – see pricing below]

Compiler and Editor, Martyn Bane, introduces the book with the following words:

"What counts is what one has in the boiler, not what one feeds into it."

Ing. L.D.Porta's simple statement outlines, in just a few words, what became his approach to boiler water treatment. It seems at odds with accepted thinking on the topic, what did he mean by this? Very simply, if the boiler water chemistry is within a defined range the nature of the feedwater is of no concern.

It has been known since the 1970s with certainty, but for a few decades previously less clearly, that with a certain boiler water chemistry it is possible, in a practical sense, to prevent scale formation, corrosion and caustic embrittlement1. The use of Porta's system also ensures fully mobile, non-adherent sludge formation and the production of technically pure steam, foaming and boiler water swelling are controlled.

The boiler water chemistry is controlled through the addition of chemicals dosed at a defined rate, whilst the locomotive is in service, regardless of feedwater conditions. Naturally, the testing of boiler water samples needs to be undertaken to ensure success. The test results indicate if extra alkalinity needs to be added or if a boiler blowdown is required. Boiler water alkalinity and dissolved solids concentration are the two factors that are controllable conditions.

The implications of this are clear. Feedwater constantly varies at and between watering points. There is nothing which can be done to change this unless a form of external treatment is applied, which the above suggests is not necessary. Therefore why be concerned by feedwater variation? Trying to accommodate any variations through adapting treatment dosing is always going to be, at best, difficult and inadequate. History has shown this to be the case, but it remains a common approach.

This volume contains much information supporting Porta's statement and approach.

Such is covered in Porta's 1975 "Water Treatment" paper included in the book. However, it may be seen from its **Table of Contents** that the book covers a much broader canvass, including papers on boiler water circulation and on boiler water pre-heating, and papers by other authors, including three papers by Martyn himself.

For those who don't know him or of him, Martyn was an early advocate of Porta's water treatment practice and set up his own company in the early 2000s to market the technology within the UK and beyond. The company failed to prosper, partly because of difficulties in obtaining a satisfactory formulation of antifoam that allowed Porta's recommended alkalinity and total dissolved solid levels to be obtained, but largely because of challenges persuading steam locomotive owners and operators to break with past practices and to adopt new ones. Notwithstanding, Martyn successfully demonstrated what Porta Treatment could achieve by applying it over a period of several years to the boiler of ex-GWR 4-6-0 No 6024 King Edward I, in the maintenance and operation of which Martyn was heavily involved. This he describes in one of his papers.

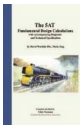
The book fills 505 numbered pages (511 in total) with coated surfaces that serve to enhance its several coloured illustrations.

Potential buyers are invited to download **72 sample pages** from the book which give a taste of the wide range of topic covered in it.

Book price (soft cover): £40.00 (less 20% discount to ASTT members) plus £5.50 postage within the UK. Postage extra outside the UK.

Note: the book is also offered in Hard Cover for a price of £48.00 (less 20% discount to ASTT members) plus £5.50 postage within the UK. Postage extra outside the UK.

Titles published by the Advanced Steam Traction Trust

	Year	Author	Title	Pages	RRP*
	2015	David Wardale	The 5AT Fundamental Design Calculations	556 (b&w)	£49.00
	2016	Alan Fozard and others	The 5AT Feasibility Study edited	230 (colour)	£35.00
	2018	Ian Gaylor	Steam Locomotive Design Specifications and Calculations for New Build Baldwin 2-4-2T 'LYN'	604 (colour)	£52.00
	2018	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 1 - Tribology and Lubrication	250 (b&w)	£27.00
	2019	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 2 - Adhesion, Compounding and the Tornado Proposal	256 (b&w)	£27.00
	2021	L.D. Porta transcribed and edited by Chris Newman	Selection of Papers by L.D. Porta – Vol 3 - - Steam Locomotive Boilers, Fireboxes and Combustion	290 (b&w)	£27.00
	2024	L.D. Porta and others Compiled by Martyn Bane	Selection of Papers by L.D. Porta - Vol 4 - Locomotive Boiler Water – Treatment, Circulation and Preheating	513 (colour)	£40.00 (£48 hard cover)
	2022	Compiled and edited by Chris Newman	A Compendium of Articles and Papers to celebrate the Centenary of the birth of Livio Dante Porta - Volume 1	226 (colour)	£27.00
	2023	Compiled and edited by Chris Newman	A Compendium of Articles and Papers to celebrate the Centenary of the birth of Livio Dante Porta – Volume 2	331 (colour)	TBA
	2023	David Wardale	Reminiscences of a Trainspotter	67 (b&w)	£16.00

As noted above, it is planned to add another title in the near future – viz: Volume 5 of the series of papers by Livio Dante Porta.

* The RRPs (recommended retail prices) shown include UK postage. Additional postage costs may apply to some titles. Paid -up members of ASTT are entitled to a 20% discount on these prices.

All these books can be purchased through ASTT's website at http://advanced-steam.org/books-forsale/.

ASTT ANNUAL CONFERENCE
Chris Newman

2024 Conference

As advised in recent flyers, ASTT will hold its 2024 conference in the Astor Court Hotel in Derby over the weekend of 5th to 6th October 2024. There will be space for around 40 attendees in the meeting room, so those wishing to attend are urged to secure their place at an early date.

An interesting selection of papers are being arranged, with an emphasis on alternative low-carbon fuels. As usual we can expect an update on our Revolution project from Jamie Keyte, who has also offered to give a short talk on the industrial history of Derby.

The conference programme also includes a visit to the Princess Royal Class Locomotive Trust home of LMS Pacifics 6203 and 6229, and as usual the conference includes a conference dinner (at the Aston Court Hotel).

Members are urged to support ASTT by registering to attend the conference. Please write to info@advanced-steam.org to register.

2025 Conference

As reported in our last Newsletter, 2025 will be a year of celebration that will mark the bicentenary of the opening of the Stockton and Darlington Railway on September 27th, 1825. Plans to mark the occasion are still being developed, but they are likely to be around the country under the auspices of an SDR200 organisation (see https://www.sdr200.co.uk/ and https://railway200.co.uk/. Listen also to Peter Hendy's talk about "Railway 200 & how the railway made the modern world" in Green Signals' podcast No 7.

ASTT plans to participate in these festivities, both through its 2025 conference and through our *Revolution* project which might possibly be completed in time for the bicentenary (though there's no certainty of that). Our current idea is to plan for our conference to be held in the Darlington/Shildon area and for *Revolution* to be put on display at some suitable location – the aim being to publicise ourselves and increase membership.

We would very much like to receive suggestions from members about how we might go about promoting ourselves at, and in advance of, the bicentenary. We will be even happier to receive offers of help with organising and promoting our presence at the event, both in terms of the conference and displaying *Revolution*.

Please let us know if you can offer any suggestions and/or help.

ASTT Conference 2025

Quoting selectively from the Railway 200 website :-

“By now many will have seen announcements about “Railway 200”. The Stockton & Darlington Railway opened on September 27, 1825, connecting places, people, communities and ideas and ultimately transforming the world.

Railway 200 is a year-long nationwide partnership-led campaign to celebrate 200 years of the modern railway and inspire a new generation of young pioneering talent to choose a career in rail. It invites community, rail and other groups to get involved.

Railway 200 aims to excite interest from the next generation by inviting young people of all backgrounds to consider a career in rail. It also hopes to attract more volunteers to heritage railways.

To help tell the Railway 200 story, four main themes will be explored:

- Skills & Education
- Innovation, Technology & Environment
- Heritage, Culture & Tourism
- Celebrating Railway People”

ASTT are making plans for our 2025 conference to be recognised as part of the Railway 200 celebrations and have pencilled in the weekend of 4th/5th October 2025 as the date, with a return to Darlington and including a visit to the Darlington Locomotive Works to see the P2.

We would like to advertise the conference through the Railway 200 app and want to put on a strong and topical agenda, so if there are presentations that you have seen at our conferences or elsewhere and would like to hear again, please let me know within the next month .– john.hind@adavnced-steam.org

WIKIPEDIA PAGE FOR THE INSTITUTION OF LOCOMOTIVE ENGINEERS

Chris Newman

In the August 2023 edition of this Newsletter, I contributed an article about the founding of the Institution of Locomotive Engineers. In the article, I reported on the dearth of information about the institution on the Internet and on my frustrated attempts correct this situation by creating a Wikipedia page about it.

I've created several Wikipedia pages over the years, including one on the 5AT, but mostly on subjects more obscure than I.Loco.E., and have had no more than a modicum of trouble getting them accepted. However, over the last 18 months or more, I've posted three or more drafts of an I.Loco.E. page and have met with rejections each time, always on the grounds that I haven't included enough references.

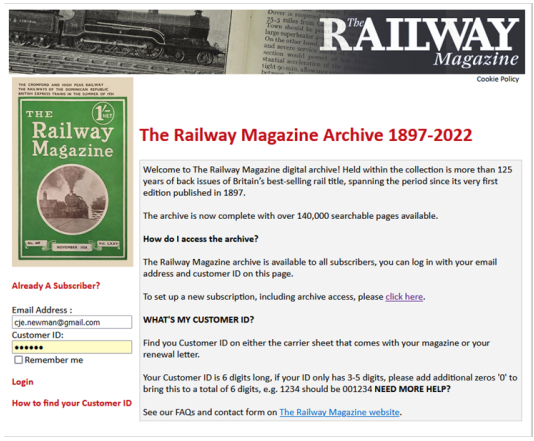
In trying to source more reference material, I came across a searchable digital archive for the Railway Magazine dating all the way back from its first publication in July 1897 and extending through to 2022 or thereabouts. Whether my latest draft, with all the Railway Magazine references that I've added, will be accepted this time remains to be seen, but if any member would like to help to expand the reference list that I've created (now totalling 40 items), I'll be very grateful.

You should be able see where I've got to by going to **https://en.wikipedia.org/wiki/Draft:Institution_of_Locomotive_Engineers.**

ACCESSING THE RAILWAY MAGAZINE ARCHIVE

Chris Newman

If anyone is interested in browsing through past Railway Magazines, you have to pay a subscription for the service which can be found at **https://www.railwaymagazine.co.uk/archive/**. I paid £32 for six months' access to the archive but have so far been too busy to get my money's worth from it. But there's no doubting that it offers a wealth of fascinating historic information.



STAPLEFORD MR TRIALS
John Hind

We have no alternative fuel trials planned at the BVR this year as we feel our learning has plateaued with the current generation of Manufactured Solid Fuels. However, we ran two days of trials at the Stapleford Miniature Railway (SMR). This was the first time we have run trials at the SMR measuring fuel consumption and checking fuel characteristics.

For each fuel we did two circuits of the run, which gives a 4-mile test rather than the 18 miles we do at the BVR. Testing at Stapleford means that we do not need as much fuel as at the BVR - at the SMR we need 20 kg and 200kg at BVR. We also do not need to fit in with public services, so if we have to stop in-section, we are not delaying any public trains.

In view of the relatively short run, we did a warmup run at the start of the days testing before we did any measured trials.

We also are testing on an engine without a brick arch or a superheater and we could see a difference in evaporation between the SMR's Curwen Atlantic and the BVR's ZB locomotives, which are larger locomotives and have a brick arch.

We did a 'base fuel' test on anthracite, which is the fuel that the SMR currently use, then we retested Arigna's Harvest Flame, then Harvest Flame mixed with 20% ovoids – these tests were done at Arigna's request.

We also tested 3 fuels that Richard Coleby and Ian Gaylor have developed using Harvest Flame, dipped in hot Rice Bran Wax, which is another renewable product.

The tests with the Arigna fuels confirmed the higher fuel consumption with Harvest Flame found at the BVR and a marginally better consumption with the 80/20.

The trials with our own fuels were disappointing as they did not show the improvement in fuel consumption expected and because of the organic content of them, small quantities of hydrogen cyanide were detected in the exhaust plume. We have handed over some samples to a laboratory and are hoping for some data on its combustion properties before deciding next steps.

If the tests at the SMR had been successful, the next step would be to test at the BVR. It is very much one step forward and two steps backward!

Arigna Harvest Flame

Arigna Harvest Flame on the road

ASTT developed fuel

ASTT developed fuel in the firebox

WATTRAIN 2024
ANNUAL CONFERENCE
Stefano Benazzi via Peter Lewis

The World Alliance of Tourist Trams & Trains has held its 2024 Conference in Castellammare di Stabia (Italy) on July 20th and 21st.

I wish to thank the participants, in person and online. The European Federation of Museum & Tourist Railways, the Heritage Rail Alliance (USA), the Association of Tourist and Heritage Rail Australia, the New Europe Railway Heritage Trust, the Italian Federation of Tourist and Museum Railways, the Advanced Steam Traction Trust, International Railway Heritage were represented.

The Italian firm Arsenale SpA (https://arsenalegroup.com/en/home-en/) - which created a series of luxury trains all over Italy and is in the process of extending its activity outside Europe, "La Dolce Vita" Orient Express, Italy, reservations@orient-express.com , orient-express.com - has sponsored our event and we are extremely grateful to them.

I heartily thank Peter Lewis – WATTRAIN's Communications Director - who made it possible to have an online Conference for one day and a half with many overseas online presentations, solving many technical glitches. Peter will distribute and disseminate the presentations, the transcripts, the Power Points, etc.

Also, Helen Ashby (Director, International Railway Heritage) was instrumental in helping us connect and manage PCs.

David Morgan, WATTRAIN's President Emeritus, was the Keynote Speaker at our gala dinner on July 20, and his presentation was much appreciated.

The comments exchanged concerning some East European countries and an African country were heard with great interest, and I am sure they can be conducive to further developments: connecting with each other, which is, in fact, the raison d'être for WATTRAIN. The presentations concerning coal, fossil fuels, insurance, climate influence, communication and specific information about some continents and/or countries were very useful.

We visited the National Railway Museum in Pietrarsa, owned and managed by the Fondazione FS on behalf of Italian national Railway Entity; the visit - with an English-speaking guide - was extremely interesting and the participants were unanimous in praising the work done, the site, the management, the attractivity of the Museum both for Rail fans and for the general public. Many of them stated that the Museum gained, in their experience, first place amongst the Railway Museums in the World.

The Hotel dei Congressi in Castellammare di Stabia created a very friendly environment, complementing top notch hospitality, cuisine, room service, and the use of the swimming-pool, the pizzeria, the roof-garden. WATTRAIN thanks the Owners, the Manager and all the Personnel.

Some of us also visited the Pompei excavations, a must for anyone staying nearby.

Notwithstanding the informatic disturbances and the connected flight delays, the Conference took place. We are sorry that one of the participants had to renounce his trip because of the cancellation of his flight.

A non-WATTRAIN participant stated that it was "possibly the most enjoyable and productive railway heritage related conference he had ever be to".

We hope that the Conference will help us to enhance our efforts worldwide to make Tourist and Historic Railways and Museums a must for young people and an important part of their knowledge of the past and of their Duty of Memory towards all those who worked in that sector.

THE SUSPENSION SYSTEMS OF STEAM LOCOMOTIVES AND THE MECHANISMS REQUIRED TO ADJUST THE SUSPENSION SYSTEMS CORRECTLY

Martin Young MSc. (Eng) CEng CMILT MIET

Foreword:

The Steam Locomotive Weighbridge on which this article is based, was in regular use at Ashford Railway Works in Kent from 1902 to 1989.

Between 1968 to 1981, I worked at Ashford Railway Works, serving my five-year Apprenticeship, and then working in the Drawing Office up to when the Works closed in 1981. I then moved to Derby and worked in the Drawing Offices at the (then) BR Railway Technical Centre, and the BREL Head Office as a Principal Draughtsman until 1987 when redundancy loomed again. The Channel Tunnel Project gave me the opportunity of working on that project, which I did until 1994 when the project was successfully completed.

It was during this time, that I was tasked with organising an operational trial that required loading and unloading cars through a full-size mock-up of the proposed double deck Tourist Shuttles.

The full-size mock-up was on the old Ashford Works site.

Visiting the site again after over eight years, I found that a few light industries now occupied some buildings, but the old Erecting Shop was occupied by the Balfour Beatty 'On Track' Plant and Machinery Workshops, and men who I had previously worked with!

A visit to the Workshop to catch up with my old workmates, led to one of them asking me to see if the Locomotive Weighbridge, or 'Balancing Tables' could be preserved. A few of them had worked on the 'Tables' during the last days of steam loco repairs, and so, not having worked on it myself, they explained its importance to me. I was told that they had recently used it to adjust the springs on the heavy lifting cranes and other rail equipment they maintained, and despite requests to Network Rail to have it retained for their use, the building and 'Tables' were to be demolished, and the site used for new sidings.

Being a member of several Railway Preservation Societies, I took up the challenge, as described in the following chapters.

To me, after over thirty years of commitment to ensure the preservation of the Ashford 'Balancing Tables', it has been a bitter / sweet experience. All of my older workmates have passed away, so as a tribute to their forethought that I have persevered to conserve the 'Balancing Tables'.

It was a great privilege to meet and get to know Sir William McAlpine. A true gentleman.

Gordon Maslin is another gentleman who I have been honoured to know. Gordon worked for Pooley's, and worked on Locomotive Weighbridges, and so knows the true importance of their use. The interesting story of his involvement with the Ashford 'Balancing Tables' will be included in the next articles.

The long-term future of the Weighbridge. It is now 2024, and it has been decided to conserve what is left of the weighbridge on its present site.

The next articles will detail other extant examples of Locomotive Weighbridges, and investigate how modern rolling -stock is designed, and go into the worlds of new technologies, model engineering and education.

The Suspension Systems of Steam Locomotives Part 1

The weight of steam locomotives when in operation has a significant impact on the performance of the locomotive, the track and the track bed. Many have read of the 'hammer blow' effect produced by the reciprocating masses of the wheels, connecting and coupling rods, but there is little mention of the importance of correct load distribution and how it was achieved.

There are many locomotive diagrams that show the overall dimensions, but there is also noted the spacing of the axles, and the calculated axle weights of the locomotive in 'light steam', i.e. boiler full to operating capacity, coal in the firebox, and the tender filled to designed capacities of both water and coal, as shown in Figure 1.

This weight distribution is also important to the factor of adhesion of the engine, where the maximum axle loading that the track can take is set by the Civil Engineer.

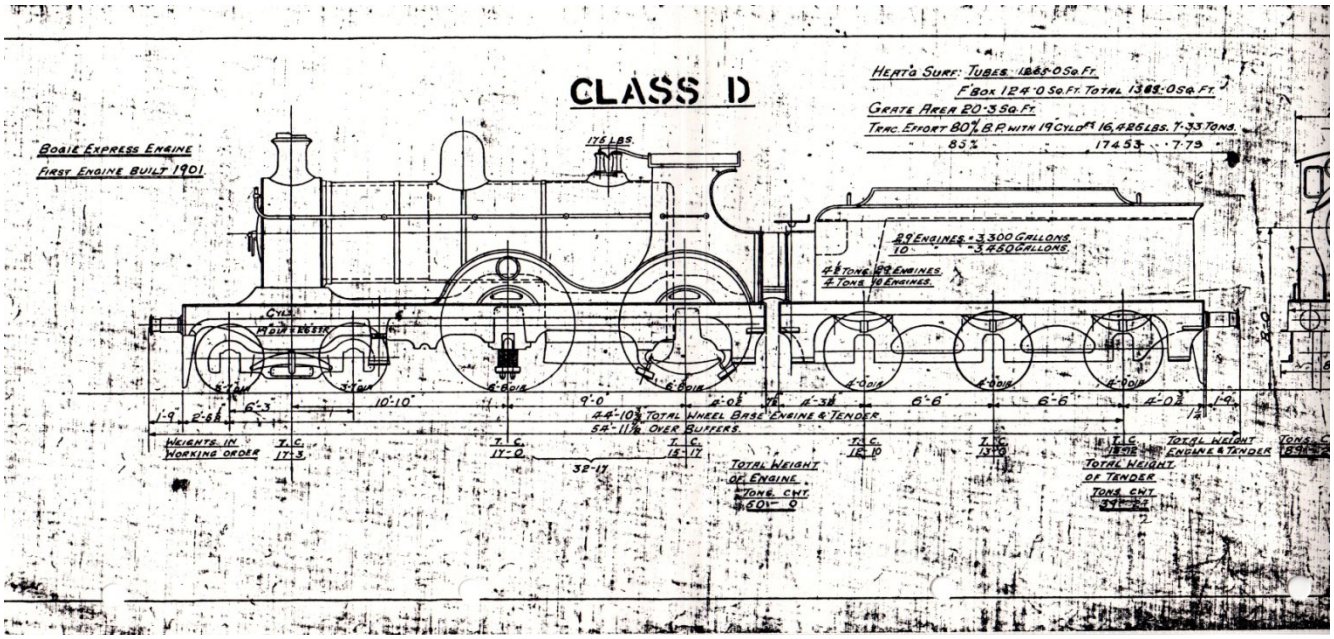


Figure 1 South Eastern & Chatham Railways 'D' Class Locomotive Diagram (1901)

The diagram also clearly shows the types of suspension springs fitted, i.e.

- leaf springs on the leading bogie of the engine
- coil springs on the leading driving axle of the engine
- leaf springs on the trailing driving axle of the engine
- leaf springs on the tender axles

In the days of steam traction, the use of leaf springs was almost universal. Dating back to the days of horse and carriage, they were easily made by local blacksmiths and were perfectly adequate for the ride quality and slow speeds of traffic at that time.

The coming of railway technology saw leaf springs undergo design changes to meet the higher demands expected of them, and in so doing Locomotive Works included huge Smith's shops, part of which was given over to the making and repair of springs, including coil springs.

The D Class locomotive indicates that the SE&CR Drawing Office at Ashford realised the advantages that coil springs could give by fitting them to the leading driving axle. This class of locomotive is perhaps the first example to use coil springs.

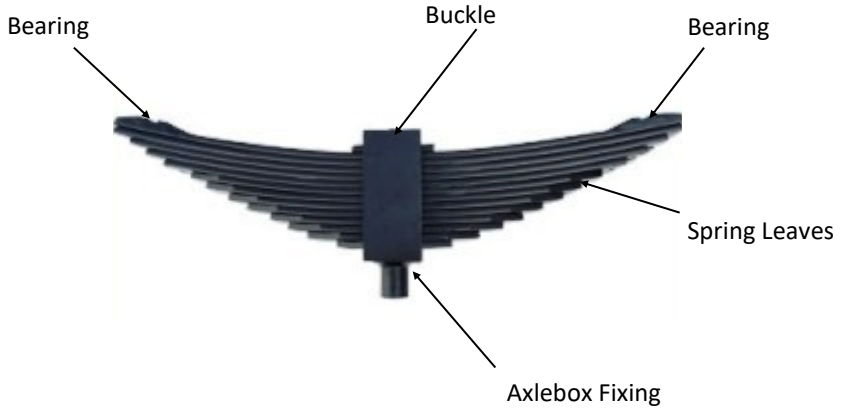


Figure 2 Typical Steam Locomotive Leaf Spring

I will not deal with the manufacture and assembly of the various parts, except for the buckle which holds the leaves together, and the testing. The buckle is important and was introduced as it did away with having to drill holes to bolt the leaves together, where the holes, located in a high stress point, frequently led to broken leaves, and spring failures. Instead of drilling, locating nibs were pressed in to centralise the leaves, then the buckle was forged, and then shrunk on to the assembled leaves. The completed spring was then mounted onto a 'scragging machine' that would cyclically load and unload the spring a number of times to settle the leaves whilst lubricant was added. When satisfied that the spring had met the design criteria, the operator would print off the test results for reference to the spring. However, a leaf spring has an inherent weakness that a coil spring does not. The weakness is known as hysteresis (interleaf friction), that makes the leaf spring less responsive to dynamic loading which in turn affects the accuracy of setting up the suspension system of a steam locomotive.

When a new engine was being built, or an engine being rebuilt after a General Overhaul, the frame and boiler would be assembled ready for the fitting of the driving wheels and bogies. Then the driving wheels and bogies would be accurately positioned ready for the assembled frame and boiler to be lowered onto them. The springs would be fitted, and roughly adjusted before fitting of the brakework and ancillary equipment. The finished engine would then be attached to its tender to complete the locomotive.

Prior to entering revenue earning traffic, the locomotive had to be inspected and tested. Part of this process included setting up the suspension in accordance with the Locomotive Diagram to achieve the required weight distribution, as shown in more detail in Figure 3.

Here can be seen that the engine bogie has to bear 17 tons (t) 3 hundredweight (cwt); the leading driving axle has to bear 17t, and the trailing driving axle has to bear 15t 17cwt distributed over a wheelbase of 22ft 11½in. The adhesive weight from the driving wheels is 32t 17cwt. The tender was weighed separately. This is fine for the longitudinal weight distribution, but how about the lateral distribution, which is equally important, so the axle weight is divided by two to give the respective wheel weights.

In the days before electronic load cells, the only way to set the respective wheel weights in an efficient manner was to place the entire engine on sets of scales, known as Weigh Tables or Bridges, and every major railway works owned a set.

Weigh Tables were normally supplied by scales manufacturers such as the well-known Henry Pooley and Sons of The Albion Foundry, Liverpool, or W & T Avery Ltd. of the Soho Foundry, Smethwick. They] soon became sophisticated pieces of mechanical equipment that could deal with the different axle spacing and wheel loads of the various classes of locomotives, but mainly consisted of either an eight balancing platform (4 axles) with eight

indicator heads, as per the Ashford example, or twelve balancing platforms (6 axles) with twelve indicator heads. They could also be used for passenger coaches and freight wagons.

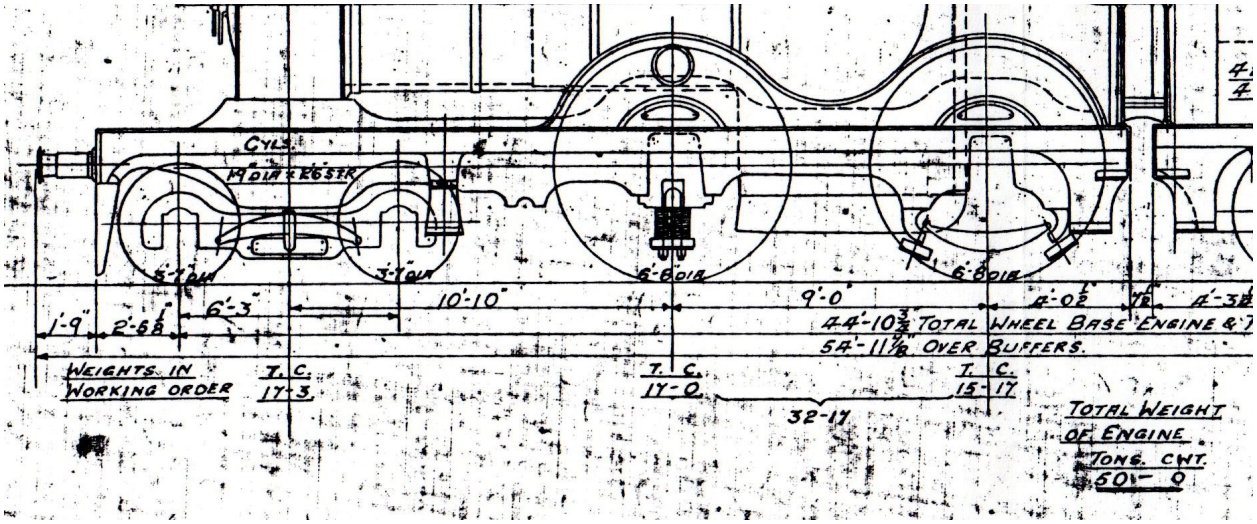


Figure 3

Below is an extract from the obituary of Henry Pooley:

'In 1846 Mr. (Francis) Trevithick (son of Richard Trevithick), the then Locomotive Superintendent at Crewe, consulted Henry Pooley on the subject of balancing locomotive engines by actual weight; and he arranged and made the first multiple weighing apparatus ever used for this purpose. It was embodied in the patent taken out by him in 1847, 'for improvements in weighing machines.'

The railway wagon weighbridge was greatly simplified and improved by him; the parts were framed together in a new and very secure manner, thus reducing its cost and the cost of its foundation work.'

How the suspension system of a typical steam locomotive was set up.

Before use, the Weigh Table indicator heads would be calibrated to zero, and the indicator head mechanism locked.

A locomotive would be run onto the Weigh Tables and the engine positioned on the balancing platforms, the lock would be released, and the indicator heads would then show the respective weights acting on the balancing platforms, and the unequal readings noted down by the Foreman. The locomotive would then be run forward, and the tender weighed. Fitters would then adjust the springs, until the correct readings were shown. However, this exercise was not as simple as it would seem due to the aforementioned problem of interleaf friction, and so became a matter of educated trial and error. As a check that the settings were correct, the locomotive would be run up and down the track off the Weigh Table a few times, to settle the springs, and then positioned on the balancing platforms again for final adjustment to the engine and tender springs, and the adjusters locked. The final recordings would be noted to the locomotive, and it would then be sent into revenue traffic.

Final 'ideal' readings for the engine of a 'D' Class locomotive would be:

- **RH** Leading bogie wheel. 4t 53/4 cwt. Trailing bogie wheel. 4t 53/4 cwt. Lead driving wheel. 8t 10cwt. Trailing driving wheel. 7t 181/2 cwt.
- **LH** Leading bogie wheel. 4t 53/4 cwt. Trailing bogie wheel. 4t 53/4 cwt. Lead driving wheel. 8t 10cwt. Trailing driving wheel. 7t 181/2 cwt.

These types of Weigh Tables gave the Foreman a complete picture, and as each spring was adjusted, he could see immediately the impact that adjustment was having on the other springs.

In fact, a fine balancing act, but achieving the correct settings was of safety critical importance, reducing the risk of derailment and resultant loss of life as well as reducing track damage, wheel slip and improving ride quality.

The example, on which this article is based, was in use at Ashford Railway Works in Kent from 1899 to 1982.

The Weigh Tables were manufactured and installed by W & T Avery Ltd. in a brick building. The table frame was a bolted cast iron structure, 28ft - 5ins long by 7ft - 4ins wide, set on substantial foundations beneath floor level; in which the eight, 6ft long balancing platforms, complex arrangement of levers and counterweights were assembled. The four indicator heads, with two indicator arms per head, and associated lever assemblies were housed in a large, panelled cabinet of varnished pine with windows on both sides of the indicator heads that was fixed to the floor, set back from the nearest rail to allow the fitters room to access the springs. Short sections of track outside each end of the building were laid perfectly straight and level to maintain accuracy, when setting up locomotives with different wheel arrangements.

It has been verified that the Weigh Tables were successfully used to set up the suspensions of 4-4-2, 4-6-0, 4-6-2, 2-8-0, and 2-10-0 wheel arrangement locomotives.

How the Weigh Tables worked, in simplified terms:

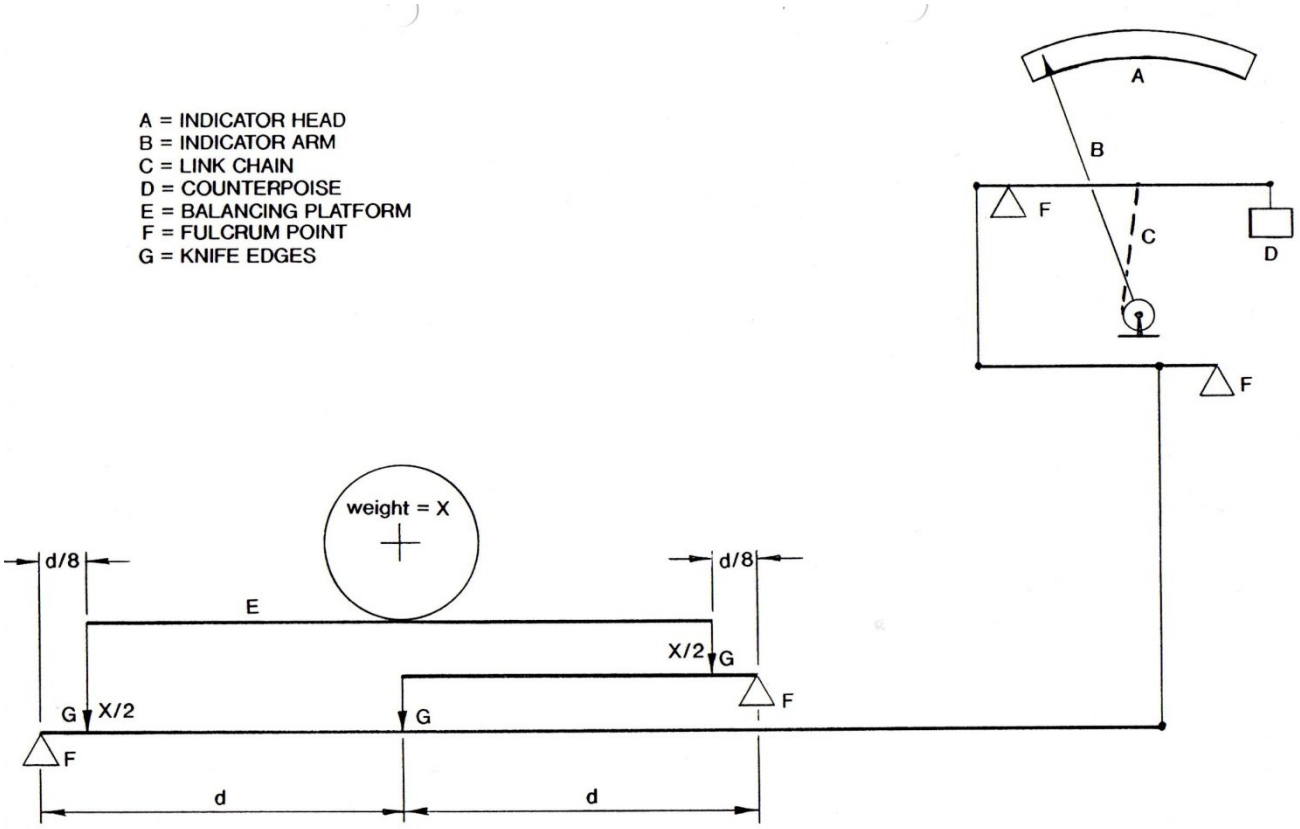


Figure 4 Levers and Compound Ratios Diagram

The fulcrums of the various levers are marked **F**. Knife edges, marked **G**, were used to minimise friction as would happen with a pinned joint. The two links shown connecting levers **b**, **c** and **d** were also fitted with knife edges.

To 'zero' the indicator arms, fine adjustment was made to the weight setting of Counterpoise **D**.

Balancing Platform **E**, shown with a central wheel load **X**; bears at each end via two knife edges **G**, on to levers **a** and **b**. Load **X/2** is therefore transmitted to lever **a** at a point **d/8** from its fulcrum, and load **X/2** to lever **b**.

As lever **b** is proportioned exactly the same as that part of lever **a**, to the left of the centre line of **X**, i.e. in each case the distance from **F** to **X** = **d**, and the compound ratio = **d/8**. In practice, for each pair of balancing platforms; levers **b** are mounted at right angles, with their lengths and ratios differing due to the track gauge, and position of the indicator heads.

The compound lever arrangement ensures that wherever **X** is applied along **E** the indicated weight shown at **A** will always equal **X**. This feature enabled the Weigh Tables to be used to set up locomotives with different wheel arrangements.

In use, levers **a** and **b** rotate downwards. The right-hand end of **b** pulls lever **c** downwards, which in turn makes the right-hand part of lever **d** from its fulcrum rise, and the resulting motion of link chain **C** rotates the drum of the indicator arm clockwise to indicate the weight. Simple, but effective!

Up to forty years ago there were at least three known examples of Locomotive Weigh Tables in existence in Great Britain. The first was in the old Ashford Railway Works, Kent. This was in a derelict condition and was identified as being unique in design by Engineers from Avery - Berkel.[1] It was recovered by agreement with British Rail Property Board on the understanding that the Tables should be restored to working order in the custody of the Bluebell Railway.

The second later example was installed by Henry Pooley and Sons Ltd. during 1930 in Swindon Works. It was extant in working order until about 1990. It was housed in its own brick building that became the workshop for a Locomotive Preservation Society. This Weighbridge had Indicator Heads that looked like the old type of shop scales on which we weighed ourselves, years ago. 'Merchant Navy' Class locomotive 35027 ‘Port Line’ was set up on these Tables during its overhaul to 'Main Line' service at the Swindon Railway Heritage Centre in 1989. Redevelopment of the site meant that the Society had to move out, and the National Railway Museum subsequently launched a recovery campaign. The dismantled Weighbridge was put in store on the Science Museum storage site at the ex-RAF Wroughton airfield. It has been said that the Science Museum did offer it to a number of heritage railways. Apparently, no offers were received, and so it was scrapped in 2007. The reason given: there was not enough storage space!

The third is a modern example to be found in the old British Rail Research Centre, in Derby. Housed in a side building to the Engineering Development Unit building, this example has been modernised a number of times since its installation in the 1960’s, and last seen had been fitted with load cells and digital readouts.

'Castle' Class locomotive 5080 ‘Defiant’ was set up on these Tables in 1986 before entering mainline traffic. Then in 1990, 'Princess Royal' Class 46201 ‘Princess Elizabeth’ stalled twice on Settle & Carlisle excursion work, and was subsequently dispatched from Carnforth to Derby where it was found that there was a difference of some two tons between the driving axles.[2] Recent news informs that they are now owned by Rail Vehicle Engineering Limited, and are still playing a valuable role in rail safety by providing vital data from the wheel / rail interface of new rail vehicles.

Also at Derby was another Weighbridge that survived in a building similar to that at Ashford until quite recently. It was located on sidings near the old Locomotive Roundhouse ‘4 Shed’. The shed ended up housing shunting locomotives before it was demolished to make way for the Etches Park train depot.

Today, electronic load cells have taken over from the technology and principles of compound levers and moments. But the old technology is still relevant and important for trainee Engineers to understand, so these examples of weighing apparatus are as important for future generations as saving rare examples or recreating lost types of steam locomotive. In fact, not one Railway Preservation Society in Great Britain owns a Locomotive Weighbridge. A pair of hydraulic load cells are used to adjust the suspension of one wheelset at a time: a laborious and tedious process. Time and cost are not issues with a volunteer workforce, and where the maximum speed restriction on preserved railways is 25mph.

However, where steam locomotives are allowed to run on the national rail network at speeds up to 75mph, stringent safety precautions apply, and so it is important that the suspension systems of these locomotives are set correctly.

The modern rolling stock operating throughout the world no longer rely on leaf springs. Suspension systems use coil and air springs, including passive and active damping mechanisms that maintain the wheel to rail interface, and control ride quality as speeds continue to increase.

1. Avery Berkel is the successor company of W & T Avery Ltd.

2. Quoted from Steam Railway. February 1991. Page 14, as copied at the end of this article.

But, even so, these modern suspension systems need to be set up correctly, a process that will be explained.

Archimedes stated: “Give me a lever long enough and a fulcrum on which to place it; and I shall move the world”.

The Weighbridge Shed at Ashford Works. 1991

The indicator heads and the eight weighing platforms prior to removal.

Close up view of an Indicator Head showing the accuracy of graduations marked in tons, quarters and hundredweights.

The exposed foundations before demolition of the building.

'Princess Elizabeth' out of balance by two tons

'PRINCESS' Pacific No.6201 *Princess Elizabeth*, singled out by BR for loco weight distribution tests after stalling twice during recent Settle & Carlisle excursions, was found to be out of balance by around two tons in a December examination.

'Lizzie' travelled from Carnforth to the weighhouse at Derby's Railway Technical Centre on December 10, where BR Mechanical Inspector Colin Wood found the middle driving wheels carrying some two tons less than their optimum load, while the leading driving axle was carrying around two tons overweight. A variation of half a ton is normally allowed between adjacent axles.

After overseeing weight correction through the adjustment of main springs, Inspector Wood confirmed: "An uneven loading can result in poor adhesion on the rail, but while undoubtedly it didn't help, we can't say conclusively that this was the sole cause of the problem. Both *Bahamas* and *Duchess of Hamilton* also stalled on the S & C during the October/November period, when the rail was particularly greasy."

● All S & C Pacific-hauled trains have been restricted to 11 vehicles or equivalent until March 31, at the insistence of BR InterCity Special Charters Manager David Ward. No.6201 completed it alloted duty on the December 15 'Cumbrian Mountain Express', hauling nine vehicles plus an ETHEL train heating unit, without trouble.

Trust quits station

Acknowledgements

Information on 'Clan Line' provided by S. Austin BSc.

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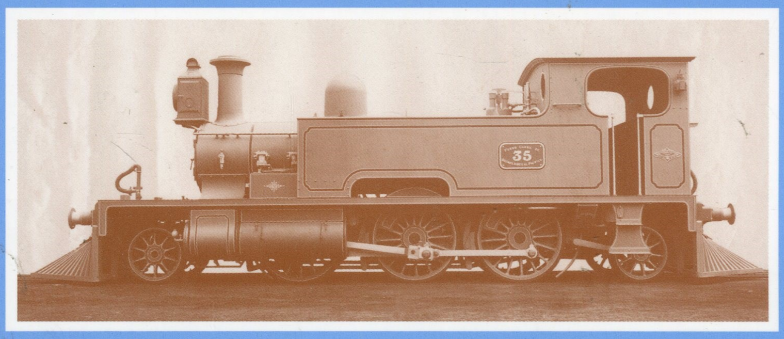
RAILWAYS AND MOTIVE POWER OF ARGENTINA

COMPLETE LISTING OF PUBLIC
RAILWAYS WITH BASIC
DETAILS AND
COMPREHENSIVE LOCOMOTIVE LISTS



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