LOCOMOTION No.1

An Assessment of its History and Modifications Through Archaeological and Archival Study

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June 2023

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Introduction

Since 1857, when *LOCOMOTION No.1* was erected on to its plinth outside Darlington's North Road station, it has been revered as the artefact that made possible the very beginning of the world's public railway system. Few people who have a deep, or even passing, interest in railway history have not heard of its role as the vehicle that pioneered the world's first public steam railway in September 1825. Several years of steam locomotive operation for the haulage of coal and other minerals on industrial lines had allowed experience to be gained with the thermo-dynamic, mechanical and material innovation of steam locomotion. This made possible the erection and operation of a reliable means of motive power for a public railway, the investment in which was a major financial risk to its proprietors. These same proprietors understood and respected its role just 32 years later with its preservation as an artefact of historic, economic and social importance to world development.

Until now our knowledge of *LOCOMOTION*'s story has been dictated by the appearance of the artefact itself and by the writings of Victorian historians seeking to provide their readership with stories they wished to read, without the detail of its actual life experiences. The Victorians were excellent engineers, but poor historians.

Any machine that makes a useful contribution to its industry and a return on its initial capital expenditure, goes through years of maintenance, modification and even major re-building as experience builds up and improvements are made in design, efficiency and materials. At the conclusion of its working life a machine, such as *LOCOMOTION*, incorporates components that were fitted from the different stages of that working life. This allows the interested observer to learn much about the problems and solutions that its maintenance teams faced throughout its career. The archaeology of historic machines is a new form of enquiry and learning that builds on the curatorial endeavours of museum teams who have had them in their keeping for decades, but without the resources or experience necessary to pursue further detailed examination.

In conjunction with any archaeological project, it is both necessary and informative to undertake in parallel a thorough archival enquiry to seek out contemporary written references about the artefact. Such enquiry reveals questions and contradictions that can sometimes be answered by examining the artefact directly. Co-incidentally, the physical examination of every component on the artefact reveals questions and contradictions that can sometimes be answered by the written word. The combination of these disciplines thus provides a greater understanding of the detailed story of the artefact.

The conclusions are based on a combination of the actual evidence revealed by the respective enquiries and, where specific issues cannot be ascertained, the circumstantial evidence that strongly indicates a course of events.

The authors have developed experience with nine major archaeological projects on early steam locomotives over the past thirty years. They have learned much from these projects, not only about early thermodynamic, mechanical and material developments, but about the examination and recording of components at first hand, together with the selection of relevant written documents from archival collections of great magnitude, from many origins.

LOCOMOTION No.1 has been an icon for the startup of public railways ever since 1857. Its ungainly appearance, with parallel motion, has captivated railway historians and model makers since that time. Following our project, however, it may now be recorded that the artefact is in fact a combination of the remains of the locomotive at the conclusion of its working life, which was then itself reformed in 1857 with replacement components to replicate a form as near to what it was believed to have been like when it first ran on the Stockton & Darlington Railway on its opening day in September 1825. It is not thought that any of its surviving components date from that time, although there are enough early components to warrant a great deal of interest from which much can be learned about early locomotive technology. Its tender meanwhile is an erroneous replica.

Identifying the artefact has been carefully considered. When first completed it earned the nickname '*Active*' a name that gained common usage as a form of '*lingua franca*' amongst the railway's footplatemen. Even on its retirement there were those who still referred to this name. From October 1827, the need to identify more specifically each of the railway's growing fleet, led to the introduction of numbers in the order in which they had been delivered. The *Active* was thus given the number '1'. In the summer of 1833, the railway's Sub-Committee decided to name the locomotives in its fleet, with No.1 being given the name *LOCOMOTION*, probably with cast nameplates affixed to the sides of the boiler. Throughout this report, the locomotive has been identified by the name/number by which it was known according to the practice of the time.

It has been a great honour for the authors to be asked by the National Railway Museum to undertake the investigation into *LOCOMOTION* and its history. The timing of this enquiry allows its results to be made available to a much wider readership in advance of the bicentenary of the opening of the Stockton & Darlington Railway in 2025. Our 'hands on' work was undertaken chiefly in 2022 through visits to the NRM's 'Locomotion' Museum at Shildon in County Durham to which *LOCOMOTION* had been moved some months previously. Our work was conducted under the supervision of Anthony Coulls, the Museum's Senior Curator of Rail Transport & Technology.

We would like to thank Anthony and all his colleagues for their assistance and cooperation during the course of these visits, particularly through their arranging for the removal and eventual re-instatement of certain components that made the examination of the artefact so much more thorough. However, it was not possible to examine those parts of the boiler's exterior that are covered in wooden cladding. The boiler plates were covered in protective paint during its last works conservation in 1961, before the fitting of new, and now surviving cladding. However, we were advised that, owing to the current presence of asbestos dust, for health and safety reasons it would not be possible for the cladding to be removed to allow an external examination of the boiler plates. This limited our investigation work to a restricted interior examination of the plates and fittings only.

In addition to the archaeological work, the authors undertook visits to, and communications with, those archives and museums that hold records relating to the early years of the Stockton & Darlington Railway, namely:

'Search Engine', the National Railway Museum, York

The Science Museum, South Kensington

The National Archives, Kew

Head of Steam Museum, Darlington

Preston Park Museum, Eaglescliffe, near Stockton

Durham County Archives, Durham

Tyne and Wear County Archives, Newcastle-Upon-Tyne

Northumberland County Archives, Ashington

North of England Institute of Mining and Mechanical Engineers, Newcastle-Upon-Tyne

Literary and Philosophical Society, Newcastle-Upon-Tyne

Central Library, Newcastle-Upon-Tyne

Discovery Museum, Newcastle-Upon-Tyne

North of England Open Air Museum, Beamish

North Eastern Railway Association, Darlington

The Institution of Mechanical Engineers, London

The Institution of Civil Engineers, London

J.W. Armstrong Trust

University of Michigan Library, Michigan, USA

Baltimore & Ohio Railroad Museum, Baltimore, Maryland, USA

We received much assistance from the curatorial and library staff of each organisation and would like to express our grateful thanks to them all. We are further indebted to David Gray for his loan, to the Locomotion Museum, Shildon, of the ‘No.1’ and ‘1825’ plates once carried by the artefact. We are also indebted to Dr. Peter Northover and Dr. Kamal Badreshany for their advice regarding certain queries about materials that arose during the progress of the project.

PART I - HISTORY

1. Origin of the Locomotive 1824 - 1825

The locomotive was built by Robert Stephenson & Co. which was formed in June 1823 as a manufacturing company to meet the anticipated requirements of the growing railway industry, especially the Stockton & Darlington Railway (S & D R).[1] Its partners were Edward Pease (1767-1858), the successful Darlington businessman and Chairman of the S & D R; his cousin, Thomas Richardson (1771-1853), a successful London banker; George Stephenson (1781-1848), the Engineer of the S & D R and other railway projects; his son, Robert Stephenson (1803-1859), then an engineering assistant to his father; and Michael Longridge (1785-1858), the Manager of the Bedlington Iron Works. With the conflict of interest, as both client and contractor, for George Stephenson becoming evident during 1824, he stood down from his financial participation in the company at the end of June that year, in favour of Robert Stephenson to whom he passed his two shares.[2]

The company began trading in the Bedlington Iron Works' premises on the 11th July 1823, whilst seeking premises of its own in Newcastle.[3] The 1200 square yard site in South Street, just off Forth Street in that city, was selected as the site of the new factory and, after a phased transfer of men and equipment from Bedlington, was ready for use by the autumn of 1824. It had a workforce of 40 or so millwrights and other tradesmen when it began manufacturing. Wrought iron plate and sections were largely obtained from Bedlington, whilst castings were obtained from the adjacent foundry of I & J Burrell, for whom George Stephenson was also a partner. Powered by a new stationary engine, the first workshops were a machine shop, boring and grinding shops, a smiths' shop, a pattern shop and an erecting shop. The first orders for the works were related to the colliery, marine and paper industries, as well for early railway equipment.[4]

The S & D R enquired as to the terms for acquiring its first two locomotives on the 16th July 1824.[5] On receiving a satisfactory quotation of £500 per locomotive from the Stephenson Company, subsequently increased to £600, the railway ordered both locomotives on the 16th September 1824.[6] The order was received at a particularly difficult time for the manufacturing company. Robert Stephenson himself had left England for his three-year period in the silver mines of South America, whilst George Stephenson was increasingly becoming involved in several new railway schemes at that time and was rarely in Newcastle.

After Stephenson's surveys of both the Liverpool & Manchester and the Liverpool & Birmingham Railways, he had much preparation work to provide maps, plans and designs associated with the respective routes.[7] They had to be completed in time for submission to Parliament for the 1825 session. He was also asked to survey other routes, including the Midgeholme line, serving Lord Carlisle's collieries in Cumberland,[8] and the Bolton & Leigh Railway.[9]

The absence of both Stephensons meant that Michael Longridge was obliged to direct the affairs of the Stephenson Company to ensure that the factory remained solvent and that the wages were paid, in addition to his work at the Bedlington Iron Works. To supervise the manufacturing work, Stephenson had engaged Timothy Hackworth (1786-1850), who started at the South Street factory in the summer of 1824, but his appointment was on a short-term basis only.[10] In case Hackworth could not remain for any length of time, a full-time works

foreman, James Kennedy (1797-1886), was also appointed by Stephenson.[11] He was a Scottish millwright, with experience in stationary and marine engine erecting, who had been recruited in Liverpool.[12] He joined the Stephenson Company in mid-August 1824. With Hackworth remaining at the factory only for the second half of 1824, he and Kennedy supervised the millwrights, smiths, machinists, and fitters, including the talented William Hutchinson (1792-1853), who was later appointed as foreman. A foundry was added to the Stephenson company's premises in the summer of 1825, after which time George Stephenson stood down from his association with the Burrell company.[13]

Detailed design work for components of new engines and other equipment at that time was largely left to the millwrights, but progress on new machinery design required direction from Stephenson. He had largely been on hand to provide that direction as his early locomotives had progressed at Killingworth and Hetton but, after 1822, his absences meant that there would be long delays in between decisions being made for each component. It was therefore evident that, at first, little work could be carried out on the first locomotives for the S & D R.

The criteria on which Stephenson approached the design of the first locomotives, was to base it on the successful Killingworth type, but with improvements. This empirical approach had minimum risk, but he was also obliged to provide locomotives for the railway that suited its track. The re-laying of the Killingworth Colliery line with wrought iron rails in 1820 had allowed an increase in the size and weight of each locomotive that it used.[14] For the Hetton Colliery line however, with its cast iron track, the weight of its locomotives was limited, and they were made correspondingly smaller and lighter. The debate about the cost and longevity of rails on the S & D R however, had resulted in a third of its route being laid with cast iron rails and the remainder with wrought iron ones.[15] The weight of the first locomotives was thus limited by the railway's cast iron rails that Stephenson reluctantly had to accept.

His specification therefore was for a shorter locomotive than his 1821 example on the Killingworth line, but fitted with 4 ft diameter, rather than 3 ft diameter, wheels. These had been successfully demonstrated by Nicholas Wood (1795-1865), the Killingworth viewer, as being operationally preferable, and he had thus started to re-fit its locomotives accordingly.[16]

Stephenson remained concerned about the tendency of track to move out of horizontal alignment in all weathers, causing the locomotives in motion to be suspended momentarily on three wheels, before the fourth wheel re-engaged the track with an impact force risking both the cast iron track and the locomotive wheels. His 'steam springs' had partially mitigated this problem, but he further sought to introduce a tubular form of axle guide for the rear wheelset, with a mid-upper hinge secured to the under-side of the boiler, that would allow a continuing three-point contact with the track. To achieve this aim would prevent the use of 'surging chain' couplings hitherto used on his Killingworth and Hetton locomotives. This, in turn, led him to introduce outside coupling rods connected to crankpins on the wheels, with return cranks to provide for 90-degree separation of piston action.

He also sought to provide greater coordination of the driving motion using parallel motion replacing the slide bars formerly adopted on the Killingworth type locomotives. Such major alterations required Stephenson's personal superintendence, which he was unable to provide at first because of his other activities. He was therefore obliged to turn to drawing out the geometry of his ideas on paper. This marked a significant step in locomotive development, being the first occasion that a design concept had been so presented before manufacture. His

undated sketch of these first concepts about parallel motion for use on the S & D locomotives has remarkably survived.[17] The sketch was accompanied by explanatory notes, which may be seen as being instructions to Hackworth and Kennedy:

> This scetch will shew you my ideas on the way (I) would combine the tow (two) Engines together I have placed tow Beams upon one pivoted on one side of the Engine, each has a long & short End so as to alow the Crank pins to work clear of each other the black line shew to work on one side and the doted one on the opposite side of the Engine – the long end of the Beam will work a longer stroke than the short one and the tow wheels on one side must be made to such as shewn in the scetch the Beam will work back to back like a pare of shers (shears) and they should project a little further out than the wheels so that the connecting rods may not grind against the wheels you will preceive that a black line and a doted one work together one on the fore wheels and the other on the hind ones and on contrary sides the Bearings are a little low to bring these to a square with the axles of the wheels you can put on the paralil motion like the Etherley Engines
>
> I have given a scetch of it but not the proper lengths the rods from the Beams ought to be about 2 inches diameter and the Beam about the same strength as the present one that the piston rods are attached to the tow levers on the other side of the Engine that will be required for the Parilile motion may be very slight one as they will only have to carry the Radeous Rods
>
> I think it will be better to put on ball and socket joints on to all the Beams so that they will stand at one side like a Crank Pin by being so the joints will always be at ease in any part of stroke I think 2 floating Cyllinders will do would put the same form on the other end but not to work mearly to support the Boiler

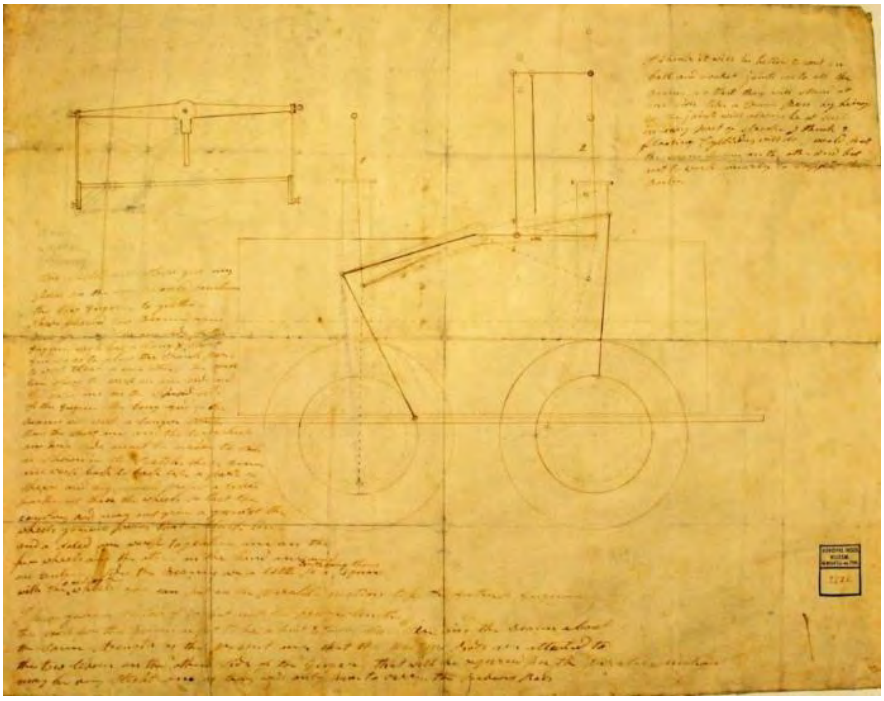

Fig. 1.1 George Stephenson's initial sketch of his first arrangement for the S & D R. locomotives

(Tyne & Wear Record Office, TWCMS C6181)

A later sketch has also survived showing two more developed schemes. It is not known if Stephenson also prepared this second drawing, or if this was an attempt by Hackworth and/or Kennedy to offer alternative interpretations of the driving motion that Stephenson was seeking. The left-hand arrangement is that of William Freemantle's parallel motion, dating back to 1803 (otherwise 'Grasshopper' motion),[18] whilst the right-hand is of James Watt's parallel motion dating from 1784.

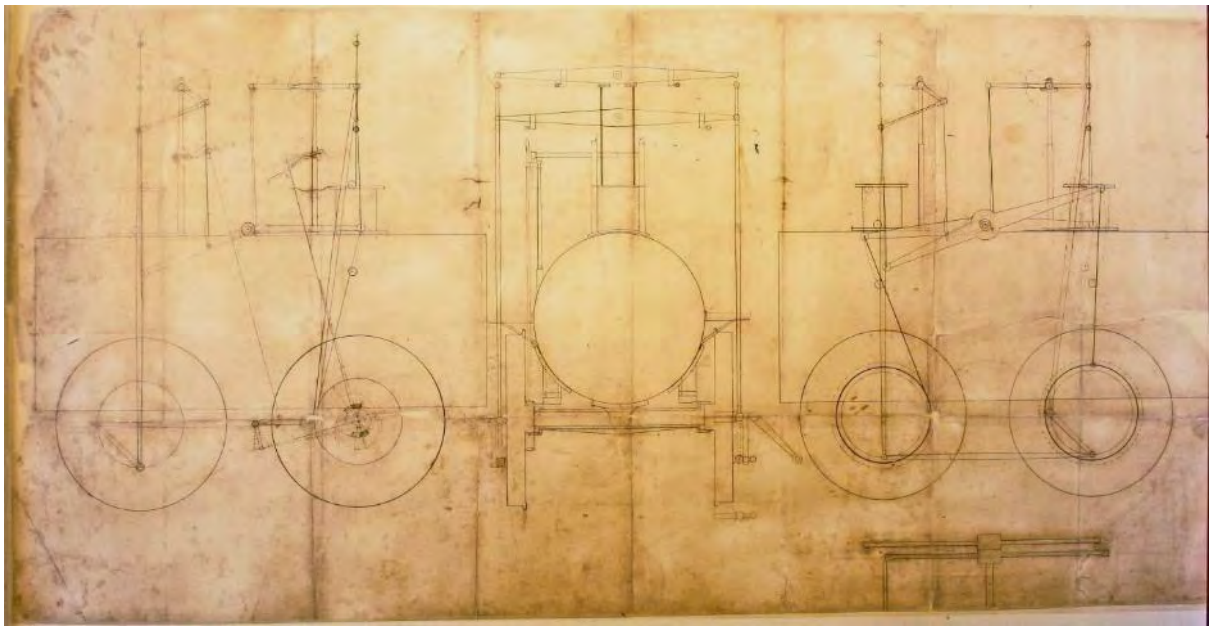

Fig. 1.2 Schematic drawings of alternative driving motions (NRM, ROB/3/2)

The Freemantle arrangement was like that fitted to the first works engine at South Street offering an indication that there had been some experience in its working arrangement. This, therefore, was the arrangement chosen by Stephenson.

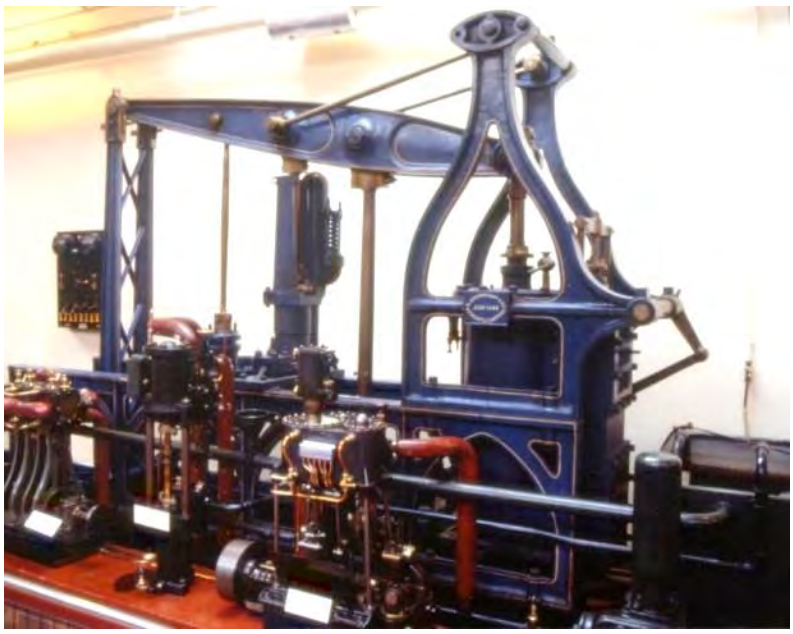

Fig. 1.3 Robert Stephenson & Co. works engine with Freemantle motion

With Stephenson spending such little time at South Street, the indecision about the preferred arrangement appears to have delayed the first locomotive's construction, perhaps with just the boiler, frame and wheelsets completed. By January 1825, the directors of the S & D R wrote rather anxiously to enquire about when the locomotives might be delivered:[19]

> The enormous loss which the company sustains weekly by its works not being brought into usefulness – It is resolved to write to the engineer and request he will from the most mature consideration inform this Committee when the travelling engines and the Brussleton and Etherley engines will be completely ready to commence our operations and to beg that he will take no work in hand whatever until the same have been completed. No small dissatisfaction being felt that 4 months have elapsed since the order for these engines being given and so little effected.

However, far from easing up from his commitments, Stephenson took on a large amount of additional work. Towards the end of 1824 and into the early part of 1825, he took on responsibility for the survey and route design of further routes between Leeds and Hull, Canterbury and Whitstable, London and Manchester (The London Northern Rail-Road), Manchester and Bolton, and London to South Wales rail project. This early 'mania' for new routes did not last too long, however, as the London capital market was later hit by a recession,[20] but as Stephenson was anxious not to lose his position as the country's 'leading' railway engineer, he accepted all the advances that were made to him. He was to deal with this avalanche of work by forming "an office for Engineering and Railway Surveying". It was named George Stephenson & Son, and based alongside the Stephenson factory in Newcastle, for which he engaged a team of young men who would undertake much of the routine survey work on his behalf.[21]

The most time-consuming activity he was engaged on in 1825 was attending Parliament in London between the 3rd of February and the 1st of June on the business of the Liverpool & Manchester Rail-Road's Bill, during which he gave evidence to the Committee of MPs. The failure of the Bill was partly due to the errors of his surveying team but, as the responsible engineer, it led to his services being withdrawn by the rail-road. His resulting loss of reputation meant that several of his other schemes were also terminated, although the recession in the London capital market also temporarily reduced the interest in railway schemes.

The directors of the S & D R continued to press Stephenson to complete the order for their two locomotives in the early months of 1825. The railway was desperate to begin its services in order that it could start earning revenue. This was the moment that the millwrights at the Stephenson factory sought to press for better remuneration. The frustrated Michael Longridge wrote to Stephenson on the 5th March:[22]

> As the Darlington Rail Way Engines must be finished in three months we have no choice at present but to comply with the demands of the Men – which however will be attended with bad consequences. There have been two Meetings of the Master Mill Wrights & there is to be another on Monday – but it is of no use whatever.

Stephenson returned to Newcastle in early June and only then had the time to sort out the problems associated with the stationary and locomotive engines for the S & D R. For the first locomotive, nicknamed from the outset as the *Active*, it is probable that its boiler, which was similar to those employed on the Killingworth line, had already been completed. It is also likely that the iron frame was in hand, if not completed, and the wheelsets cast. What was awaiting his instructions was the arrangement of the parallel driving motion and the valve motion, together with the rear-mounted centrally pivoted transverse axle-tube and coupling rods. Thus, it would seem that the important decisions on the locomotive's arrangement were not made until the two-month period from the second week of June 1825.

Some of the Stephenson company's men were required to finish, to a fully operational standard, the stationary winding engines for the Etherley and Brussleton inclines. The remainder would have been on hand to fit out the *Active*. There may therefore have only been sufficient time to complete the whole of the lower part of the locomotive, with frame, wheelsets, horns and axle-boxes for the front wheelset, and the rear axle-tube for the rear wheelset, together with the coupling rods. But there was insufficient time to complete the workable geometry of the previously untried parallel motion, together with the valve motion.

By July 12th, Stephenson, under much pressure from the S & D R's Railway Committee that the line had to open as quickly as possible, undertook to have the line open within two months. This gave the Committee encouragement to announce that the opening would be in September.[23] Stephenson thus found himself under intense pressure to complete the *Active* as a reliable locomotive by that time. It is therefore most likely that the first boiler, with the yet unworkable parallel motion, was laid aside and substituted by the yet unfitted boiler for the second locomotive. He would then, most probably, have fallen back on the well-proven 'Killingworth' type arrangement of slide-bars and crossheads, whilst introducing connecting and coupling rods, and abandoning the use of 'steam springs'.

No drawing or detailed description of the exact form of the *Active* is known to have survived, but an informed contemporary description of the locomotive was published by William Newton (1786-1861). He was one of the first two influential patent agents based at the Patent Office in London in the 1820s. He also acted as editor of the London-based monthly magazine, *The London Journal of Arts and Sciences*, in which he sought to summarise all new patents and to provide news of the latest 'Inventions and Discoveries'. His description of the S & D R and its 'locomotive steam engines' was accurate and informative, suggesting that he had been briefed by someone who knew the locomotive design specification well. It is likely that this had been passed to him by George Stephenson himself, who spent a lot of 1825 in the capital, and thus had time and opportunity to brief Newton. Newton wrote:[24]

> The induction and eduction valves of both cylinders are worked by rods connected to eccentrics below, and the alternating power of the pistons is communicated by parallel motions and sweep rods on each side to cranks upon the spokes of the running wheels;

However, with such urgent arrangements being made at the Newcastle factory to complete the *Active*, it is most unlikely that Stephenson had time or opportunity to inform Newton of

the temporary abandonment of the parallel motion. The changes made to *Active*'s driving motion seem not therefore to have been corrected in the *London Journal*.

Stephenson wrote to Joseph Pease on September 13th that "the Improved Travelling Engine was tried here last night and fully answered my expectations", which may have referred just to the axle and coupling arrangements rather than the parallel motion as well.[25]

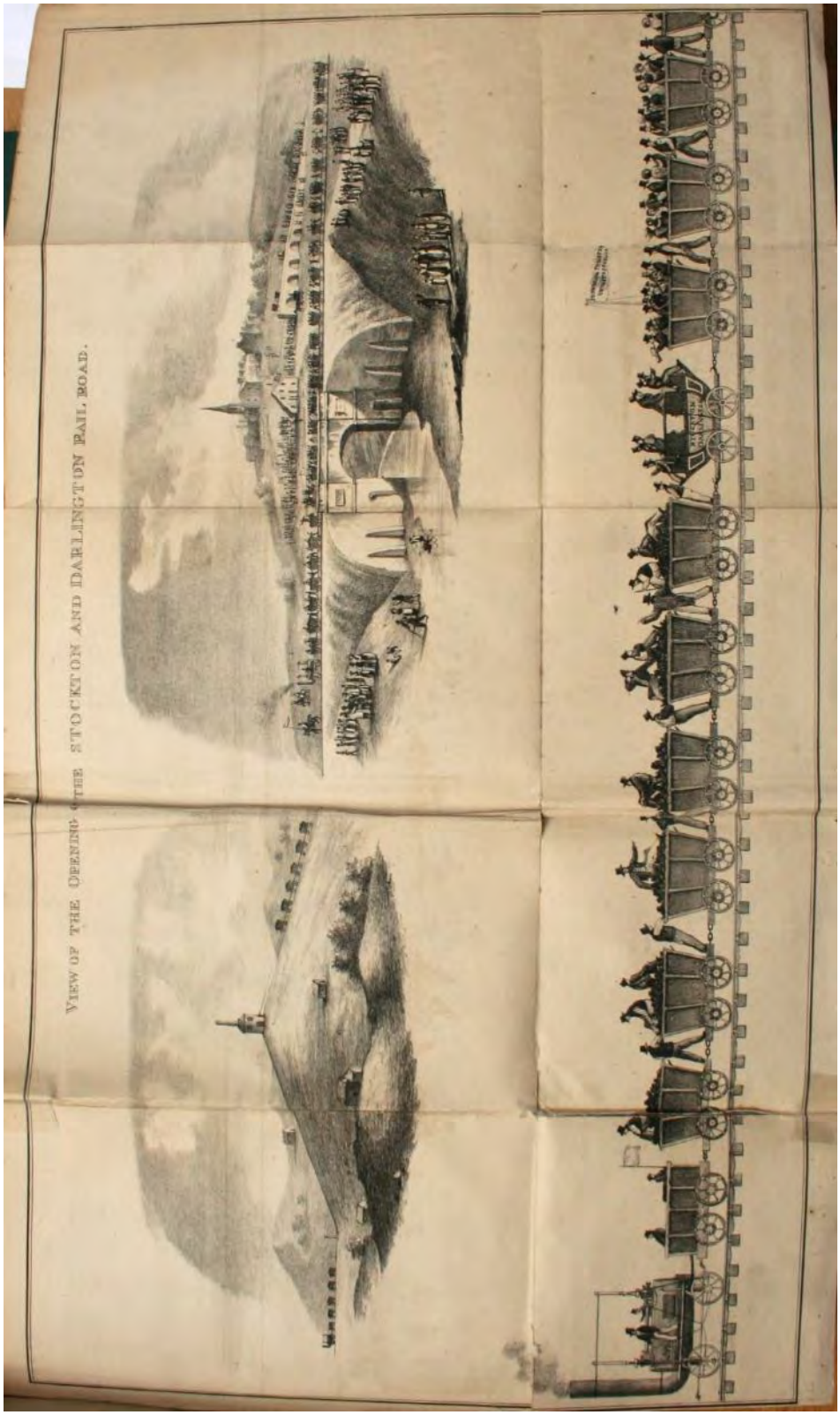

Fig. 1.4 Contemporary illustrations of the opening of the Stockton & Darlington Railway on September 27th 1825 (1)

[An Account of the Stockton and Darlington Rail-Way, Newcastle, Printed by Edward Walker, 1826; Inst. Civil Engineers, 385(09) 428]

Although there is no specific contemporary evidence to support the temporary postponement of the parallel motion, there are three contemporary sketches of the opening day, which appear to show the locomotive with a slide-bar arrangement.

Fig. 1.5 Contemporary illustrations of the opening of the Stockton & Darlington Railway on September 27th 1825 (2). [Science & Society Picture Library – 10199026 – artist unknown]

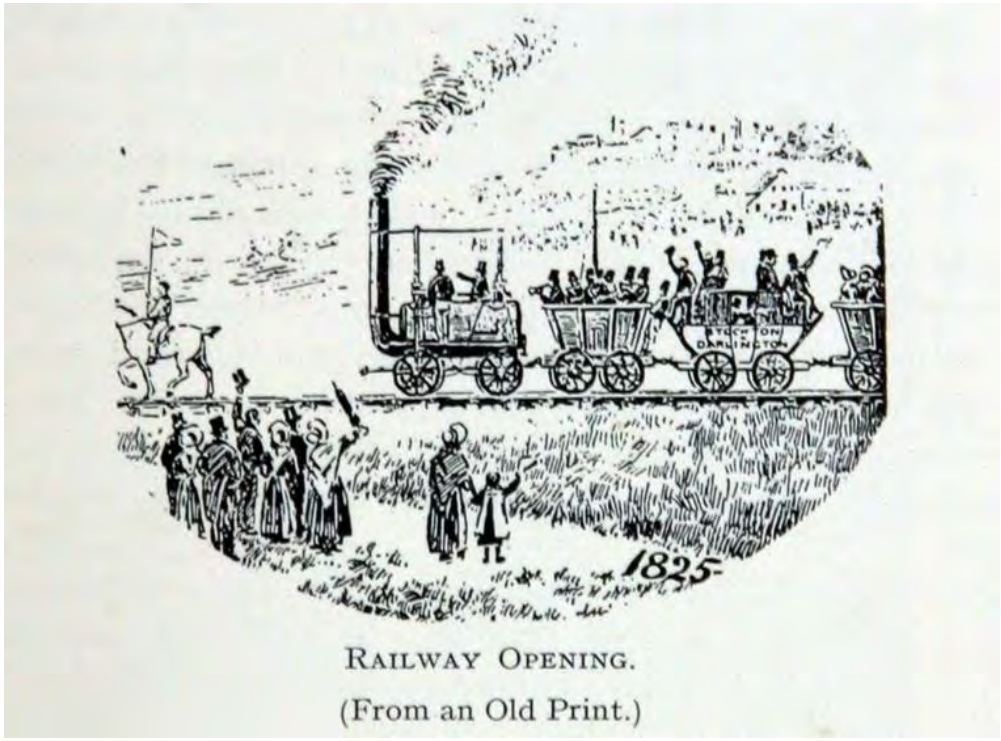

Fig. 1.6 Contemporary illustrations of the opening of the Stockton & Darlington Railway on September 27th 1825 (3).

[Robert Young, *Timothy Hackworth and the Locomotive*, London, 1923, p.113]

In pursuing the actual arrangement of the locomotive's driving motion, an important question, looking forward, is why the *Active* was able to perform so well on the opening day of the railway, but the operation of the second new locomotive just a few weeks later was a failure requiring considerable remedial work (below & Section 2).

It is remarkable to note that, just nine days after it was delivered, *Active* performed so well with the opening day special train, hauling about 80 tons without any reported difficulties, and earning the admiration and appreciation of the S & D R directors.[26] Just three days later, on the 30th September, the Sub-Committee invited Robert Stephenson & Co. to quote for two further locomotives.[27]

In sharp contrast, however, the second locomotive (the Stephenson Company's Travelling Engine (T/E) No.4), which was finally completed and delivered just five weeks later at the end of October 1825 (invoiced on the 1st of November)[28] was anything but successful. At the time of its completion Stephenson had been obliged to travel all the way to Canterbury with John Dixon.[29] This was to install him as Resident Engineer of the Canterbury & Whitstable Railway to commence laying out that line following enactment of the company's first Parliamentary Bill. Stephenson was thus not present in the factory to ensure that the parallel motion on the second locomotive was properly tested, and any snags put right.

As a result, when the locomotive was tried out on the S & D R line it was immediately shown not to operate at all well. The railway's Sub-Committee discussed this setback at its meeting on the 11th of November:[30]

> This Committee feel very much dissatisfied with the manner in which Messrs. Stephenson & Co. have delivered the last locomotive engine on account of its very imperfect state the smiths having been employed a whole week before it could be got to work. Richard Otley is directed to inform them of the same…

That the second locomotive was so poor after the success of the first, was inexplicable to the directors who, a week later, further expressed their annoyance:[31]

> Resolved That Robert Stephenson & Co. be requested that in any engines they may furnish us with not to send any engines with new and experimental apparatus that such fitting up as hath been tried and approved already….

Hence it is clear that some significant changes had taken place between the first two locomotives sent out by the Stephenson Company, and that the parallel motion was fitted to the second and subsequent locomotives rather than on the *Active* itself. In this regard it may be noted that James Kennedy left the Stephenson Company's employment very shortly after the completion of the second locomotive, without working any notice. Although this suggests some disagreement with Stephenson, perhaps over the new motion arrangement, no evidence has been located to understand the precise reason or date for his ceasing employment at the Newcastle factory.

Kennedy's departure left the works without adequate manufacturing supervision, leaving Stephenson in a dilemma regarding the time he should spend there and the several other

commitments he had elsewhere. He was therefore obliged to seek, very quickly, a replacement foreman to supervise the work of the factory. On the last day of October, he wrote in some desperation to Galloway, Bowman & Glasgow of Manchester, seeking a candidate for the foreman's position:[32]

> Could you procure for me a person capable of taking the charge of a Steam Engine manufactory in my absence? He must thoroughly understand the Steam Engine building, and would be preferred if he also understood the conducting of a Foundry….. If you can procure me such a person, it will confer on me an incalculable obligation.

This approach, and perhaps further ones to other manufacturers, was unsuccessful, but subsequently the very competent William Hutchinson was promoted to the position of works foreman.

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The conclusion is that *Active* was dispatched from the Forth Street factory in Newcastle with its crossheads guided by vertical slide-bars, and without the parallel motion that Stephenson had sought. Some evidence of this form, albeit not wholly reliable, may be seen in the detail of the views shown in Fig. 1.7.

Fig. 1.7 Three contemporary images of the special opening day train hauled by *Active*. In each case the motion apparently shows slide bars for each cylinder above the boiler. [Images from Figs. 1.4 to 1.6 – details]

The close-up drawing of the train reproduced in Fig. 1.4 has clearly been copied from the drawing of Stephenson's patent locomotive with steam springs used on the Killingworth Railway, but with the specific omission of its surging chain. It is therefore possible that this sketch had been made copying the form of locomotive then being used on the Killingworth and Hetton colliery lines, and is not necessarily representative of *Active*'s appearance at the opening ceremony.

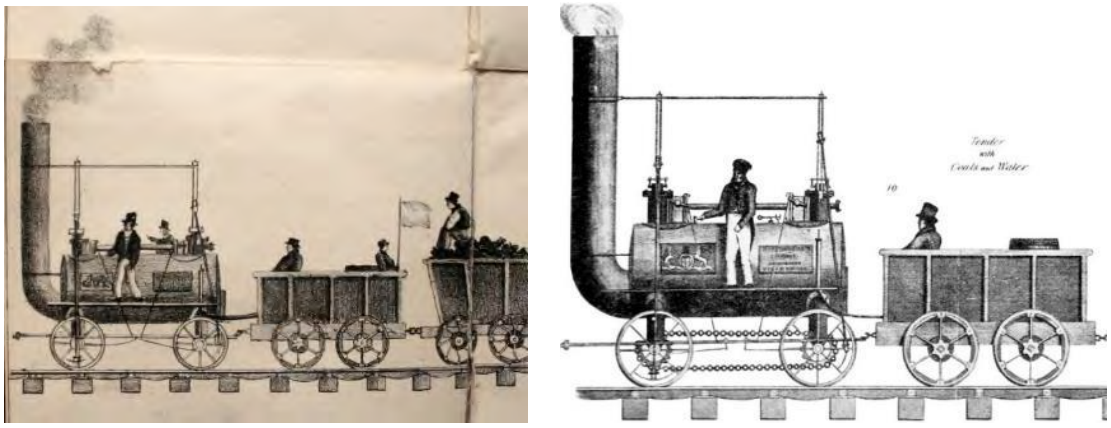


Fig. 1.8 (Left) Detail of Fig. 1.4 showing the *Active* and tender. The sketch has apparently been modified from an earlier sketch published in Newcastle (Right) of Stephenson's patent locomotive.

Further evidence suggesting that *Active* had been built incorporating slide bars and crossheads may be seen regarding the first two locomotives that had been ordered from the Stephenson company in approximately July of 1824. Both had been ordered by Lord Ravensworth & Partners for use at their Mount Moor colliery railway at Springwell in County Durham. With the subsequent order of the two locomotives by the S & D R, priority was given to these latter, and manufacture of the Mount Moor locomotives (T/E Nos. 1 and 2) was postponed. They were eventually delivered in April 1826. It is noteworthy that they were fitted with slide-bars and crossheads rather than parallel motion, confirming that this earlier Killingworth type practice had been perpetuated into the first products of Robert Stephenson & Co.

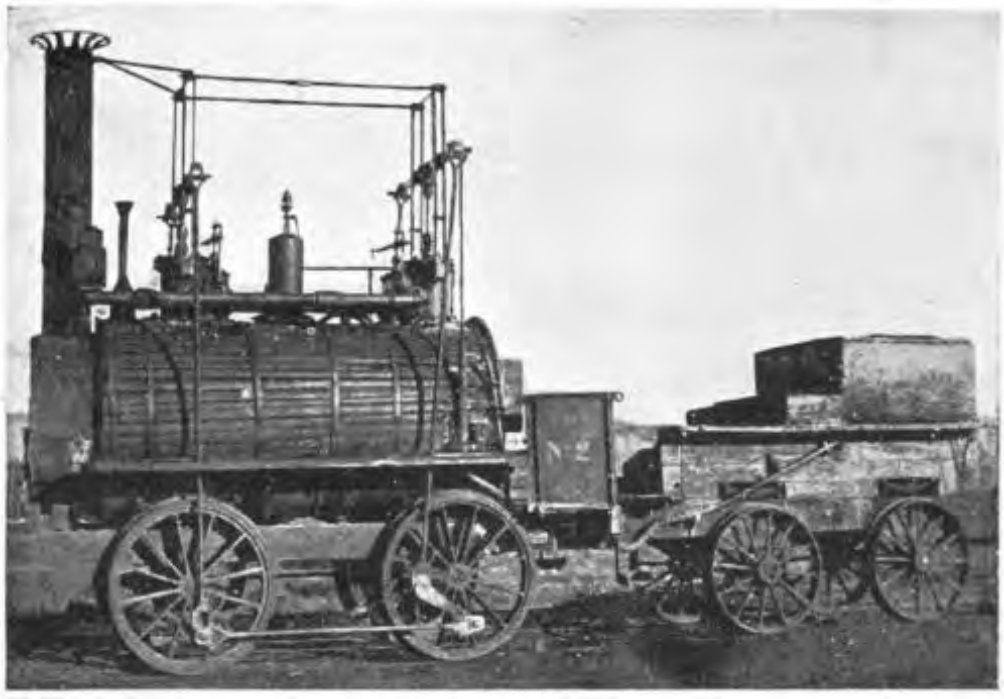


Fig. 1.9 Mount Moor Colliery locomotive No. 2, believed to be T/E No. 2 completed by Robert Stephenson & Co. in April 1826, with slide-bar motion.

[NRM, Bleasdale Collection; Photographed by R.H. Bleasdale in 1862].

In the absence of specific evidence, however, the possibility remains that *Active* was fitted with parallel motion from the outset, and that William Newton's description of the parallel motion was accurate.

Also, in early 1827 the first six locomotives on the line were witnessed by two visiting Prussian engineers who recorded in some detail what they saw.[33] These would have been the first five locomotives built by Robert Stephenson & Co., together with the experimental locomotive, nicknamed the *Chitapratt*, built by Robert Wilson, also of Newcastle, which had been under trial on the line. The Prussians collectively described the five Stephenson locomotives as having, without exception, "crossbars", "half-beams" and "counter-rods", confirming the use of parallel motion. However, with variations known to have been made between *Active* and the later locomotives, the Prussians may have been merely describing the later four examples as the prevailing design standard of locomotive and didn't complicate their account by separately describing the *Active*.

2. Operating Career 1825-1828

The 'improved Travelling Engine' (R. Stephenson & Co. Travelling Engine (T/E) No.3), nicknamed the *Active,* was completed in the second week of September 1825. It was successfully 'tried' at the Forth Street works on the evening of the 12th, as communicated by George Stephenson to Joseph Pease.[34] Such was the urgency to open the railway that, even before the locomotive had been delivered, Pease promptly issued an invitation on behalf of the railway's proprietors to an extensive guest-list to announce that the railway would be opening on the 27th of the month:[35]

> The Stockton & Darlington Railway Co.
>
> The Proprietors of the above concern hereby give notice that their main line of Railway commencing at Witton Park colliery in the West of this County and terminating at Stockton upon Tees in the East, with the several branches to Darlington, Yarm &c being about 27 miles in extent will be formally opened for the general purpose of Trade on the 27th Inst.
>
> It is the intention of the Proprietors to meet at the permanent Steam Engine erected below the Town at Brussleton near West Auckland and situate about nine miles West of Darlington at eight o'clock a m and after inspecting their extensive inclined planes there proceed at nine o'clock precisely by way of Darlington & Yarm to Stockton upon Tees where it is calculated they will arrive about one o'clock.
>
> An elegant dinner will be provided for the Company who may attend by Mr. Foxton in the Town Hall Stockton at three o'clock to which the Proprietors have resolved to invite the neighbouring Nobility & Gentry who have taken an interest in this very important undertaking.
>
> Any Gentleman who may intend to be present on the above occasion will oblige the Company by addressing a Note to their office Darlington as early as possible.
>
> A superior Loco Motive Travelling Engine on the most improved construction will be employed with a train of convenient carriages for the Conveyance of the Proprietors & Strangers.
>
> Railway Office
> Darlington
> September 14 1825

The *Active* was immediately made ready for delivery, being said to have been 'brightly painted', although there was no indication of the colour scheme that was chosen.[36] Sometime after the opening 'she lost her gaudy colours'. The use of the name, *Active*, during her time on the railway was apparently universal. Fifty years later it was publicly noted:[37] 'Thus did the primitive engine of the line … justify the name she long bore - "The Active".

It was loaded onto a road 'dray', provided by the Pickersgill company, to convey it to the Stockton & Darlington Railway on Thursday evening, the 15th. It departed behind an eight-strong team of Pickersgill's horses, on Friday morning, the 16th September. The trailer was

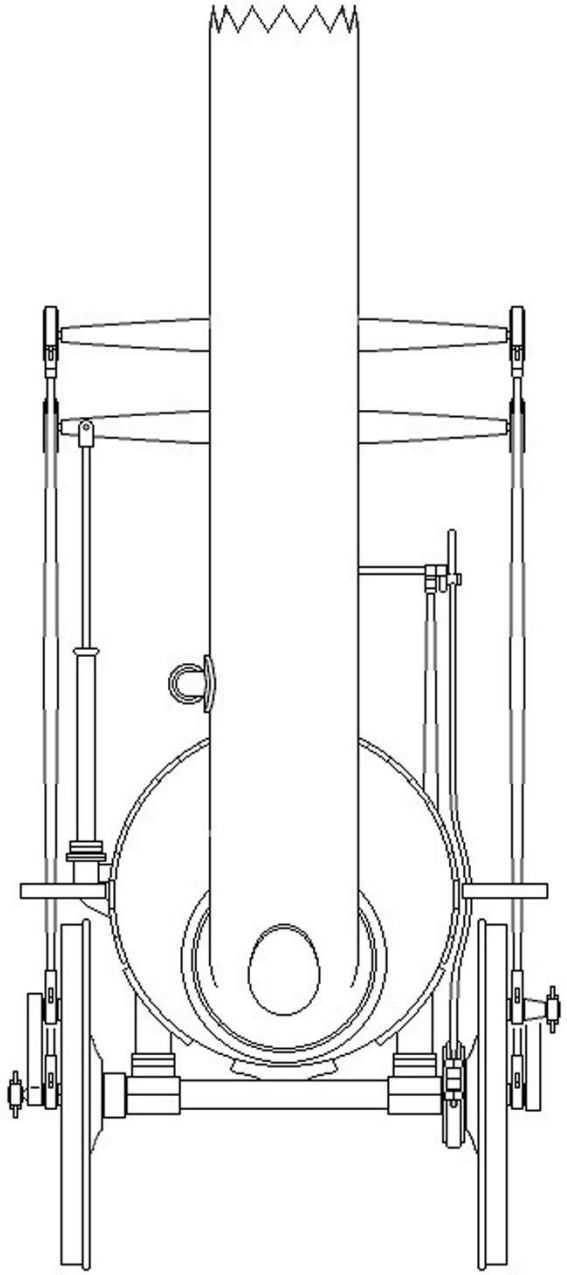


Fig. 2.1 (a) Conjectural front view of *Active* when first made in 1825

hauled to Aycliffe Lane, near Heighington village on the line of the Stockton & Darlington Railway, about 3 miles the Darlington side of Shildon, arriving on or about the 18th September. Its arrival was witnessed by many people who turned out to witness 't'iron hoss', many of whom assisted with the removal of the locomotive from the dray onto the track. They included two brothers, Robert and James Robinson who recalled their experience fifty years later in the *Northern Echo*.[38]

The crowd included three other lads, aged about 13, including one Crawford Marley.[39] When the engine had been placed on the rails, the lads were asked by George Stephenson's elder brother, James (1779-1847), who was supervising the operation, to help fill the boiler with water. They ran to a nearby farmhouse to borrow some buckets and filled the boiler with water from a nearby spring. Also, some years later, the endeavours to light the fire were recalled by a labourer, Robert Metcalf, who was employed on the line:[40]

> No.1 came to heighton (*sic*) lane by road we had to get her on the way when we got her on the way we pump water into her we sent John taylor for a lantern and candle to acliffe when we done that I thought I would have my pipe it was a very warm day though it been back end of the year I took me pipe glass and let me pipe I thought to myself I would try to put fire to Jimmy ockam (oakum, *ie* flax fibres soaked in pine tar) it blaze away well the fire going rapidly lantern and candle was to no use so No.1 fire was put to her on line by the pour (power) of the sun 8 waggons was as many she could trail….

Once steam had been raised, Crawford Marley and his two unnamed friends, who had helped with the watering, were given a ride on the locomotive…. the railway's first passengers.

A tender was provided, but the manufacturer of the chassis went un-recorded. It contained a 'huge water barrel' that was made by Mason Brotherton of Blackwellgate, Darlington. The barrel was so large that it had to be erected outside in the street as it would not have been possible to have got it through his gate.[41]

After a few days of trial running, a special train was run from Shildon to Darlington and back for the benefit of some of the railway's directors on Monday evening, the 26th September.[42] In addition to George Stephenson, the party was composed of Edward Pease, his three sons, Edward, Joseph and Henry, Thomas Richardson and William Kitching who rode in the company's carriage *EXPERIMENT* which had only arrived by road from Newcastle that day. The train was driven by James Stephenson, who went on to be the regular driver of the locomotive for the first couple of years (Section 6).

Notification of the opening of the S & D R, on Tuesday, 27th September, had been prepared in the form of a printed notice, for circulation to the press and public, dated eight days before, on the 19th.[43] On that day a special train was laid on to travel between Brussleton Plane and Stockton for the benefit of directors, guests, employees and associates, but it was soon apparent that many uninvited people would seek to obtain a ride as well, on what was seen to be a momentous occasion. The train was made up of wagons and the passenger carriage, assembled at the bottom of the Brussleton incline. The locomotive, 'looking very bright in her coat of fresh paint',[44] on that day driven by George Stephenson himself, accompanied by his brother, James, and fired by William Gowland, was coupled up to the train, which was made up as follows:[45]

Five waggons loaded with coal, with passengers sat on the top

One waggon with sacks of flour, with passengers amongst them

One waggon with 'surveyors and engineers'

EXPERIMENT passenger carriage in which the railway's directors and 'other proprietors' were seated

Six waggons filled with 'strangers'

Fourteen waggons filled with workmen and others

Six waggons loaded with coal with passengers sat on top

Although only 300 tickets had been circulated,[46] the total load, with nearly 700 passengers, came to about 80 tons. The *Active* was said to have achieved a speed of ten to twelve miles per hour on the first part of its journey to Darlington. The train was followed by 24 further waggons drawn by horses, which contained 'workmen'.

The train took two hours to reach Darlington, having been delayed three times by problems. Firstly, the wagon containing the 'surveyors and engineers' twice had a problem with an axle. The vehicle then had to be detached and left in one of the passing loops, but in doing so a bystander was struck by the vehicle and sustained a minor injury.[47] The other problem was with the feed-water pump on the loco. which was apparently dealt with after half an hour's delay, some oakum having to be cleared out.[48] On arrival at Darlington the six waggons at the rear were dropped off, and the coals they contained distributed amongst the poor. Two additional waggons were then attached, providing accommodation for members of the Chairmen's band, who played 'cheering and appropriate airs' between Darlington and Stockton.

Fig. 2.2 Contemporary lithograph of the opening day of the Stockton & Darlington Railway

[Fig. 1.4 An Account of the Stockton and Darlington Rail-Way, 1826 - detail]

The train proceeded towards Stockton at an average speed of about four miles per hour, stopping only at Goosepool, to take on more water. The final downhill gradient towards the Tees at Stockton was taken at a speed of 15 or 16 miles per hour. Arrival in Stockton was 3 hours 7 minutes after departing Darlington, the whole spectacle having been watched by an estimated 50,000 people at the trackside.[49]

No revenue movements were recorded for the railway on the day after the opening, the arrangements for operating a service, together with horse haulage, no doubt needing to be properly set up in conjunction with the coalmine owners. Initial movements of coal were to Darlington and Stockton, for land-sale. On Thursday, 29th September, movements of coal on behalf of New Etherley Colliery were undertaken to Darlington only, in addition to four tons of coal for the locomotive itself.[50] On Friday, 30th September, the locomotive moved 30 tons of coal on behalf of the Old Etherley Colliery from Brussleton to Stockton for land-sale.

In early October the locomotive broke one of its cast iron wheels and an urgent call for a replacement was made to the Stephenson Company.[51] With the Stephenson foundry being too busy with other castings for the Stockton & Darlington Railway, Michael Longridge issued instructions for the Bedlington Iron Co. to undertake the work quickly.[52] A fresh set of wheels was cast at Bedlington and sent to Shildon on the 10th of October,[53] and the locomotive was back in service on the 12th/13th of the month.

To cover for the unavailability of the locomotive, several horses had to be substituted, and to meet the railway's urgent requirement for the second locomotive, T/E No.4 was despatched by the Stephenson Company on the 1st of November 1825. Such had been the rush however, that it was not finished to a standard suitable for service and required urgent modification (Section 1).[54] *Active* therefore had to soldier-on on its own until the end of November before the coal movements could be shared between the two locomotives. Both locomotives required considerable maintenance to replace and repair broken and bent components arising from the dynamic forces incurred in operating the services over imperfect track.

The wheels therefore continued to give trouble and by the 15th November Hackworth was obliged again to report to the railway's officers that:[55]

> I am desired to inform you that one of the wheels belonging to the Locomotive Engine is so much wore that 'tis unsafe to venture with it another journey. It nearly got off the axle today while on her way to Darlington we expected to have had a duplicate set of wheels and axle before now as Huntley knew the state we were in before he left. If they are ready do not lose one moment in sending them off. If the ventelator (*sic*) is done send it with them.

By the 25th November, the position had deteriorated further. The Sub-Committee of directors recorded that:[56]

> Innumerable accidents and inconveniences having arisen from some defects in the Locomotive Engines and this Committee considering the great expences they have incurred in alterations and repairs fall generally on Robt. Stephenson & Co. direct the Clerk to make out an account of the expenditure and to transmit the same to them, and request they will protempore place a Smith or person sufficiently acquainted with

> Locomotive Engines at Brussleton or elsewhere in order to superintend the alterations and repairs which attach to the said engines on account of this not being perfect and complete when set at work

The problem with the wheels was addressed by George Stephenson who then tried out a wheel that was stronger than the earlier ones that had given such trouble. In January 1826 he wrote to Timothy Hackworth:[57] "How does the new plan of wheels do? Is there any appearance of working loose? How does the old engine get on?"

The new design of wheels seems to have been successful and the reliability of the two locomotives began to improve, and the coal-haulage service began to pick up.

The first shipping staithe at Stockton was not opened until January 24th 1826, for the commencement of 'export' coal shipments to the south-east of England.[58] Two further locomotives (T/E No.5 & T/E No.6) were despatched from Robert Stephenson & Co. on the 17th April and the 18th May 1826.

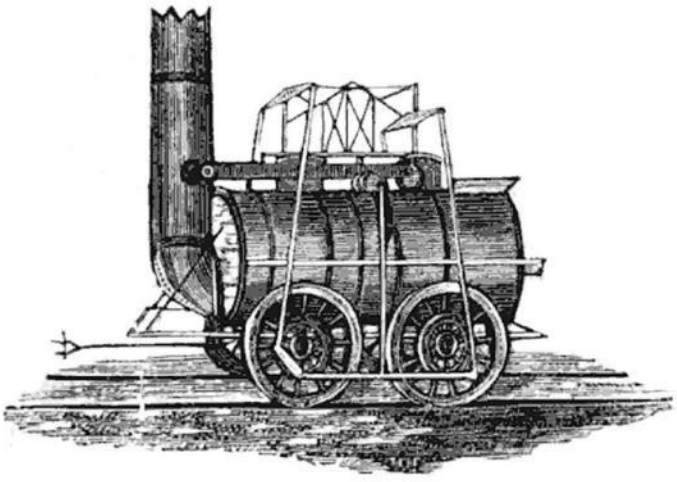


Fig. 2.3 Early view of a Stephenson-built locomotive for the S & D R.

[The Parochial History and Antiquities of Stockton Upon Tees, by Rev. John Brewster, 1829, p. 479]

Operations on the line for the four locomotives from 1826 were composed of coal movements from:

Brussleton Plane to Darlington (land-sale): 8½ miles
" " " Fighting Cocks (land-sale): 12 miles
" " " Goosepool (land-sale): 14 miles
" " " Carters Lane (land-sale): 14 miles
" " " Early Nook (otherwise Urly Nook or Urlay Nook) (land-sale): 16 miles
" " " Yarm Branch (land-sale): 16½ miles
" " " Yarm township (land-sale): 17½ miles
" " " Penney Pot Gate (land-sale): 18 miles
" " " Potatoe Hall (land-sale): 18 miles
" " " Stockton township (land-sale): 20 miles
" " " Stockton staithes (export): 20 miles

The operations with loaded coal eastbound and empty waggons westbound were fitted in, without a timetable, together with horse-drawn movements of coal and empties, along the single track with passing loops at intervals. This led to several delays, as movements conflicted. As trains approached each other, the later movements approaching the mid-point of a single-line stretch, marked by a post, were required to reverse back to the passing place in the rear.[59] This was an awkward movement for horse-drawn operations, which incurred severe delays, and often resulted in derailments. The introduction of horse-drawn passenger services from October 1825, exacerbated the problem.

One of *Active*'s drivers described the locomotive as 'not having much power', but it was, nevertheless, 'a very good engine', which 'lasted well, considering how often she got off the line'.[60] Its speed was typically five miles an hour when hauling sixteen wagons.

The drivers of the locomotives, contracted by the company to operate the services, were subject to the management of the Locomotive Superintendent, Timothy Hackworth. *Active* was driven by James Stephenson, the second locomotive by Robert Murray, the third (from April, 1826) by William Gowland, and the fourth (from May, 1826) by Michael Law (Section 6).[61]

New workshops to maintain and repair the locomotives were set up at Shildon. They were still being built in January 1826, prompting George Stephenson to enquire of Timothy Hackworth:[62] "I hope by this time you have got the Shops covered in; so as to get the engines under cover to repair there."

The coal traffic grew significantly during 1826, *Active* alone had drawn 1,583 tons of coal from Brussleton Plane for six destinations along the line in the month of October, accumulating some 24,591 ton-miles in that period.[63] Thomas Storey (1789-1859), the S. & D. Ry.'s engineering superintendent, undertook a survey of the line's operations at the end of 1826, and calculated that (on average) "One Locomotive Engine will perform 6 Stockton and Yarm journeys and 3 Darlington journeys each week at 45 tons each journey or 405 tons per week and at 50 weeks per annum: is equal to 20,250 tons. Therefore 3 engines should perform the whole leading of Coals…. Also one Duplicate Engine."[64]

A further analysis was undertaken in time for the annual meeting of the railway's proprietors on 10th July 1827. It concluded that:[65] "Each of the (locomotive) Machines … draws after it 20 waggons and frequently 24…. and forming in all a mass of 77 tons in the one case, and 92 in the other…"

A fifth locomotive of similar design, again with parallel motion, was delivered by Robert Stephenson & Co. in March 1827 (T/E No.7). Its driver was John Cree.[66] The growing locomotive fleet needed ready identity, and, by the October of 1827, they began to be referred to in company records by numbers allocated in the order of their delivery. *Active* was thus referred to as 'No.1' in the railway's documentation thereafter.

No.2 received "grievous injury" on October 1st 1827 at Stockton wharf. It had been "wantonly set off, in consequence of which it was exceedingly injured and other serious damage along the wharf at Stockton".[67] However, the railway's sub-Committee considered that the fireman was to blame for the incident and that he had tied down the safety valve when the locomotive was stationary.[68] It had become common practice for the train crew to tie down the weighted safety valve lever arm whilst on the move, to stop its oscillation. The

fireman was promptly discharged. The Sub-Committee immediately issued an order for all drivers: "this Committee directs that a fine of 10/- be imposed on any Engine Man who shall dare to fasten down the safety valve when the Engine is at rest…." The indications are that, due to the extensiveness of the damage, this locomotive was withdrawn from service from this time and dismantled.

On November 23rd, Hackworth was instructed to obtain a small jack-screw for each locomotive, presumably to assist with any derailments that might subsequently occur.[69]

On Monday 19th December 1827, James Stephenson's locomotive, almost certainly No.1, broke a crank at Darlington, and he spent the next day helping to repair it.[70]

The railway achieved 307 days of coal movement during 1827.[71] Some details of the ton-miles of coal that was hauled by No.1 during 1826 and 1827 have survived in the railway's archives. The incomplete records show that 25,000 ton-miles were being achieved in some months, mostly conveying coal from the bottom of Brussleton Bank to Stockton, Yarm and Darlington.

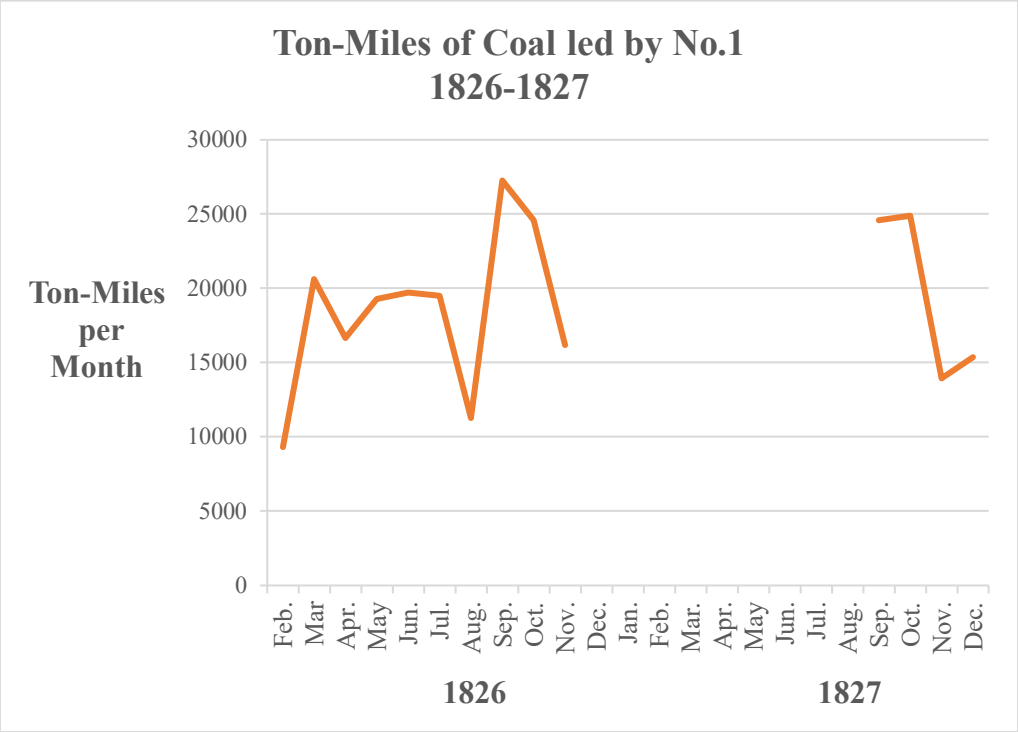


Fig. 2.4 Ton-Miles of coal led by No.1 in 1826 and 1827 – (blank entries = missing data)

[Source: NA, RAIL 667/1527 and 667/1529]

John Cree had taken over as No.1's driver by the 19th March 1828, by which date James Stephenson was driving No.5 locomotive.[72] It was on that date that the flue-tube of No.5 locomotive imploded, severely scalding John Gillespie, who was blown 24 yards away from the engine and badly injuring another employee who broke a thigh.[73] Stephenson had secured the safety valve expecting a continuous run with a loaded train through a single-track section of the line. He was, however, delayed by seven horse-drawn movements of empty

wagons returning to Brussleton and, whilst trying to sort out the congestion, had omitted to release the safety valve.

The rupture might have indicated a stress weakness between the flue and the backplate, and the sub-Committee resolved:

> that in future the Engines belonging this Co. be tested every four months at Shildon by a pressure of Water at least 10 lbs over and above the maximum allowed by the safety valve."[74]

The sub-Committee went on to insist that a 10-shilling fine be levied on any driver who left his Locomotive unattended by at least an "approved fireman when ever there is a fire under the grates".

George Stephenson was immediately informed by letter written by Edward Pease, to which he replied on the 23rd March from Liverpool:[75]

> The account of the accident with the Loco-motive Engine has hurt me very much – As I expect Robert here either to night or tomorrow I merely write this to day that something must be done to the other engines immediately to prevent a similar accident –
>
> If a short pipe of about 3 inches diameter is put upon the top of the Boiler where it is out of the way, with a copper cap screwed on the top of the pipe, only of a sufficient thickness to bear a pressure of 20 lbs per inch more than is intended to be used the cap will give way before any other part of the Boiler and the steam and water will be discharged into the atmosphere the exact strength of the copper can be tested by the hot water Pump – I shall immediately on Robert's arrival here, call his attention to this point -

A like for like replacement flue was ordered for No.5 by Hackworth from Robert Stephenson & Co. in Newcastle on May 14th/15th 1828.[76] This was quickly made, weighing 16 hundredweight 2 quarters and 1 pound. The invoice was issued the following month.[77]

On June 8th 1828 the company decided to discontinue the use of horses for coal movement, although they were to be used to move any residue if the locomotives were fully employed.[78]

On July 1st 1828 the boiler-flue on No.1 itself then collapsed, fatally wounding the driver, John Cree, who died on July 3rd.[79] The locomotive had been working a loaded train from Shildon and had stopped to replenish water at Aycliffe Lane. The person assisting at this point was also injured. There are no records to say whether or not No.1 had been pressure tested beforehand in accordance with the sub-Committee's order of March 21st.

The implosion of No.1's fire-tube was the third event of its kind, (for locomotives Nos.1, 2 and 5) in 7 months. In a letter George Stephenson questioned Hackworth about locomotives being 'laid off' by the S & D R in favour of horses, a false rumour having been set about by Thomas Brandreth in Liverpool, and causing Stephenson to comment "It was a great pity that these accidents took place with the tubes".[80]

3. Increase in Boiler Heating Surface 1827-1833

Locomotives Nos.1-5 on the line had boiler barrels which were 4 ft diameter and 11 ft 6 in long containing single flues of 25 in diameter, providing a heating surface of 75 square feet.

A question has arisen about the diameter of the boilers of these five locomotives. The visiting Prussian engineers in 1827 recorded that these boilers were 4½ ft diameter, and that the connecting rods were 8 ft long.[81] In preparing Fig. 2.1 it was found that these dimensions are mutually incompatible; either the rods needed to be longer, or the boiler diameter needed to be smaller. The pre-production drawing, Fig. 1.2, shows a boiler with a diameter of only 4 ft, and this is argued to be the correct size for these five locomotives. Fig. 2.1 shows that connecting rods that are 8 ft long fit well with a 4 ft diameter boiler.

In December 1825, the railway took delivery of a further locomotive on four wheels, built by Robert Wilson of Forth Street, Newcastle. The railway company agreed that the locomotive could be tried out on the line to see if it could provide benefits for the railway, over and above the performance of the Stephenson locomotives. It was nicknamed the *Chittaprat* by the footplatemen who drove it on the trials, the name apparently derived from the exhaust sound of its four outside vertical cylinders driving the rear axle.

Hackworth oversaw the trials, which did not demonstrate a reliable design and, after trials lasting three or four months, it was withdrawn from service and laid off in the yard outside Shildon's workshops. *Chittaprat*'s boiler was seen by two Prussian engineers when they visited the railway in March 1827 to take notes and measurements of all they saw.[82] They wrote in their report that it offered a larger heating surface than the Stephenson locomotives, having a return-flue within its boiler (10 ft 10 in long x 4 ft 4 ins diameter). The fire-tube was 26 in diameter reducing to 18½ inches diameter for the return flue, providing a heating surface of c125 sq ft.

Although no action was taken for a year or more, the increased heating surface of this boiler apparently gave encouragement to Hackworth to re-use it on a new and larger locomotive that he was considering assembling at Shildon. He had the length of the boiler and its return-flue increased, which he then placed on three axles. The heating surface of this locomotive, named *ROYAL GEORGE*, exceeded 150 sq ft. The heating surface increase, together with the additional adhesion of the six wheels, made it significantly more powerful than the earlier Stephenson locomotives.

Thereafter opportunities for the fleet to benefit from the adoption of return-flues was taken. When No.1 burst its flue on the 1st of July 1828, Hackworth took the opportunity to expand upon the benefits of the return-flue boilers to seek to develop yet more heating surface by trying out a replacement boiler with a double return-flue. He visited Robert Stephenson & Co.'s factory in Newcastle, a day or two before the 23rd September 1828, to discuss a number of matters including the design of a double return-flue boiler, which he then ordered from the Stephenson company.[83]

The boiler diameter, increased by 6 in to 4 ft 6 in, was made accordingly and was delivered during November 1828. The recent trio of flue failures made Hackworth cautious for the future, and he also ordered a duplicate return-flue for the loco. in case there was a repetition of the flue collapsing.

Under the date of the 19th November, the invoice was made out for the boiler and double return-flue (weight 3 tons 6 cwt 3 quarters and 27 lb), together with the duplicate flue (weight 1 ton 13 cwt and 13 lb) for an overall charge of £175 3s 9d.[84] The invoice also included two chimneys (total weight 7 cwt and 2 lb) for a charge of £14 0s 8d., and a stay in three pieces (weight 3 qr 6 lb) for a charge of £1 17s 8d. The rivets were also charged for separately (weight 2 qr 14 lb) for £1 1s 10d.

The duplicate double return-flue compared with the single-flue replacement for the No.5 locomotive just six months earlier which for its weight (16 cwt 2 qr and 1 lb) and six pieces of flange, was charged out at £28 1s & 4d.[85]

The boiler was fitted to No.1 at Shildon workshops, and, from December 1828, it operated with two chimneys, which exited the back-plate above, and to both sides of, the fire-hole door. It provided approximately153 sq ft of heating surface, an increase of about 80 per cent compared with the previous 75 sq ft. of the original single-flue. It operated with two tenders, one with a water barrel at the front, and the other with a coal supply at the back. The boiler apparently performed well as the double return-flue remained with the locomotive for the next five years. The French engineer, Chevalier F.M.G. De Pambour, was provided with a list of the Stockton & Darlington Ry. locomotives, and the work that they had undertaken during the five months between July and December of 1833, which he published in his book on British locomotive performances in 1835/6.[86] He identified No.1 as still having the double return-flue boiler in that latter part of 1833.

A return-flue was adopted for the later 0-6-0 locomotive, *ROCKET*, built by the Stephenson Company (T/E No.15) for the S & D R, and delivered in September 1829 as its No.7. It was also adopted by Hackworth for his *SANS PAREIL* locomotive which competed in the Rainhill Trials in 1829.

The successful introduction of multiple copper flue-tubes, with a further significant increase in heating surface, on the Stephensons' 0-2-2 Rainhill Trials locomotive, *ROCKET*, was followed by a general installation of multiple tubes on later locomotives, including those subsequently built for the Stockton & Darlington Railway. Larger six-wheeled locomotives, commencing with *MAJESTIC* and *CORONATION* built in 1831, had boilers built by the Bedlington Iron Company with single central flues and multiple copper return flues, with further significant increases in heating surface to approaching 300 sq ft. One of the earlier Stephenson 0-4-0 locomotives, No.4, by then named *DILIGENCE*, was given a similar new boiler in December 1833, with a heating surface of 398 sq. ft.[87]

4. Operating Career 1828-1834

No.1 commenced operation with its 4 ft 6 in diameter replacement boiler with double-return flues and chimneys, from the end of 1828 (Fig. 4.1). To provide the draught for the two flues, new vertical cylinders, again fitted within the boiler crown, were cast with exhaust flanges bolted to the two exhaust pipes, fitted on both sides of the boiler centre line.

Parallel motion was fitted. The parallel motion of the other Stephenson-built locomotives had required a lot of maintenance and skill in setting up reliably, but by the time of No.1's rebuilding, enough experience had been gained to encourage Hackworth to adopt it. Locomotives Nos. 3 to 5 were renumbered 2 to 4, and *ROYAL GEORGE* was numbered 5.

Nevertheless, by the date of this rebuilding the Stephenson Company had completed its Travelling Engine No. 8 for the S & D R, (the railway's later No.6), known as '*Experiment*'. Delivered in November 1827, this locomotive abandoned vertical cylinders and parallel motion in favour of horizontal internal cylinders fitted through the backplate of the boiler. Its motion was guided by a cross-shaft pivoted between brackets mounted on the boiler's backplate. The abandonment of the vertical cylinders was almost certainly an attempt to reduce the maintenance difficulties with the track, and the experimental nature of its drive motion gave rise to the locomotive's name.

By the end of the 1820s and into the early 1830s the volume of coal traffic to Darlington, Stockton, Yarm and the intermediate land-sale points had increased substantially, and, with its speed increased to eight miles per hour, with occasional occurrences of twelve miles an hour, No.1 played its full part in this workload.[88] The discontinuous contemporary records illustrate the ton-miles achieved by the locomotive between 1829 and 1833.

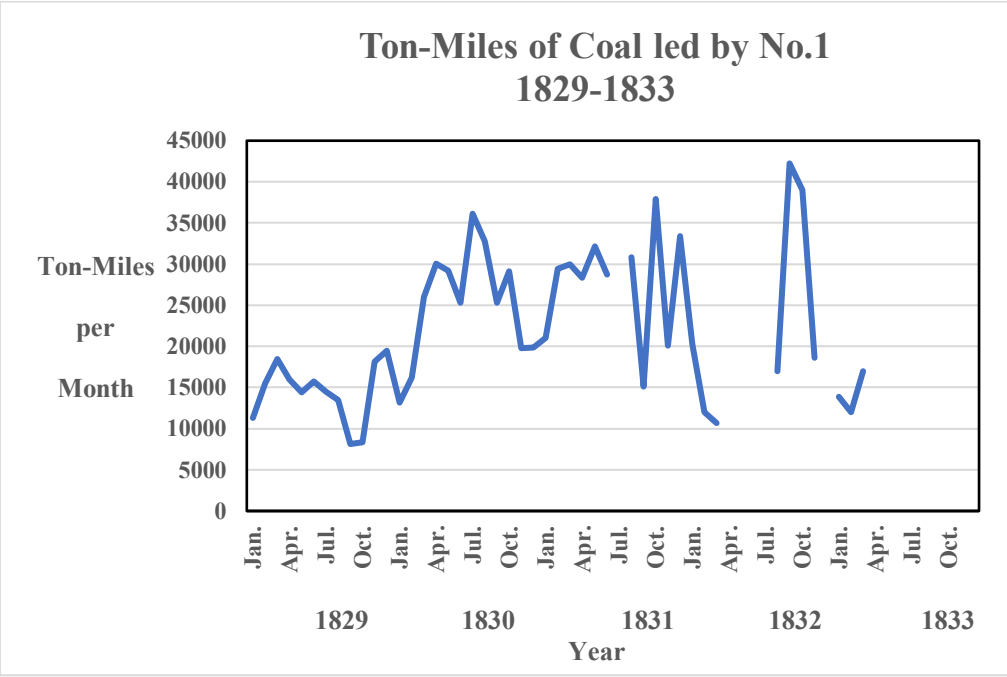


Fig. 4.2 Ton-miles of coal led by No.1 between 1829 and 1833. Gaps = missing data.
[Source: NA, RAIL 667/1299, RAIL 667/1452, RAIL 667/1453]

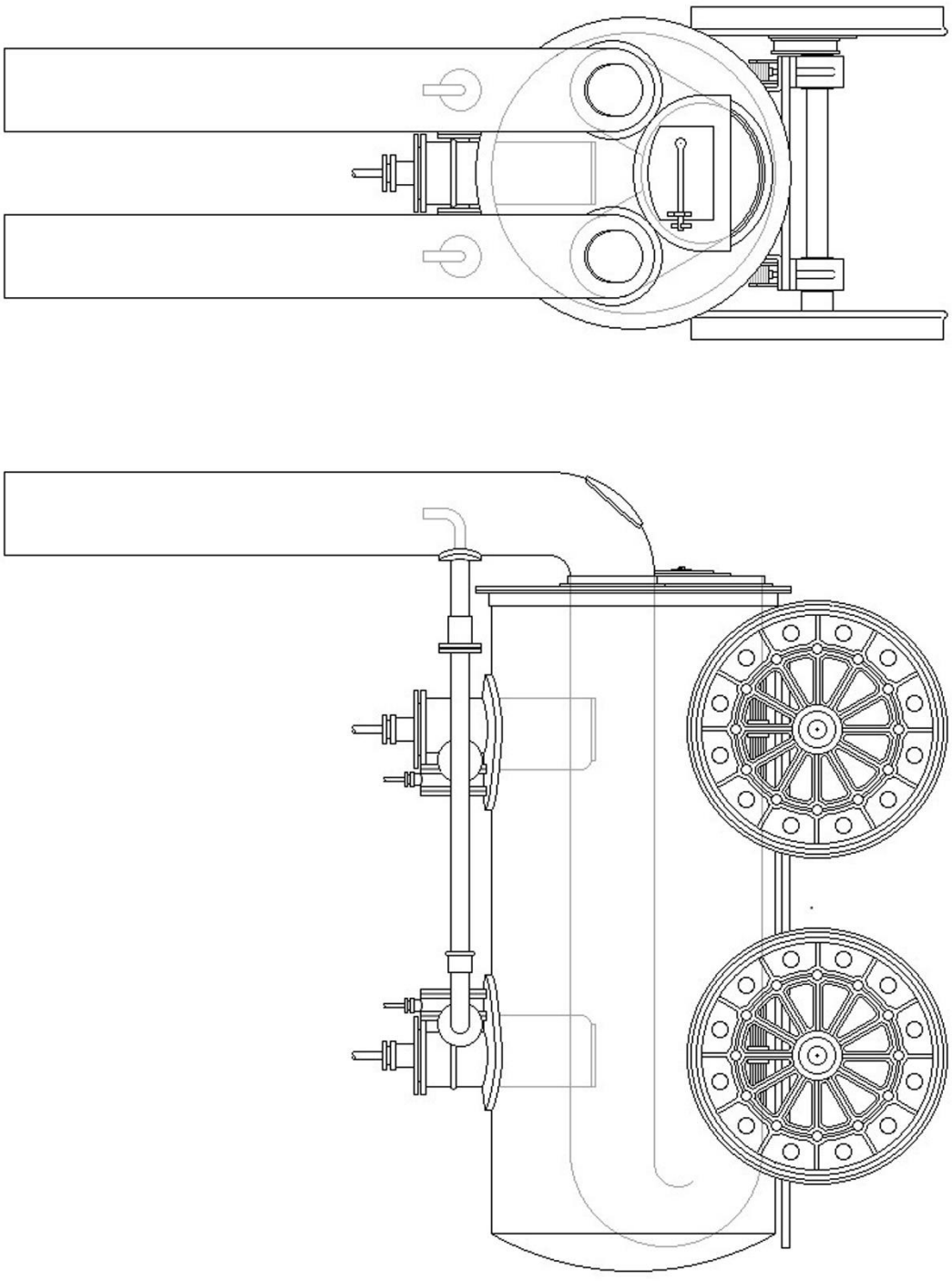


Fig. 4.1 Conjectural views of No.1 as rebuilt in 1828 showing replacement boiler, double return flue and chimneys (Parallel motion, connecting and coupling rods omitted)

By 1829, the route had become congested due to the delays caused by the single track and waiting time in passing loops. Also, the track was deteriorating unacceptably, caused by the un-sprung loads of the early locomotives, particularly on the inclines and curves. The railway took the decision in that year to lay a second line of rails linking the passing loops to increase the capacity of the route. The resulting doubling of the line to two uni-directional tracks increased the capacity of the route significantly, allowing an increase in the number of daily journeys that were undertaken by each locomotive. The increase in the monthly ton-miles achieved by No.1 increased from typically 20,000 to 40,000.

As coal traffic built up on the railway, delays were being recorded from the turn-round time, particularly at Brussleton Bankfoot. To speed things up, Thomas Storey was ordered to provide a coaling platform at that point to allow for rapid coaling of the locomotives.[89] Also to combat delays, Timothy Hackworth was instructed to engage two traffic despatchers, one for each end of the line, to supervise the speedy despatch and dispersal of coal waggons.[90] The problems persisted however and the directors ordered that, from August 1831, the engine men would be fined the whole charge of the empty waggon return-movements where they were undertaken by horse.[91]

A serious track-side fire occurred in June 1832, and an area of trees in a plantation was destroyed. The directors ordered Richard Otley, the Secretary, to write to the landowner:[92]

> That the Company feel most anxious to use the power they possess of employing Engines on their Railway with as much care and circumspection and as little injurious to Land owners as they possibly can.

The event led to a scramble for designs of spark arresters to try out on the locomotives to prevent a recurrence.[93] A few weeks later a successful design of wire mesh to cover the Chimney tops was concluded as being the best remedy for the spark problem.[94] All the locomotives were subsequently fitted with the wire mesh spark arresters.[95]

However, the matter was taken further by the landowner who resorted to taking legal action "against your Locomotive Engines" in the Court of Kings Bench in York.[96] The matter was considered by the Court over the next five months and in December 1832, the Company's Solicitor reported:[97]

> That the Locomotive Engines employed by this Company, have been declared by the Court of King's bench to be no nuisance.

In 1832 the railway also called in consultant engineers, John Birkinshaw and James Wakinshaw, to report on the state of the original rails and the best form of new track to overcome the problems.

The consultants reported that:[98]

> All the Rails appear wearing fast, and seem to suffer much from the heavy engines & the great velocity at which they travel….. The greatest number of faulty rails appear on the Inclines & at the Curves."

The original cast iron rails, fitted on the last mile of route into Stockton were "much broke" and badly needed replacing. The remainder of the track had been laid with 28 lb/yd wrought

iron rails, which were also wearing badly. Between the second and third mileposts over 10 per cent were "bad", with lesser proportions along the remainder of the route also being "bad". The consultants were:

> both of opinion that these defects are not in any degree owing to imperfection in the manufacture but are attributable to the quality of the No.2 Welch Bar Iron being so much deteriorated in consequence of the lowness of the prices.

The railway had commenced re-laying the track with replacement 32 lb/yd rails with half-lap joints, which were themselves giving trouble, and some recently laid rails were being supplied at 40 lb/yd to seek to accommodate the later, heavier coal-hauling locomotives, all of which were mounted on three axles to reduce their axle loading.

In 1833, the S & D R decided to add names to all its locomotives, in addition to the numbers they carried. The earliest written reference to the name *LOCOMOTION* for No.1 was in July of that year, but no evidence has been found to indicate whether nameplates were fitted from that time or if the name was painted on the side of the boiler.[99]

The issue of speed of the coal trains was again addressed in August of 1833 when Thomas Storey and Timothy Hackworth further considered the problem. They decided to recommend to the railway's sub-Committee that:[100]

> those Engines mounted upon Springs on all the wheels may travel at 10 miles an Hour, and those on 4 wheels and not having Springs on all the wheels, do travel at 8 miles an hour.

The railway company's long-standing aspiration for an extension of the line to Middlesbrough, to take advantage of deeper water there than was available at Stockton, could only be fulfilled by the erection of a bridge across the River Tees at Stockton. The expense of such a bridge would allow an increase in the size of vessels that could be loaded with coal and a shorter navigation time in the river. In 1828 the company had approached Captain Samuel Brown, RN (1776-1852) (later Sir Samuel Brown of Netherbyres), of Edinburgh, the designer of the first road suspension bridge (the Union Bridge) that was opened in 1820 across the River Tweed to the west of Berwick-upon-Tweed.

Brown discussed the proposal to erect a suspension bridge across the Tees with Joseph Pease Jnr. in Edinburgh, who reported back to the railway's sub-Committee in October 1828.[101] The bridge was estimated to cost £2,200 and the decision was taken to proceed with the project. Tenders for the masonry piers were prepared in the following month.[102] William Burn, also of Edinburgh, was appointed as the Resident Engineer by Brown in March 1829, whilst Thomas Storey acted on behalf of the railway with tendering and liaising with contractors.[103]

Work had commenced on building the bridge by July 1829, but problems were encountered with flooding, both from the high spring tides up the river and from a freshwater spring in the river bank on the Durham side of the river. In September, to overcome this problem, an 8-in diameter pump was installed and driven by steam from one of the railway's locomotives. Access was gained by laying down a siding, 1½ furlongs long (330 yards), from the main line to the bridge pier site on the Durham side of the river. The locomotive was not identified, but

being one of the smaller engines, it is probable that one of the early Stephenson engines, was used for this purpose: "The connecting rod of the engine is to work by means of a crank, the pump of 8 inch bore fixed in the dam a few yards from the side."[104] It remained there pumping until November 5th when the bank of the coffer dam that was supporting the engine began to give way and the engine seems then to have been withdrawn.[105]

The bridge was completed, ready for trial, by December 13th 1830. Samuel Brown was unavailable on this day, and Alexander Mitchell stood in for him to oversee the trials.[106] The first test, with 28 empty chaldron wagons which were run onto the bridge, "which filled it from end to end". The deflection was 2 3/10 inches. An 8-ton locomotive (possibly No.1) was then attached to the 28 empty wagons and run onto the bridge. This caused a deflection of 5 8/10 inches. 16 loaded wagons were then run on to the bridge, spaced evenly along it, which caused a deflection of 7 4/10 inches. Storey noted:

> "After the last experiment the masonry was considerably affected in both Towers and two of the retaining plates split on the Yorkshire side of the River.
>
> It was thought proper, after fully considering the effects of the last Weight put upon the Bridge, that it would not be prudent to add any more additional Weight thereon, and that the maximum had been ascertained."

Further trials of lesser weights were then made using Hackworth's *GLOBE* passenger service locomotive which was lighter than the coal locomotives.

With the limitations indicated by the trials, it was decided that locomotives would be required to lead their loaded trains to a siding close to the Durham side of the bridge, and the wagons would then be taken over the bridge by horse, two at a time, and drawn the additional 3¾ miles on to the new Middlesbrough staithes. This practice continued for some three years whilst a resolution was sought to stiffen the bridge deck and strengthen its anchorages on both banks of the river.

In the summer of 1833, the condition of the bridge on its Yorkshire side gave cause for concern and only single wagons were then horse-drawn over it. A 'retaining plate' had been damaged by the loads and needed replacing. Storey devised a system of timber 'gearing', as he called it, to support the decking whilst the damaged plate was replaced. He then recommended that the gearing remain in place as it was strengthening the deck and would allow heavier loads to cross. He confidently expected that "Locomotive Engines may (now) be used on this part of the Line in the future, so long as the Bridge is supported by the Gearing."[107]

A month later, the *MAJESTIC* locomotive hauling 24 loaded chaldron wagons passed over the bridge successfully and took the wagons on to the Middlesbrough staithes.[108]

5. Operating Career 1834 to 1840/1

By 1834, the axle-loading of the original 0-4-0 locomotives built by R. Stephenson & Co. was proving to be disadvantageous to the track. The railway had to take decisions regarding their axle-weight reduction, either by re-building the locomotives on three axles, or, as in the case of *LOCOMOTION*, by reducing their weight.

Timothy Hackworth first tackled the problem when he stopped operating the No. 4 locomotive, (formerly numbered No. 5), that had had a replacement tube fitted in 1828 following its rupture in March that year. The locomotive, by then named *DILIGENCE*, was noted as having been "taken to pieces" at Shildon in the summer of 1833 when the Chevalier De Pambour visited towards the end of the year.[109] A valuation of the S & D R locomotive fleet and its 'duplicates' was made between the 4th and the 12th of April 1834 by George Dodds (d.1835), the engineer of the Monkland & Kirkintilloch Railway.[110] He reported that *LOCOMOTION* was in a 'tolerable condition' being still fitted with its double return flue boiler. He valued it at £370, no doubt including its two tenders. Dodds also recorded that the boiler barrel of No.4 remained in the yard at Shildon works, complete with its parallel motion rodding and connecting rods, which was valued at just £15.

Perhaps prompted by this low valuation, Hackworth quickly sought to reduce *LOCOMOTION*'s weight by substituting its boiler for that which had come off *DILIGENCE*. The re-building apparently took place in April, soon after Dodds's valuation.[111] Being a 4 ft diameter boiler, the replacement was lighter than the 4 ft 6 in diameter double return-flue boiler that it replaced (Section 3). The locomotive's cylinders were however retained and inserted into the smaller barrel, their continued use being accompanied by the two exhaust pipes, now both feeding into the single chimney. In addition, it is most likely that the frame was dispensed with, the spring-sets being located within the boiler support brackets.

A single return-flue was fitted inside this boiler at this time, these alterations resulting in a reduction in the locomotive's weight of about 1¾ tons, thus reducing its axle loading by about 18 cwt. This boiler correspondingly reduced the heating surface by just over a third to approximately 100 sq ft. The surviving motion, already mounted on the barrel, and perhaps the connecting rods, were also apparently adopted by *LOCOMOTION* (Fig. 5.1). In 1837, it was confirmed to be fitted with a single return-flue boiler, as that year's asset valuation identified a duplicate single return-flue for its boiler stored at Shildon Workshops.[112] This was further confirmed in the summer and autumn of 1837 when it became necessary to fit that duplicate flue.[113] Also, in August 1839 Francis Wishaw listed each of the railway's locomotive fleet, in which again he showed No.1 being fitted with a single return-flue boiler.[114] It retained separate tenders for coal and water.

Hackworth rebuilt *DILIGENCE* with a new and larger boiler, in line with his programme for increasing heating surface for locomotives, by using multiple return copper tubes, a feature of most of the later locomotives adopted by the railway in the 1830s. With the success of the driving motion of the later No.5 locomotive, *ROYAL GEORGE*, he also fitted *DILIGENCE* with vertical outside cylinders, acting on three pairs of coupled wheels, thus making it a completely new locomotive.

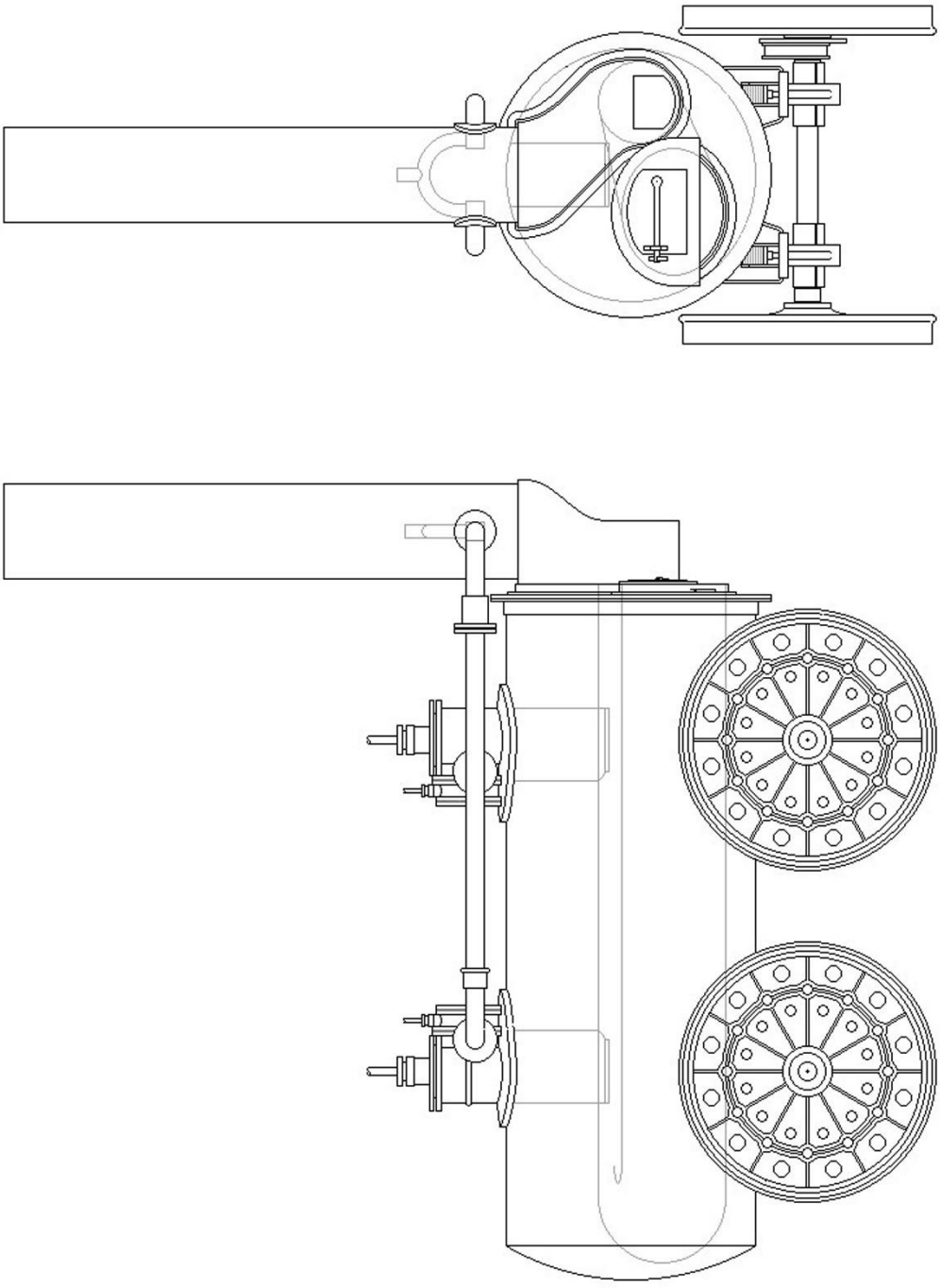


Fig. 5.1 Conjectural views of *LOCOMOTION* as rebuilt in 1834 showing replacement boiler, single return flue and chimney (Parallel motion, connecting and coupling rods omitted)

Following the strengthening of the Stockton Bridge, the directors received a report from John Graham that locomotives could be tried experimentally on the coal trains through to Middlesbrough from the beginning of February 1834.[115] The operations were successful and continued thereafter, an operation on which *LOCOMOTION* was regularly employed following its re-building to a lighter weight. The bridge was a continuing source of concern for the railway however, and it was replaced, only 10 years later in 1844, by a five-span cast iron trussed girder bridge.

The railway's extensive archive of coal movement records, prompted by the enginemen's ton-mileage based income payments, provide a comprehensive record of the locomotive's work, although there are some gaps in the surviving paperwork.

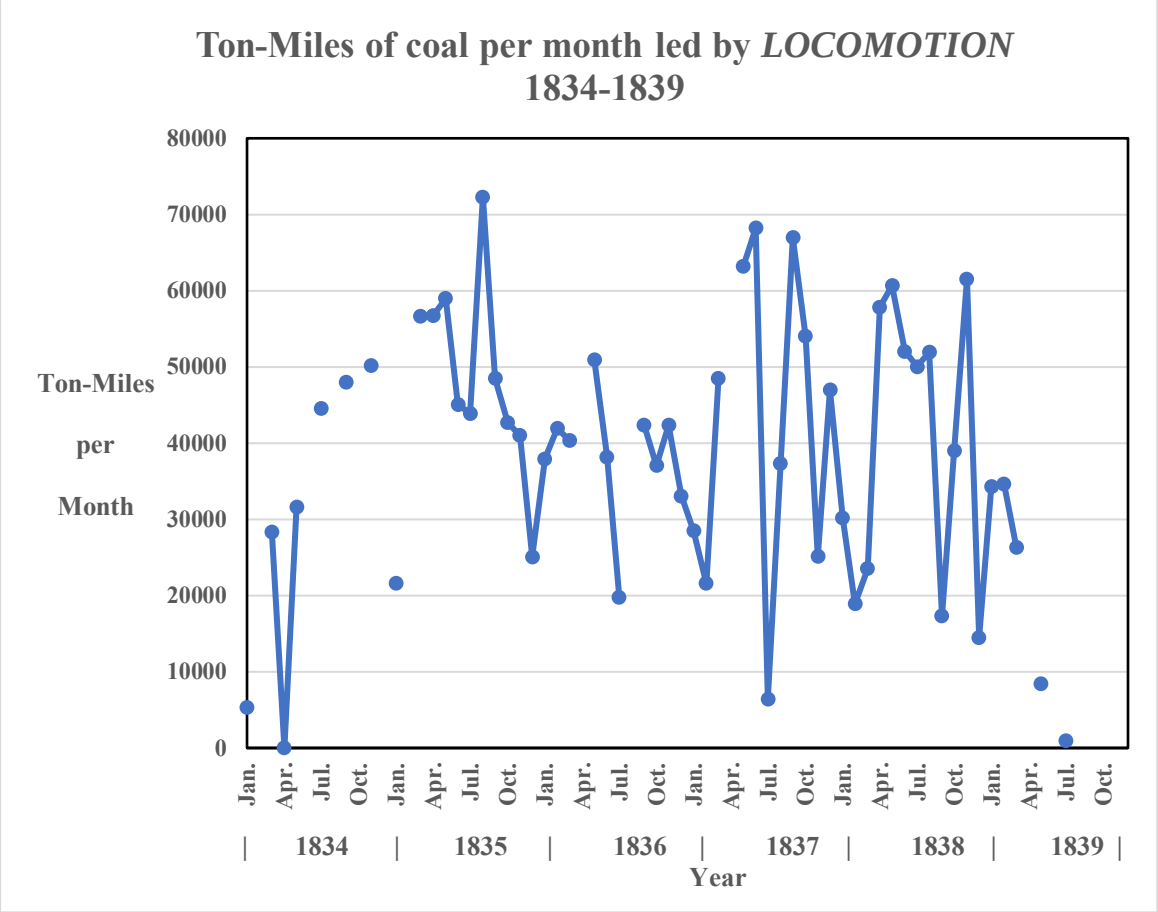


Fig. 5.2 Tonnage of coal led by *LOCOMOTION* from Brussleton Bankfoot to Darlington, Yarm, Stockton and Middlesbrough. (Gaps = missing data)

[Analysis of monthly reports prepared by the Stockton & Darlington Railway, NA, RAIL 667/1299, RAIL 667/1300, RAIL 667/1453, RAIL 667/1454 & RAIL 667/1530].

Also in February 1834, the Directors of the Stockton & Darlington Railway sought to reduce further the operating costs for the movement of coal. They decided to contract out the provision of operating services to contractors who would provide both motive power and maintenance of rolling stock and track.[116] Timothy Hackworth agreed to undertake the provision and maintenance of about half of the locomotive fleet, including No.1 *LOCOMOTION* and No.4 *DILIGENCE*, based at the Company's workshops in Shildon. He

correspondingly stood down as the railway's salaried motive power superintendent. The other half of the fleet was contracted out to the Kitching brothers, William & Alfred, who adapted their premises at the Hopetown Foundry in Darlington and became responsible for six of the locomotive fleet, including No. 2 *HOPE*, which they subsequently rebuilt.[117] The Kitching contract was later shared with William Lister who adopted premises at the Hopetown Works, also in Darlington, looking after three of the locomotives, including No.3 *BLACK DIAMOND*, which he also rebuilt.[118]

The new contractual arrangements had prompted Dodds's valuation. The contractors were charged annually by the S & D R at 5% of the value of the locomotives.[119] The three contractors' responsibilities to provide motive power sufficient to meet the railway's requirements for moving coal, together with other goods and passengers, began on the 1st May 1834.[120] They were to provide the train crews and undertake the maintenance of the locomotives, and to take initiatives for their rebuilding to make them more efficient and less costly to operate. They were also encouraged to provide new locomotives as the railway's traffic continued to grow. The new contracts were signed and sealed in July 1834.[121]

Hackworth kept meticulous records of the costs incurred with maintaining those locomotives for which he was responsible, including *LOCOMOTION*, many, but not all, of which survive in the National Archives. These confirm that he commenced operation and maintenance of *LOCOMOTION* in the May of 1834.[122] There were no long periods out of service, although routine maintenance was again regularly required. The last maintenance carried out on it by Hackworth was in April 1840.

In June 1834, in spite of the railway company's efforts to fit spark arresting netting over the chimney caps of the locomotives, it was reported that another fire was caused by one of the locomotives in the adjacent plantation, and the owner, Marshall Fowler, once again sought damages from the S & D R.[123] The directors sought the assistance of the 'contractors', Messrs Hackworth, Kitching & Lister, to provide some sought of improved cap for their engine chimneys to prevent further occurrences of fire.

In December, 1834, John Graham was asked by the directors to consider the fitting of 'fenders' to avoid collisions with any obstacles left on the track "to prevent damage and accidents".[124] However, the matter was not further discussed in the sub-Committee minutes to indicate in what form Graham may have decided the fenders might take.

On Monday, 23rd May 1835, *LOCOMOTION* collided with a loaded coal waggon that had been left on the running line near Goosepool. It had become detached from the rear of a preceding train to which no rear lamp had been fixed. The waggon was "Broke and wasted part of the Coals."[125] There was an increase in the cost of the locomotive's maintenance in July 1835, probably following the collision, the men's time and materials totalling just under £50, compared to the typical £10 for the previous two months.[126]

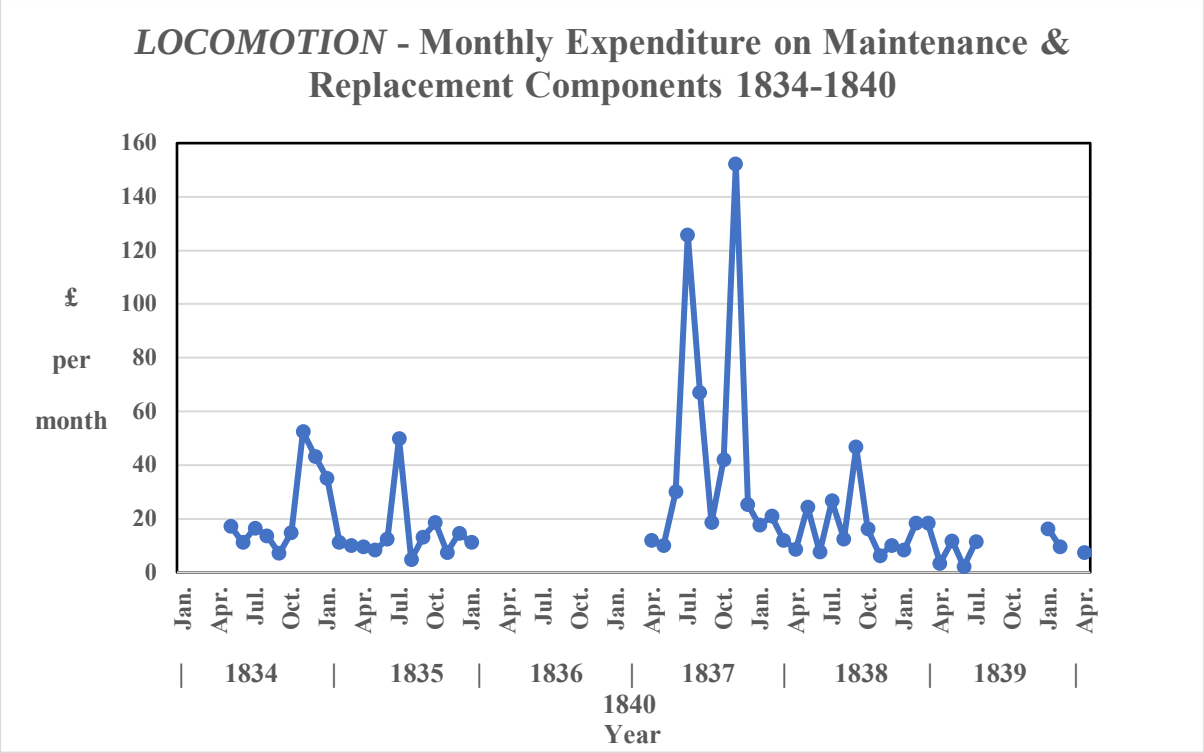


Fig. 5.3 Monthly expenditure by Timothy Hackworth at Shildon Works on maintenance and material costs to keep *LOCOMOTION* operating and suitable for the leading of coal traffic. (Gaps = missing data)

[Analysis of monthly reports prepared by Timothy Hackworth, NRM, HACK/1/3/2/2; NA, RAIL 667/680, RAIL 667/1373, RAIL 667/1374, RAIL 667/1375].

In October 1835, the railway's directors ordered the contractors to fix large numbers, made of brass, to each locomotive in a "conspicuous place" to allow identification to any witness should the locomotives be operating unsafely.[127] This was amended in the following month to be either brass or sheet iron numbers "projecting from the Engine Chimney".[128] Early in 1836, the locomotives were described as looking "slovenly", particularly in regard to the numbers, a matter which was called to the attention of the contractors.[129]

With the improvement of the track compared with the earliest years of the railway's operations, and the introduction of springs on the locomotive, the number of damaged components that needed replacement or repair had reduced. Their cost, largely wage-related, was typically between £10 and £20 per month.[130] However, two events requiring major component replacements were incurred in July and November of 1837.[131] The former involved the removal of the return-flue and the fitting of a replacement one, as well as the re-wheeling of the locomotive and the fitting of replacement piston rods. The 25 cwt replacement flue was charged at £50, before fitting. The latter occasion again required the fitting of a replacement return-flue. The November repair work may have been occasioned by a "throwing over" that occurred to No.1 at the beginning of that month at Aycliffe Lane. The "way men" had removed a length of rail for maintenance but had failed to erect a warning sign to alert the engine men to the danger. The extent of the damage was not recorded, but the repair work was charged out at £22 16 10¾d.[132]

John Graham, the railway's traffic superintendent, reported in May 1837 that the locomotives were "much in want of a Coat of Paint" and proposed to the Sub-Committee that this be undertaken, but there is no confirmation that this was agreed to.[133] In spite of *LOCOMOTION*'s appearance, its valuation in August 1835, carried out by James Kennedy, remained at £375 including its two tenders.[134] However, its value had been reduced to £280 by April 1839 and £300 a year later.[135]

Water supply to meet the requirements of the railway's growing locomotive fleet, was also a problem from time to time. On the night of the 14th/15th of January 1838 the northeast experienced an "intense frost", so much so that "the feed pipes upon the Locomotive Engines were Froze and Split and also all the Watering Stations was fast".[136]

By the beginning of 1839, the use of *LOCOMOTION* on coal trains began to diminish in favour of some of the larger and more powerful locomotives then being introduced into the S & D R fleet. When opportunity arose, consideration was given to disposing of it for second hand use. An application was made to the railway at this time by R & W Hawthorn of Newcastle upon Tyne which sought to acquire a locomotive "suitable for earth work", perhaps initiated by a contractor.[137] In the following week *LOCOMOTION* was offered to Hawthorns for £300,[138] its previous valuation having been £325 in June of 1838.[139] Nothing further was recorded in the minutes about this enquiry, and No.1 continued work on coal movements, supplemented by a small amount of general goods traffic. The railway company's monthly returns illustrate its declining use for coal leading during 1839, the final movement of coal being undertaken in July of that year.

Following its withdrawal from coal leading however it was cascaded to be used only for occasional haulage of general goods traffic and track maintenance trains. On October 24th 1839 *LOCOMOTION* was derailed at Middlesbrough and John Graham reported that it had "turned on to her side … and is much broke. The Switches was Reported …. Last week as being Defective."[140] There is no surviving report as to the damage caused to it with this accident, but it was repaired and returned to traffic.

On the 1st of April 1840, the annual contractual arrangements with Hackworth and the other contractors were terminated and the S & D R returned to taking responsibility for the operation and maintenance of its locomotive fleet.[141] A new subsidiary company was formed, named the Shildon Works Company, which took back the Shildon works site, after which time Timothy Hackworth severed his direct involvement with the railway and switched his manufacturing activities to his nearby Soho Works in Shildon.

LOCOMOTION was thus handed over to the care of the Shildon Works Company from that date, but the railway's records make no further mention of the locomotive's revenue earning activities or its maintenance requirements. In spite of the long-accepted statement that it remained in service until 1841, this cannot therefore be confirmed. To support this likelihood however, a table of the S & D R locomotives and their dimensions was prepared in November 1840, possibly by John Graham, the original of which has not been found in the company's archive. However, the table was published in *The Engineer* journal in October 1879.[142] As the list includes *LOCOMOTION* it suggests that it was then still operational, or it remained in occasional service for track maintenance trains.

6. ‘Engine Men’ and Firemen 1825-1840

The first regular ‘Engine Man’ (driver) of *Active* was **James Stephenson** (1779-1847), elder brother of George Stephenson. He had been a driver on the Killingworth Colliery railway and brought with him the necessary experience to commence regular service, whilst being aware of the many component reliability problems that were going to arise with the locomotive. Some or all of the subsequent drivers of the following four locomotives built by the Stephenson Company, Robert Morrow (otherwise Murray), William Gowland, Michael Law and John Cree, had also been drivers or firemen on the Killingworth line.

On the 22nd October 1825, Stephenson was paid 3/8d per day for the first 36¼ days he had been driving the engine, which period covered the transfer of the locomotive from the delivery dray on September 18th, trial running between the 18th and 26th September, attendance on the opening day, driving when the locomotive was in use between the 28th September and 22nd October, and assisting with its maintenance when it was not in use. He was also paid 4½ days overtime, also at 3/8d per day for additional hours he had worked. In addition, he was paid a lodging allowance of 3s per month. His take-home pay on the 22nd October was, therefore £7-12-5d.[143]

Stephenson’s fireman in this same period of 36¼ days was **William M. Gowland**. He was paid 3/- per day, and overtime at this rate, also for 4½ days, again with a lodging allowance of 3/- a month, with a take-home pay on the 22nd October of £6-5-3d. Both Stephenson and Gowland had been paid an advance of £2 when they first arrived, to assist them get lodgings and to get prepared for working away from home.[144] Gowland later became the first driver of No.3, *BLACK DIAMOND*, and went on to become an experienced driver, and notably drove Hackworth’s *SANS PAREIL* locomotive at the Rainhill Trials.

Fig. 6.1 William M. Gowland, the first fireman of the *Active* in 1825.

[SSPL – 10410318]

For the next few weeks Stephenson was paid at a basic rate of 22/- per week, whilst Gowland earned 18/- a week. Overtime continued at 3/8d per day for Stephenson and 3/- per day for his fireman. Lodging allowance continued at 3s per month. For the fortnight ending 5th November, Stephenson took home £2-19-10d and Gowland £2-9-6d.[145] Monthly payments were thereafter made, Stephenson receiving £6-11-6d for December, and £5-16-0d for January 1826.[146] Robert Morrow, the engine man of the second locomotive, started driving at the end of 1825 and was similarly paid.

However, from February 1826 it was felt by the railway company that more economy would be achieved if Stephenson, Morrow and the later engine men themselves were made responsible for the supply of the coal consumed by their locomotives, together with other consumables, such as tallow, whale oil, fine oil, spun yarn, white lead and hemp, as well as their firemen's wages. The company calculated that the costs of running the two locomotives in the 20 weeks since the opening of the line, including the men's wages, was £171 17 9d. This was calculated to be "22/25 of a farthing per Mile".[147]

Thus, from the 17th February 1826, for a trial period of six months, the engine men were independently contracted by the company to 'lead' coal from the bottom of Brussleton incline through to Darlington, Yarm, Stockton and other intermediate locations on the basis of being paid a farthing (¼d) per ton of coal per mile.[148] It was also to include the return of empty wagons back to Brussleton. The tonnage was variable, dependent upon the prevailing market for coal, the weather, the congestion on the single line until it was both doubled and less dependent upon horse haulage, as well as the condition of the track, and the maintenance requirements of the locomotives themselves.

Their ton-mile based income therefore had to pay their fixed costs (wages) as well as their variable costs (consumed coal, lubricating oil etc.). They would have needed to be astute enough to reserve some income from the months when tonnage was high, to make allowance for reduced income when tonnage was low. The trial was judged by the railway to be successful, "one farthing per ton for each mile, which price is understood to pay the contractors well."[149] In August 1827 the railway's Sub-Committee renewed the contractual arrangement for a further unspecified time.[150]

One of the early locomotive drivers, Jim Gowland, the brother of William, later reminisced that: 'we were paid better than anyone else, and we always had plenty of money'.[151]

The ton-mile details were recorded in the company's monthly records, many, but by no means all, of which have survived in the railway's papers now retained in the National Archives. These allow an insight into the railway's growing activities and the volumes of coal that were being moved. An incomplete record of the monthly sums Stephenson was paid can thus be determined:[152]

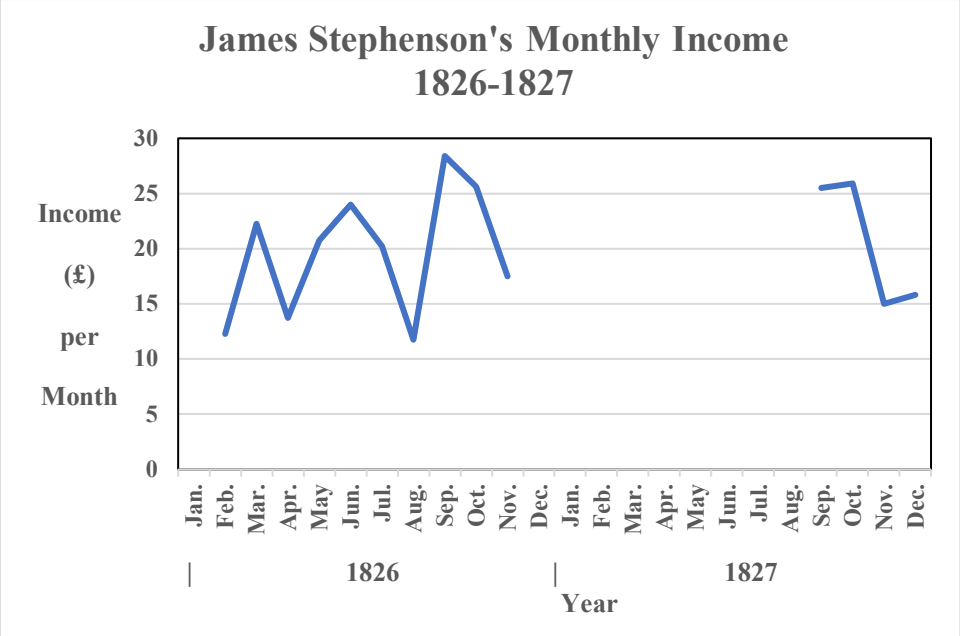


Fig. 6.2 James Stephenson's monthly income 1826-1827 (Gaps = missing data)

[NA, RAIL 667/465 and RAIL 667/1527]

From July 1827, the provision of grate-bars for the locomotive fire-grates became an additional requirement for the engine men to provide and meet the costs of.[153] This proved to be difficult for Timothy Hackworth to apply, and negotiations took place with the engine men to resolve them. A fortnight later it was agreed to value the replacement firebars at 8d for a journey between Brussleton and Stockton and return, and 4d for return journeys to either Yarm or Darlington. The arrangement was agreed to and commenced from the 1st August 1827.[154]

The drivers were required to sign (if able) for the payments they collected each month. James Stephenson left his 'mark' in the form of a cross between his given and surnames, written by a clerk:[155]

Fig. 6.3 James Stephenson's 'mark' in the payment register for October 1826 [NA, RAIL 667/1529]

The railway's directors were concerned that several drivers were travelling at excessive speed, which was to be an ongoing criticism with the engine men throughout the 1820s and

1830s. As early as July 1827, Thomas Storey, the line's engineering superintendent, reported to the railway's Sub Committee:[156]

> Engine men run the Waggons into the New staithe way at Stockton with a very great velocity, to the danger and risk of the Co.'s property.

In October 1827, the serious damage caused to No.2 locomotive at Stockton led to the discharge of the un-named fireman. The railway's Sub Committee directed that "a fine of 10/- be imposed upon any Engine Man who shall dare to fasten down the safety valve when the Engine is at rest, and the same penalty if the valves be not locked every night."[157]

James Stephenson was involved in an unspecified incident in October 1827. He was fined 10 shillings, and Timothy Hackworth was required "to inform the Engine Men that the Co. expects their most strenuous personal exertions when any Engine is off the way."[158]

Also in October 1827, No.1's unnamed fireman "got himself lame" and he had to be replaced on the 26th of that month by a member of Hackworth's team at Shildon workshops, G. Germison.[159]

On the 21st December 1827, Stephenson was joined on No.1, by **John Cree**, perhaps for a period of training before Cree took over as the locomotive's engine man. [160] Only a few weeks before, Cree had been fined 10/- for not greasing the coal waggons on his own train.[161]

Towards the end of 1827 Stephenson was transferred to the No.5 locomotive. He was then replaced full time by John Cree who drove No.1 without further recorded comment from the company.

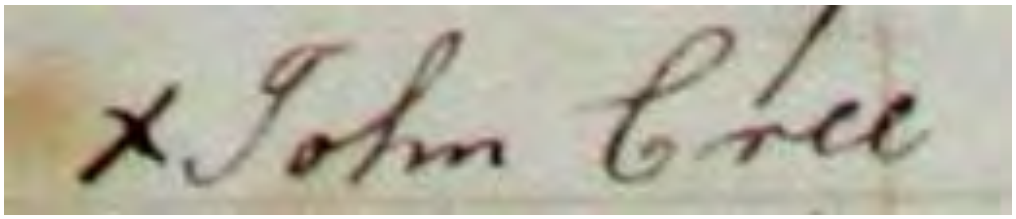


Fig. 6.4 John Cree's 'mark' in the payment register for March 1826 [N.A. RAIL 667/1527]

The only month for which his payment is recorded was the April of 1828 when he was paid £22 5 5d.[162] It was during his time in charge of No.1 that the flue of No.5 locomotive burst, seriously injuring its driver, but it was not confirmed that Stephenson was the driver. The Company:[163]

> Resolved that a penalty of ten shillings be laid upon men having the care of any one of the Cos. Locomotive Engines who shall dare to absent himself from his Engine in the absence of an approved fireman when ever there is fire under the grates.

On 1st July that year, in spite of the Company's resolution, Cree was fatally wounded as the result of the rupture of No.1's flue whilst at a water stop at Aycliff Lane.[164] There are no records of a Coroner's inquest having been held, and only a brief report in the press.[165]

Although the records relating to Cree's time as the driver of No.1 have not survived in the National Archives, the railway's Sub Committee briefly considered the event and:[166]

> Resolved the sum of 10£ be given to T. Storey for the widow of John Cree for liquidating the debt of his funeral and a donation for her benifit.

After No.1 had been rebuilt with its larger return-flue boiler, it is believed that James Stephenson returned to its footplate from its re-start of operation at the end of 1828. No doubt his experience would have been useful in obtaining the best performance from its improved heating surface.

In April 1830, No.1 was involved in a collision with some wagons causing an enquiry to be held by the directors. Although Stephenson was released from being fined for the incident, he was fined 20/- for 'neglect' in not ensuring that a 'cow' (fender) had been fitted to the engine which might have reduced the extent of the damage.[167]

James Stephenson continued on the locomotive until August that year, during which time he no doubt trained his replacement driver. Stephenson was however dismissed from his employment with the railway the following February.[168] No reason was stated for his dismissal, but thereafter he is believed to have re-joined George Stephenson.

The replacement driver on No.1 was **Henry Lanchester** (1805-1876), who had been employed by the S & D R since helping to lay the line out in the early 1820s.[169] He had gone on to become the fireman on No.1 in 1826 or early 1827, and was promoted to become No.1's driver from September 1829[170] and continued through to about July 1832.[171]

The directors were concerned about delays and congestion from the 1830s, partly caused by the imbalance of loaded and empty coal wagons and resulting congestion. In October 1830, the directors ordered Timothy Hackworth to fine the engine men 5d per empty waggon brought back along the line by horse which should have been brought back on a west-bound steam-hauled train of empties.[172] This order was reinforced the following month at Early Nook where congestion persisted.[173]

From the autumn of 1830, it became a requirement for engine men to render any assistance they could with any derailment or damage to any waggon. Failure to do so would incur a fine of 20/-.[174]

Speeding with coal and empty trains continued in the 1830s. This was particularly the case when crossing the main road between Darlington and Durham, along which passed the mail-coaches, and the need to avoid upsetting horse-drawn road traffic was stressed.[175]

Little of Lanchester's career on No.1 was recorded in the railway's papers, although the continuing problems of congestion on remaining sections of the single line led to occasional conflicts with other engine men. On January 5th 1832, a James Willing, presumably driving another unidentified, locomotive, refused to make way to Lanchester driving No.1 at Houghton Lane. This was reported to Thomas Storey, and Willing was fined 2/6d for obstruction.[176]

By July 1832 Lanchester had become experienced enough as an engine man to be promoted to drive a newly-built locomotive, No.16, that was named *DIRECTOR* in the following year.[177] He continued as a driver on the railway until 1843.

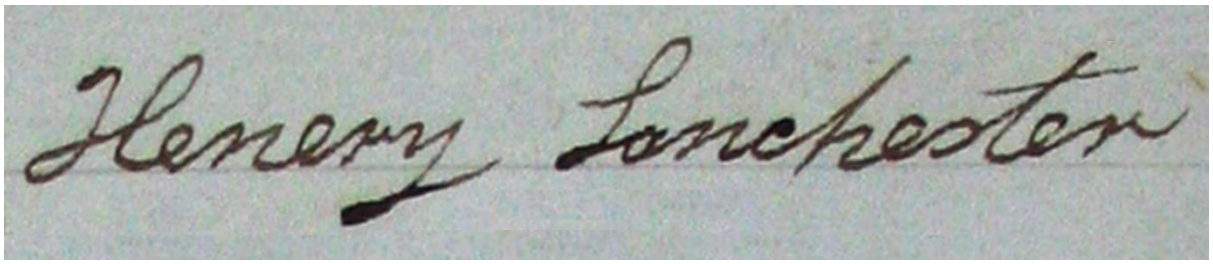


Fig. 6.5 Henry Lanchester's signature in the payment register for September 1837 [N.A., RAIL 667/1530]

Stephenson and Lanchester's income from their time as No.1's driver can be determined from the railway's pay sheets:[178]

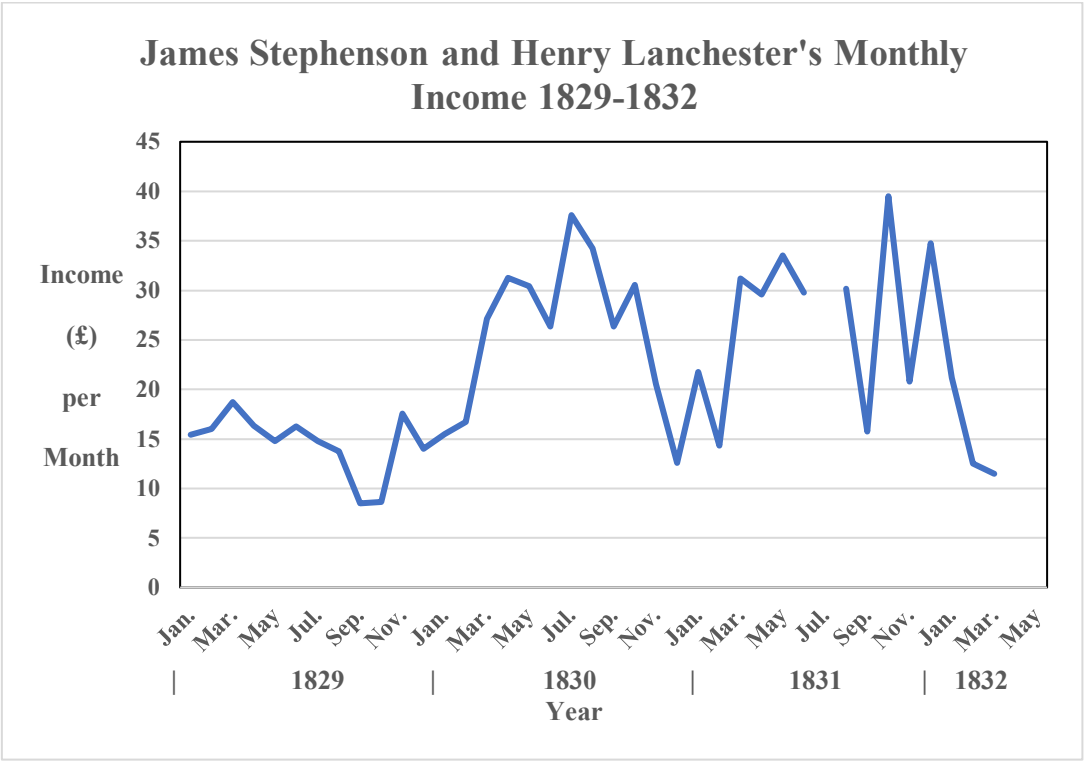


Fig. 6.6 Stephenson and Lanchester's monthly income 1829-1832. (Gaps = missing data)

[N.A., RAIL 667/1299]

The January to August incomes in 1829 were received by James Stephenson. They were at a relatively modest level, presumably as he was learning the best driving and firing method for No.1's new boiler. Henry Lanchester seems to have taken a couple of months to learn how best to achieve a satisfactory performance from the locomotive before he succeeded in achieving higher ton-mileages and corresponding income.

From August 1832, No.1's engine man was **Thomas Dickinson**, although he did not remain long in that post and, after 12 months, was no longer listed on the driving staff.[179]

His replacement was **Ralph Morgan**, the first reference to whom as the 'Engine Man' of *LOCOMOTION* came in May 1833, although he first appeared on the monthly ton-mile records a little before then, suggesting he might have begun as early as January that year.[180] He was interviewed by a reporter in 1875 and he spoke then of his time with the locomotive.[181] On August 8th 1833, *LOCOMOTION* had collided with a "dick ass" on the line, and in the confusion the train ran over the foot of his apprentice fireman (**Thomas Hutchinson**), which had to be amputated the following day.[182] Morgan drove the locomotive continuously until April 1838 and was its longest serving driver.[183]

During this time the tonnage of coal being moved from the west Durham pits to Stockton and Middlesbrough and the intermediate destinations rose substantially and the income of the engine men rose accordingly. This was beyond what was considered necessary by the railway company for the outgoings and maintenance of the locomotives, and the wages of the men. From July 1833, a 20 per cent 'discount' was imposed on the calculation of the rate No.1's driver was paid.[184] It was thus calculated that the rate would henceforth be a farthing per ton per mile hauled, less 20 per cent. From the January of 1834, the discount was increased to 30 per cent, but this was reduced back to 25 per cent just a few weeks later.[185]

From May 1834, the engine men were overseen by Timothy Hackworth (to whom Ralph Morgan then reported), William and Alfred Kitching and Willian Lister under the new contractor agreements, although it was under the same payment arrangements as hitherto.

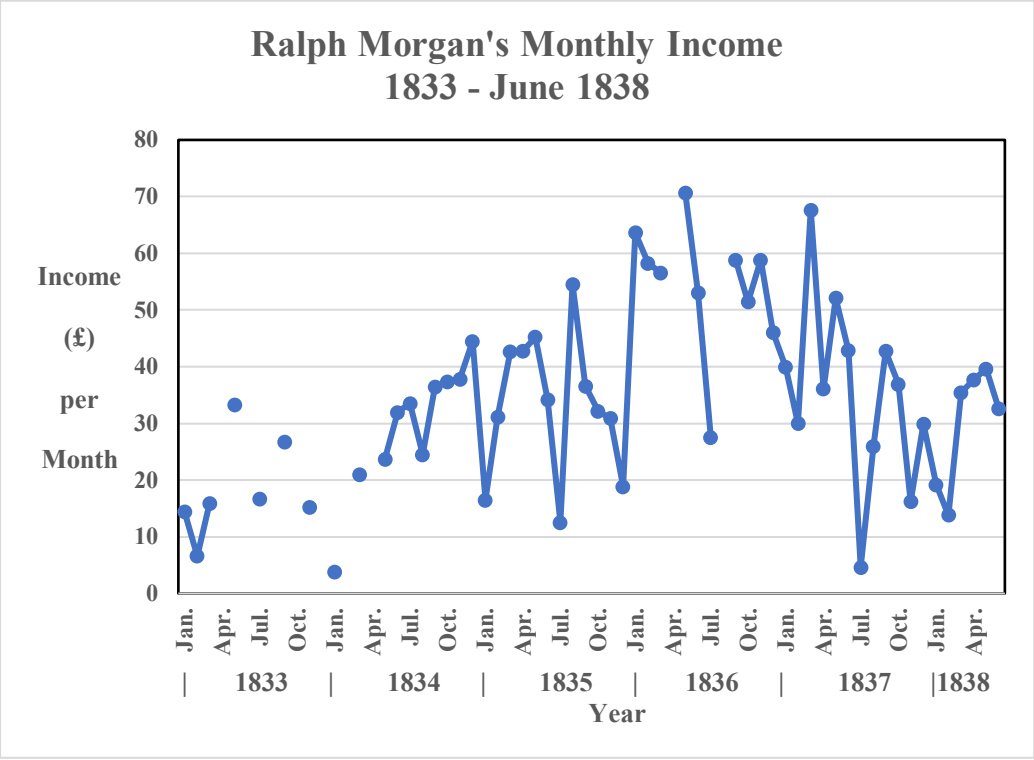


Fig. 6.7 Ralph Morgan's monthly income 1833 to June 1838. (Gaps = missing data) [NA, RAIL 667/1299, RAIL 667/1300, RAIL 667/1453, RAIL 667/1454, RAIL 667/1530; NRM, HACK/1/3/2/2]

In August 1834, the speed that some trains were driven once again gave rise to deep concern amongst the directors. They enforced rigorous fines against the engine men and, where two fines had been levied, they called for the contractors to suspend or even sack the offenders.[186] On May 1st 1835, the railway's Sub Committee ordered that the speed of the coal trains should be restricted to six miles an hour due to the number of breakages of the cast iron driving wheels on the locomotives.[187] John Graham (1799-1864), the S & D R's Traffic Manager, indicated that this would actually incur delays to the passenger trains and the restriction was correspondingly not imposed.[188]

As the tonnage and, correspondingly, the drivers' wages continued to rise through 1835, the railway again sought to limit the drivers' income and, during that year, the rate was again changed and simplified to become 4/10's of a penny per ton per mile.[189] From February 1836, the rate was changed back again to be calculated at a farthing per ton per mile, but with a discount of one third,[190] and remained at this level until June 1837 when it was altered to 35 per cent.[191] In addition, the drivers were now being paid one shilling per trip for returning empty wagons from the discharging points back to Brussleton.

At the end of 1834, the engine men engaged by Timothy Hackworth were soundly criticised by the Sub Committee for not properly greasing the waggons they were leading. They were further heavily criticised for using "insulting language" to anyone who dared to criticise their conduct. It is not known if this included Ralph Morgan, but Hackworth was required to relay this criticism to all his drivers.[192]

In February 1835, No.1 was involved in a serious collision with a loaded chaldron waggon that had been left on the main line near Goosepool.[193] It had become detached from a previous train and its driver had apparently omitted to ensure a light had been left at the rear of his train. There was no indication as to the extent of the damage to No.1, but the waggon had been smashed and the coal spilled out on to the track.

The excessive speed of the trains was again an issue in April 1836 when the directors threatened heavy fines on offending train crews.[194] To reinforce this matter the directors issued a reminder that the speed limit was to be six miles an hour. Engine men were to be fined 5/- for a first speeding offence, and 10/- for each further offence.[195]

In January 1838, Morgan was fined two shillings and sixpence for driving too fast, and in April he was further fined that sum for not having his "Fireman upon Waggons when passing Plantation", this being a requirement to look out for any fires that may have been caused by the passing of the locomotive.[196] Later that month he was transferred to drive No.4 *DILIGENCE*. However, in 1846, Morgan was recalled to drive *LOCOMOTION* on the occasion of the opening of the Redcar line from Middlesbrough.[197]

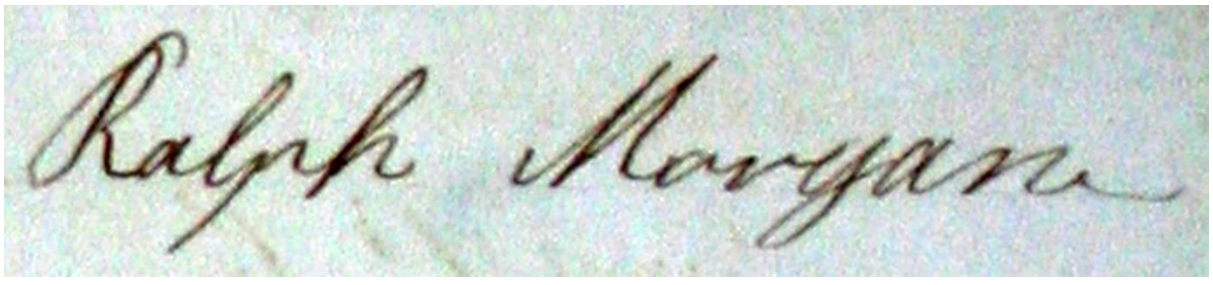


Fig. 6.8 Ralph Morgan's signature in the payment register for August 1837 [N.A., RAIL 667/1530]

In May and June 1838, *LOCOMOTION* was under the care of a **G. Glendening**, but possibly under tuition from Ralph Morgan. Glendening got into trouble early on, firstly for driving too fast, but further for "haveing waggons shearing" (presumably through lack of lubrication) and was fined five shillings as a result.[198] His time with No.1 was only short-lived however, but whether this was due to his misdemeanours is not shown in the railway's records. In the following month, June, Glendening received a further fine of 2/6d for allowing "axle shearing". However, in this case he was jointly fined with the man who was shortly to take over from him as the locomotive's driver, **John Burton**, who began his career on the locomotive the following month.[199]

Burton got off to a bad start however, being fined five shillings for two offences for speeding in his first month and a further speeding offence the following month.[200] He remained as the driver of the locomotive until July 1839 when he was re-allocated to drive No.7 *ROCKET*. During his time in charge of *LOCOMOTION* Burton's income fluctuated significantly:

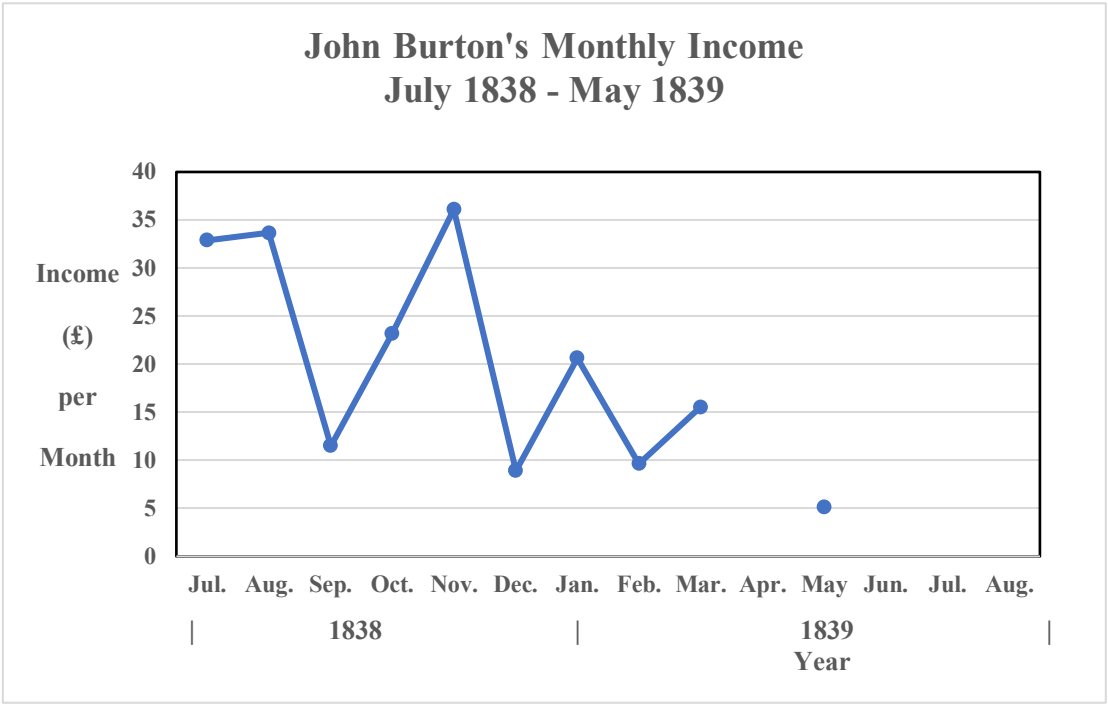


Fig. 6.9 John Burton's Monthly Income July 1838 – May 1839 (Gaps = missing data)

[N.A., RAIL 667/1299, RAIL 667/1454, RAIL 667/1530]

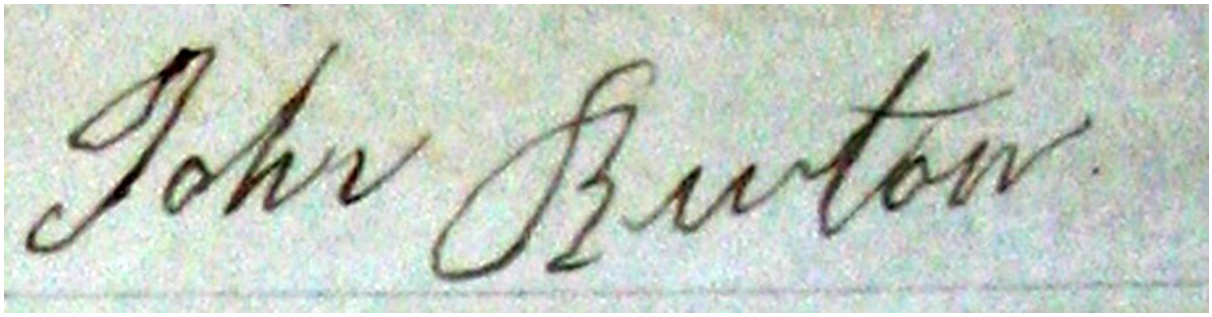


Fig. 6.10 John Burton's signature in the payment register for July 1838 [N.A., RAIL 667/1530]

It is not known who the driver was during the last few months of *LOCOMOTION*'s career operating goods and works trains until the middle of 1840.

There were several other drivers over the years, who claimed that they too had driven or fired on 'No.1':

Ned Corner was said to have driven the locomotive for several years after he joined the railway in 1830, but this cannot be substantiated from the railway company's records.[201]

Gowan Crone was said to have ridden on the footplate on the opening day, alongside James Stephenson, and had subsequently become its fireman. [202] It was also stated that he became the driver of the experimental 'Chittaprat' locomotive. It has not been possible to substantiate either of these claims.

James (Jim) Gowland, the brother of William, claimed to have driven No.1 in 1833 and 1834,[203] but there is no evidence in the railway's paperwork to corroborate this. He may perhaps have been a fireman on No.1, as was later recorded in a press report, and he was certainly one of the early pool of drivers on the railway.[204] The Gowland family had grown up in a cottage alongside that in which George Stephenson had been resident.

Robert Murray was a further claimant to have been a driver of No. 1, but it is a possibility that he was an early driver of No.2, as there is no archive record of him in relation to the older locomotive.[205]

Peter Bannison, born in 1823, claimed to have driven the locomotive for two or three months when he was 18 years of age, which would have meant that the locomotive was still operating in 1841. It is just possible that 1840 was meant, and that he had taken over from John Burton, but this cannot be corroborated from the railway's papers in the National Archives.[206]

It was also claimed in 1875 that **Henry Joyce** had been a driver on No.1 in the 1830s, but this again cannot be corroborated, although the surviving records of the railway do confirm that he had been a driver in the late 1830s and obtained several fines for speeding.[207]

Matthew Wragge (1824-1904) is another claimant to have been a driver on No.1. He used to state that, at the age of 16 in 1840, he had been a driver on the locomotive, having first been a cleaner for three years and then a fireman. The dates again suggest that this was a claim by association, although it might have been possible that he had fired on No.1 for a short period of time.[208] His latter-day portrait survives in the Beamish Open Air Museum Library.[209]

A further claim was made in favour of **Robert Yates** as being the No.1's driver for a time, but none of the railway's archives show his name and this cannot therefore be substantiated.[210] A further reference to a **Philip Yates** as driver of No.1 has also been made, and it is possible that this was the same person.[211] This was said to have been in 1846, which may allude to the locomotive's brief period running trains of general merchandise. His fireman was said to have been **James Coiley** who entered S & D R service in 1846, but again this cannot be substantiated.

Fig. 6.11 1875 photograph of an un-named driver posed in front of *LOCOMOTION*

[Source: NRM, York HQ Photos Box 9, 186-163-2].

A number of claims by men who stated that they had 'fired' on No.1 have also been made over the years, but as firemen were always employed by the drivers, they remained largely unnamed in the railway's records. **William Huntley** (1798-1880), a former pupil of George Stephenson, began work at the new Robert Stephenson & Co. workshops in 1823, and assisted with the erection of the locomotive in 1825. On the opening day of the railway, the 27th September that year, Huntley later recalled that he "had the honour of working it alternately with him (Stephenson)", but it is not possible to corroborate this, and he may merely have been on hand to assist with any mechanical adjustments that Stephenson called for.[212]

George Jennison (1811- 1884) began his working life at the age of 14 on the S & D R and was fireman on No.1 for two unspecified years, probably including 1834 as he later stated that he was on the first locomotive to cross the Tees suspension bridge in that year.[213] He also fired on a number of other locomotives.[214] He went on to become a driver, but of other locomotives, rather than No.1. He retired from the North Eastern Railway in 1883.

James Robinson claimed to have been a fireman on No.1 on two occasions in the 1830s, on the second occasion when Henry Joyce had been driving. **Robert Johnson Richardson** stated that he had been the fireman on No.1 on the occasion of the opening of the Redcar branch in 1846, but he made no reference to Ralph Morgan being the driver that would have confirmed this assertion.[215]

It was reported in 1924 that a **John Cowley** had once fired on No.1 for a day, but as he was then 83 years old, his birthday coincided with the locomotive coming out of service![216]

7. 'Duplicate' Career 1841-1856

LOCOMOTION remained as a 'Duplicate' asset in the accounts of the Stockton & Darlington Railway following its withdrawal from service in 1841. It was valued annually at a notional £100.[217] Between November 1840 and 1846, there was no record of it being used, even for works trains, or of any further maintenance being carried out on it.

From 1836, it had become the practice for the railway to sell its redundant locomotives to other railway or industrial concerns for the maximum price it could negotiate.[218] However, at that time *LOCOMOTION* was not placed on sale, indicating that either it was considered unsuitable for sale as a working locomotive, or that the railway's directors had formed a sentimental attachment to it, but had yet to make up their minds regarding its preservation. With no consideration of it being sold for scrap, the latter option apparently prevailed, thus possibly representing the first occasion where a railway asset was retained out of historic appreciation, less than 20 years after it had been brought into service.

LOCOMOTION remained at Shildon pending a decision about its future. Standing outside in the works yard it was covered with a sheet of canvass and became dirty and rusty.[219] However, in 1846 the directors had a further opportunity to use it as an operational locomotive. In that year the S & D R.'s Merchandise Committee began to arrange regular services for the movement of "merchandise" as a quite separate business from its coal and other mineral traffic, and its passenger traffic. At first the additional business was reliant on whatever motive power could be spared from those other traffics, which was not always adequate. In February 1846, the sub-Committee's minutes recorded:[220]

> The Company's Merchandise Agent made report that the detention of the Engine allotted to this Department in taking Stone, Coke, and other matters West of Shildon; has been the ground of great complaint and may cause much loss to the Company, this subject is referred to John Graham, that arrangements may be made to relieve the Merchandise Engine from this duty.

The Merchandise Agent later appealed to the Sub-Committee:[221] "In case of a Merchandise Engine Breaking down, what steps am I to take to replace it to prevent delay to the train?" It is therefore probable, though no date was recorded, that the only supplemental locomotive power available at that stage was No.1, which was then apparently drafted back into service on merchandise traffic. It was then, apparently painted in a dark brown livery.[222]

On the morning of Thursday, June 4th, that year, the Middlesbrough & Redcar Railway, a subsidiary company of the S & D R, was opened by the operation of two special trains, carrying over a thousand guests, between Darlington and Redcar, travelling via Yarm and Middlesbrough. Preceding these specials, a train of coal and limestone was drawn along the route. The event was recorded:[223]

> Previous to the train going down the new line, a short train of coals and lime had traversed the ground…. we mention this circumstance, not so much on account of the fact itself, as for the purpose of noting that this train was drawn by the very first

> locomotive engine manufactured in this country – we believe, we may say in the world – which is known on the Stockton and Darlington Railway as No.1, and which was once more brought into use on this occasion.

However, in one of the several speeches that followed the celebratory lunch in Redcar, Mr Nathaniel Plews of Darlington, a director of the Great North of England Railway, said:

> He felt more especial pleasure in meeting to celebrate this extension of the Stockton & Darlington line from a circumstance which might be looked upon as one of a singular nature – his having been brought to that place by the first engine that ever travelled with passengers in the United Kingdom – the old Stockton and Darlington Railway engine – No.1 (hear, hear and cheers)… they had that morning come by it from Middlesbro' to Redcar in 23 minutes (cheers).

A week after the opening of the Redcar line, the Merchandise Agent again represented to the Sub-Committee:[224]

> the impossibility of working the Merchandise Traffic properly unless relieved from that of the Stone Lime Brick &c:- he has also suggested further alterations, including the placing of a stronger Engine for the Active; which are to be submitted to the consideration of John Graham.

The use of the name 'Active' suggests recourse to the vernacular term which appears to have persisted amongst the S & D R staff throughout No. 1's career.[225] In any event, the reference to the locomotive as being No.1, rather than *LOCOMOTION*, is itself indicative of the number being used as a form of 'short-hand'. It may also reflect that the locomotive's nameplates, presumably previously attached to the boiler barrel, may have been removed in the early 1840s, but this circumstance was not specifically noted. How long No.1 remained in use on merchandise traffic is not known, but it seems that it was once more returned to storage in the yard at Shildon Works.

The S & D R was extended northwards in the 1840s from Shildon to Bishop Auckland and Crook to allow for the leading of coal from new mines in the northwest of County Durham via the S & D R. Separate companies, closely associated with the S & D R, undertook the railway schemes; the Bishop Auckland and Weardale Railway opened the line between Shildon and Crook, via Bishop Auckland, in November 1843, whilst the Weardale Extension Railway opened the line beyond Crook to Waskerley in May 1845. The network was further extended by the Wear Valley Railway to Frosterley, opened in August 1847.

It has been noted that No.1 was adapted in 1846 for use as a pumping engine at a colliery near the new Howden station on the line north of Bishop Auckland.[226] However, a thorough search in the railway's archives has failed to confirm this assertion. Indeed, its possibility seems to be contradicted by correspondence dating from 1849. In that year, space for locomotive storage was apparently getting difficult as John Graham felt obliged to write to Edgar Gilkes (1821-1894), the Manager of the Tees Engine Works of Middlesbrough, that

five redundant locomotives (including No.1) had "no place to stand" at Shildon.[227] He sought to store them instead in the coach shed at Stockton, which was then unoccupied. There is, however, no surviving evidence as to whether this move actually took place, but it may again have brought to the attention of the directors that a decision about No.1 was still awaited.

By coincidence, Robert Stephenson, in his role as a Commissioner of the Great Exhibition of 1851, wrote to Lieutenant-Colonel Reid, the Chairman of the Exhibition's Executive Committee, at a time when the take-up of exhibition space was hesitant, that it might be possible to exhibit three locomotives. He wrote:[228]

> I promised Col Reid when there was a probability of there being a lack of exhibitors to send an Engine or two and I had in my mind the notion of sending the old Engine with what the Stockton & Darlington was opened – (together with) the Rocket and one of our last improvements.

To have the old and new designs side by side was no doubt to emphasise the progress that had been made in locomotive design over the previous 26 years.

However, the take-up of exhibition space improved substantially in the early months of 1851 and, because he was absent in Egypt, Stephenson's idea was never pursued. It is not known if he had communicated his idea with the S & D R Directors.

The opportunities for the exploitation of coal offered by the growing network of lines north of Bishop Auckland encouraged Joseph Pease and his business partners to invest in several new pits near Crook. His new 'Pease's West Colliery Company' began coal mining in 1848. In readiness for this a siding was installed between the Weardale Extension Railway and 'West Durham Junction' and the colliery near Crook, later known as Roddymoor Colliery.[229]

Fig. 7.1 Letter heading of the Pease's West Colliery Company from 1849. [NA, RAIL 667/1176]

In 1851, John Dixon carried out the annual survey of the S & D R's locomotive fleet, and he noted that, since the previous year, No.1 had been "sent to Joseph Pease where she has been pumping water" and continued to value the locomotive for the railway company at a nominal £100.[230] This was a reference to it having been sent some eight miles from Shildon to Roddymoor Colliery where it was said to have been "considerably altered in its working parts to adapt it for pumping water out of a pit at Peases West Colliery."[231] The alterations may

well have been undertaken at Shildon Works before despatch, which possibly meant that it was hauled to Crook on its own wheels by another locomotive. However, no evidence has been found that would indicate the form that the locomotive took when it was used as a stationary engine for pumping.

It is possible that No.1 was used as a static boiler to provide steam for a pumping engine at the Colliery. The use of a locomotive for this purpose had previously been considered. Nicholas Wood had written to a correspondent as early as 1824 saying that, for a pair of 9in diameter cylinders with a 2 ft stroke, 6400 lb of water could be raised 40 feet in a minute.[232]

Once positioned adjacent to the pump, a steam line, tapped through the rear boiler end-plate, and regulator valve would have connected it to the pump. To allow water to be injected into the boiler as required when in use, it would have been necessary for its motion to have remained in use to drive the boiler feed-pump. This would have been made possible by the locomotive being jacked up clear of the track.

It is likely that it would, in addition, have been parked, with its rear end up to a pier without its tenders. This would have allowed a 1 ft overlap of the pier by the boiler, allowing the rear wheel-set to come up to the pier. This would have been achieved without the need to remove its rear drawbar bracket, which remained in place. This arrangement would have allowed a coal bunker to have been placed on the pier close to the fire-grate, easy access to the 'smokebox' for the removal of ash, a water supply to be plumbed in to the boiler feed pump, and a steam line to have been fitted into the rear end-plate to supply steam for the pump. One engine-man on the pier could thus have maintained a steam supply for the pump.

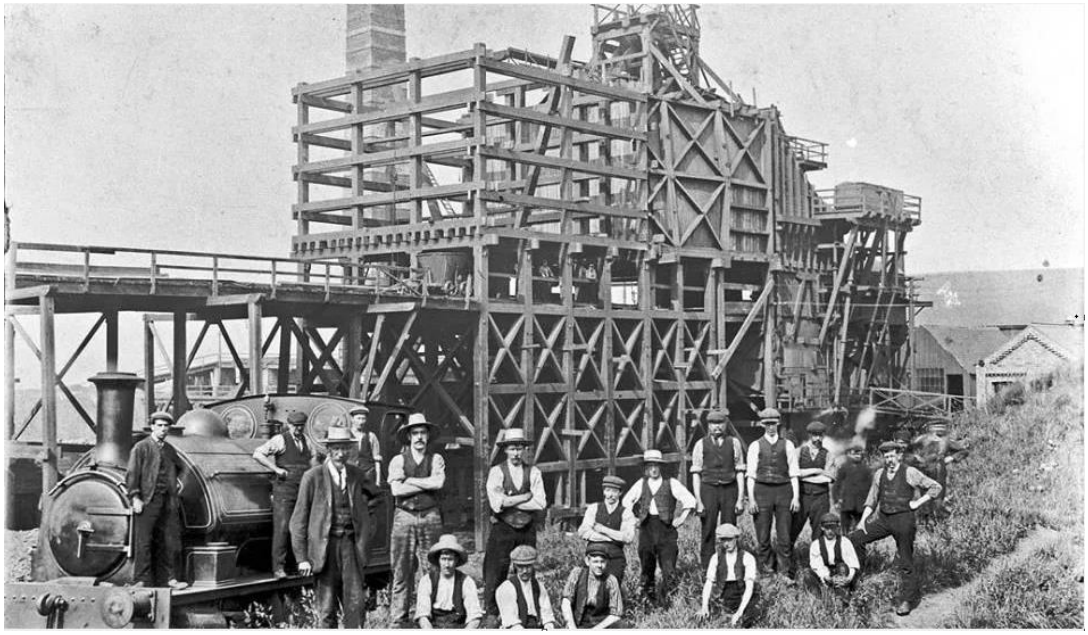


Fig. 7.2 Roddymoor Colliery in c1900. No earlier photo of the colliery has been traced. [northeastheritagelibrary.co.ukcoalsarchivec-r03apease's-west-colliery – accessed September 2022];

It has been noted by a latter-day historian that No.1 was included in a list of locomotives to be sold by auction in Stockton in January 1856, but the locomotive remained at Roddymoor

Colliery then, and no records have been found in the railway's archives to confirm this intention.[233]

No.1 was however returned to Shildon workshops on the 28th March 1856, apparently again hauled as a 'dead' load. William Bouch, the S & D R's Locomotive Superintendent, reported that it: "remains in its altered state, the connecting and side rods &c being packed in the tube."[234] He then reported that "to restore it to its original state as a Locomotive will probably cost £50 irrespective of any repairs that may be rendered needful by its use at the Colliery." It was clear that the directors had decided to preserve it for display, perhaps prompted by Robert Stephenson's idea for the Great Exhibition, but had yet to make up their minds as to what form this might have taken. Later in 1856 it was noted that No.1 was "Preparing for the Museum by order of Directors", but no further reference to a museum project has been traced.[235]

That Bouch was instructed by the directors to re-form what remained of No.1 is indicated by his choice of words "to its original state as a Locomotive". He clearly interpreted this to mean that he was required to provide a replicated vehicle that adopted as much as he could recover from the remains of No.1 but installing missing and altered components that were available from the 'duplicate' store at Shildon works. Whilst using its boiler barrel, it appears that he removed the return-flue from it and replaced it with a single flue to re-create its original arrangement, with a fireplace at the rear and a chimney at the front (Fig. 7.3). Its wheels may have survived during its time at Roddymoor Colliery, but no springs or frame were installed.

A newly assembled replica tender was provided with a square tank above a wooden body and fitted with cast iron wheels.

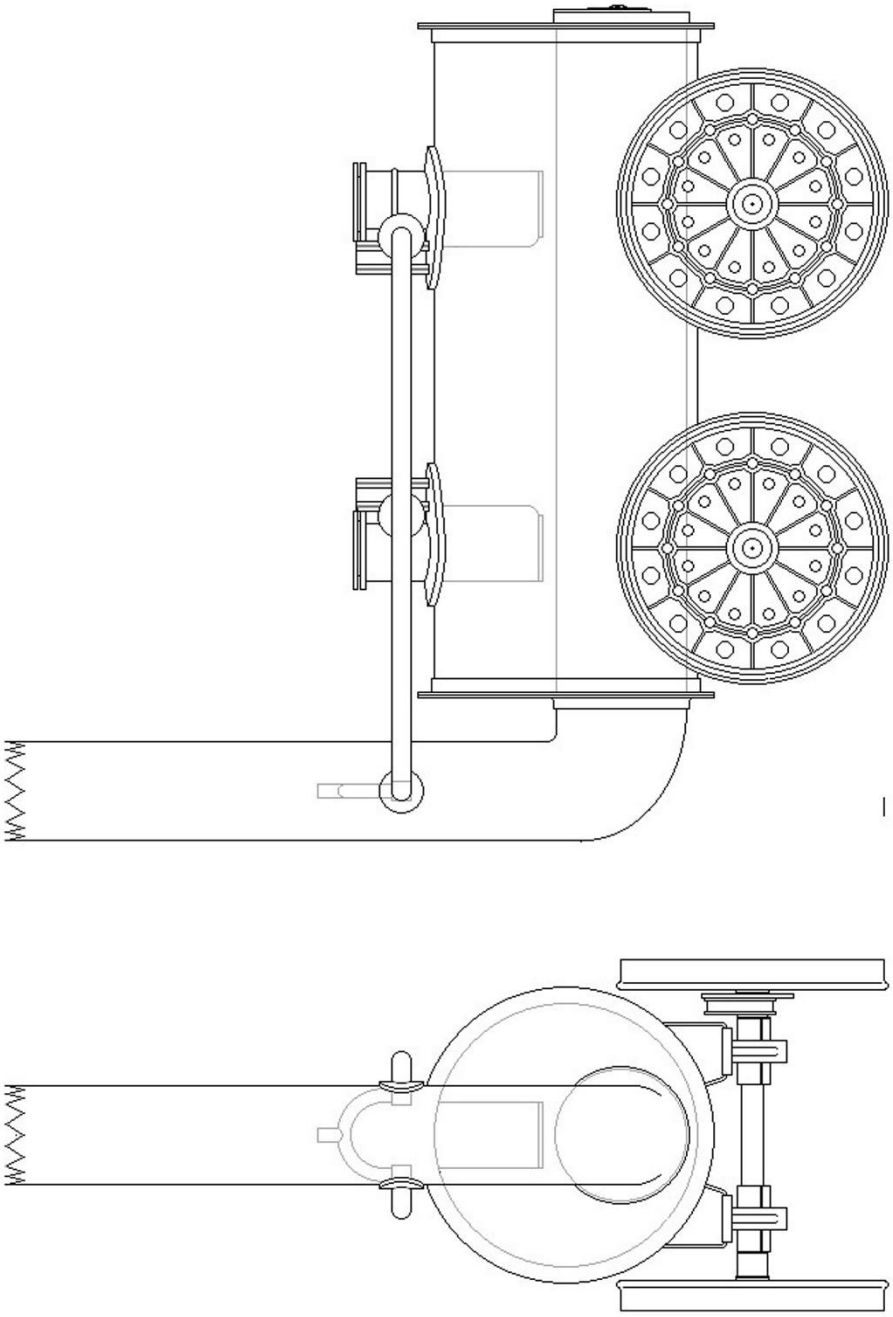


Fig. 7.3 No.1 as re-formed in 1856/7 to resemble its 1825 appearance – Showing replicated single flue and chimney arrangement. (Parallel motion, connecting and coupling rods omitted)

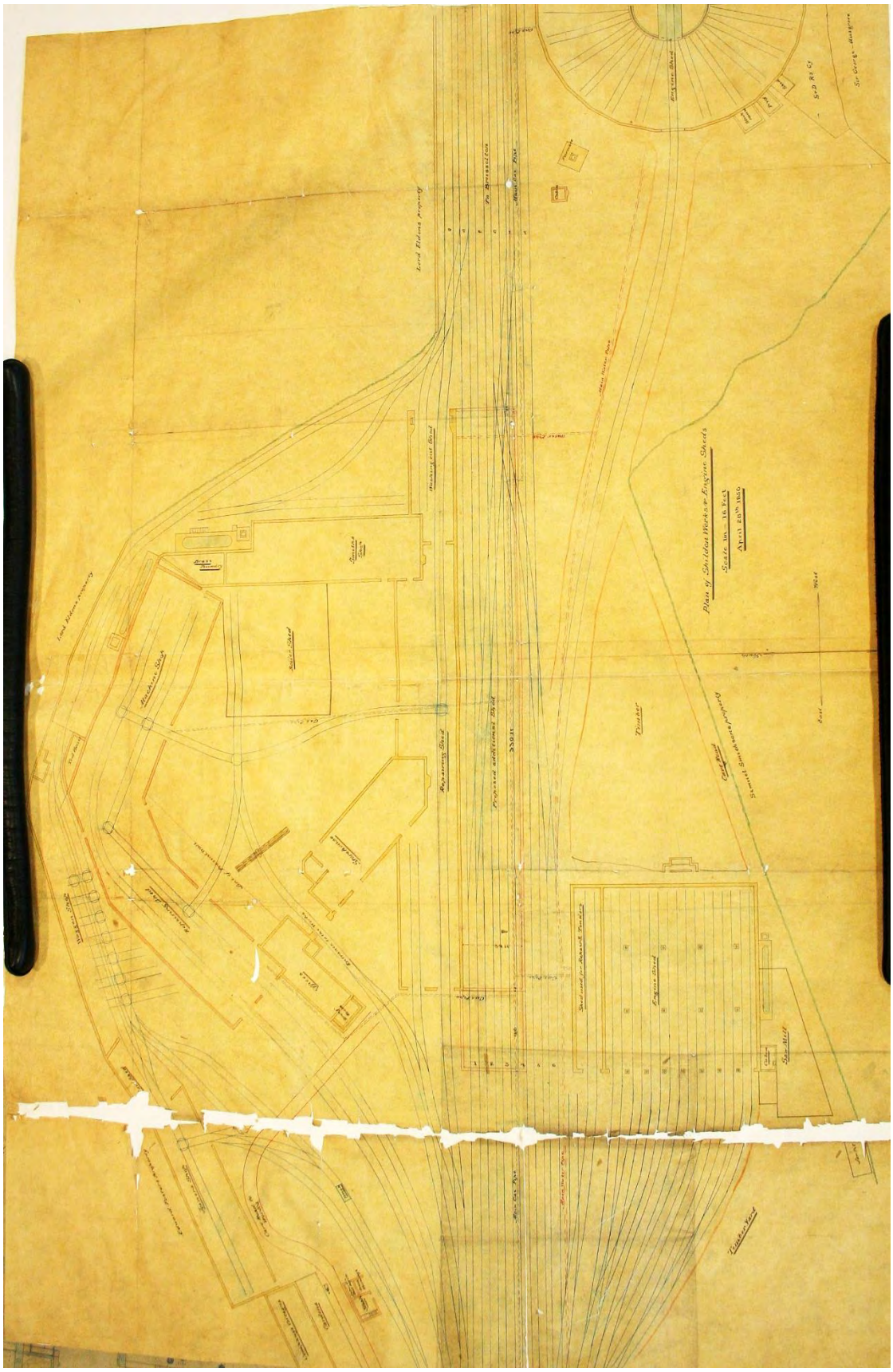


Fig. 7.4 Shildon Works layout, dated 28th April 1856, when *LOCOMOTION* was being returned to its "1825" arrangement. [NRM, NE C & W]

8. Preservation History 1856 - 2023

The notion of preserving No.1 as an historic artefact was apparently first considered in March 1856. The 'Power Committee' of the S & D Ry. discussed the subject at its meeting on the 24th of that month, enquiring as to its whereabouts and condition, and asking how much it would cost the company to return it to something close to its original appearance.[236] Such enquiry marks the second occasion in railway history where a locomotive was considered for preservation as an historic artefact. Previously, the Robert Stephenson & Co.-built *ROCKET*, winner of the Rainhill Trials, was made available for display at the Great Exhibition in London in 1851, and was taken to the Stephenson Company's works in Newcastle for restoration. However, this plan was subsequently abandoned, and it was kept there until 1862, when it was prepared for display at the Patent Office Museum in London.[237]

Consideration of the preservation and display of No.1 thus preceded that of *ROCKET* by five years. It marked an important milestone from previous consideration of all railway machinery as being assets for the railway companies alone, to being artefacts of historic significance worth preserving for nostalgia and historic understanding of the progress of the railway industry.

Prompted by the minutes of the March meeting, William Bouch, the Stockton & Darlington Railway's Locomotive Superintendent, responded on April 26th that, following its use as a stationary pumping engine at Pease's West Colliery, No.1 had been returned to Shildon Works on the 28th March 1856 still in its modified form for pumping. He wrote:[238]

> To restore it to its original state as a locomotive will probably cost £50 irrespective of any repairs that may be rendered needful by its use at the colliery.

Consideration of this expenditure, approval to proceed with the work, and the work itself took several months to complete. In 1925, the North Eastern and Scottish Magazine introduced its readers to John Cowley, a retired man from Hartlepool who claimed that he had fired on No. 1 for just one day in 1857 when the locomotive had been loaned to a firm of contractors who were undertaking the building of Durham station for the North Eastern Railway.[239] There is, however, no record in the archives of the S & D R that relates to such a sub-contract having actually taken place, and Mr. Cowley's claim cannot now be substantiated.

On May 20th, 1857, Thomas MacNay, the S & D R's Company Secretary, wrote to several employees and agents to say:[240]

> The Directors have it in contemplation to erect a suitable Pedestal, &c at Darlington upon which to place the Old Locomotive Engine No.1, as a memento of the past, and they think the laying of the Foundation Stone a fitting time to give an entertainment to the Company's Agents in the several departments, as far as they can be dispensed with from their duties.

The press was alerted to the forming of a 'Foundation Stone' for this purpose in early June. A brief report read:[241]

> The FIRST LOCOMOTIVE ENGINE: The Directors of the Stockton and Darlington Railway have determined to preserve their No 1 Locomotive Engine, the first run on a public railway, and have accordingly appropriated for the purpose a piece of ground in front of the station, at Darlington, where it will be placed on a pedestal under a shed, to be erected for receiving this relic.

The laying of the foundation stone took place, with ceremony, on Saturday, 6th June 1857, as a paternalistic gesture, in front of eighty people, mostly employees with some other invited guests. Edward Pease was invited to officiate at the ceremony, but due to his "advanced years" he declined, and the ceremony was undertaken by Joseph Pease MP, Henry Pease MP, John Dixon and Thomas MacNay. The assemblage was thereafter entertained to a "grand-dinner", with "numerous speeches". This was followed by tea for the guests at Henry Pease's estate, *Pierremont*, for which a marquee had been erected, "after which cricket and quoits were the order of the evening."[242]

The foundation stone was carved with "S. &. D. R. Nº 1. 1825." The 'pedestal' was thereafter completed and No.1 placed upon it a few days later on an unrecorded date. The plan to place a canopy or shed over the artefact appears to have been abandoned from the outset and all photographs of it on the pedestal show it to be without any form of cover.

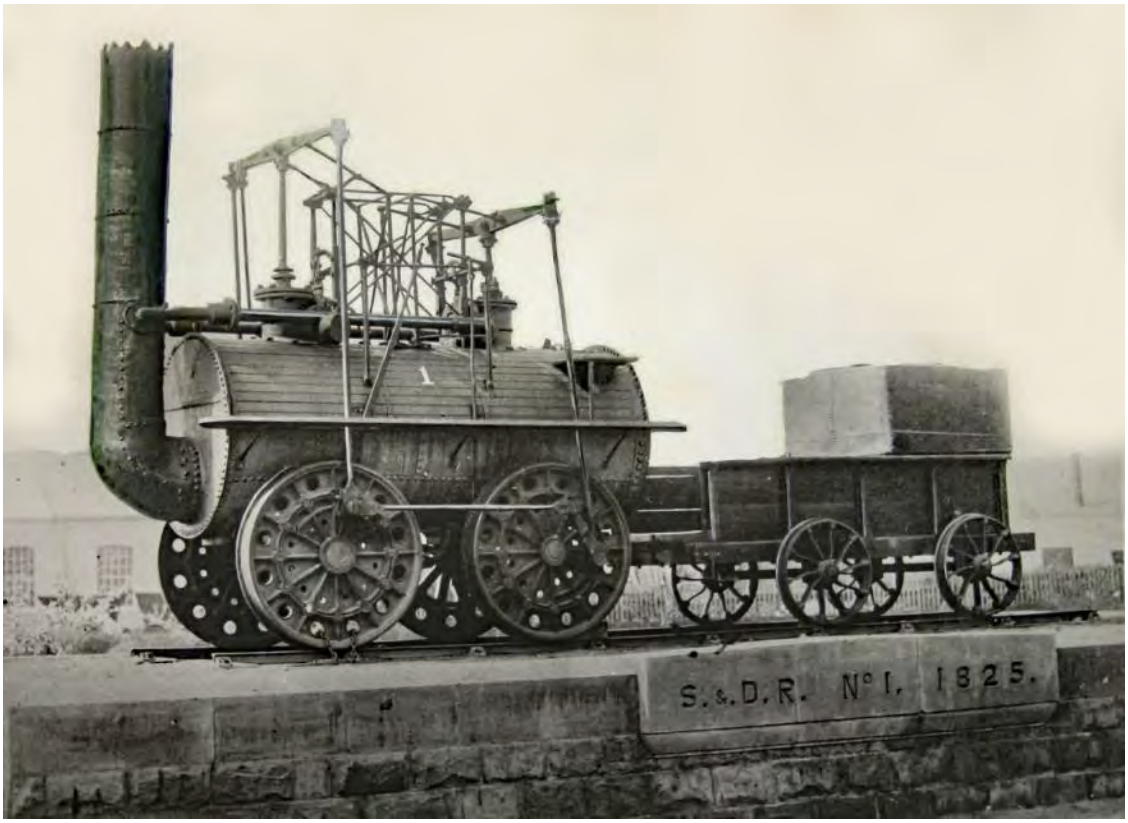


Fig. 8.1 Earliest known photograph of No.1, believed to have been taken shortly after being placed on the pedestal outside Darlington North Road station.

[NRM Collection, York HQ Photos Box 9, 1065 & x35789]

It is noteworthy that the artefact was referred to by the Company in the 1856/7 events only as No.1, without reference to the name *LOCOMOTION*. The earliest known photograph of the locomotive and tender shows a '1' fitted to the boiler-cladding on the left-side, but the locomotive name was absent.

It is not known when the original nameplates had been removed from the locomotive, but in 1940 a Dr. Jessie B. Johnson (1880-1944) of Youngstown, Ohio, representing herself and her brother, V.C.S. Johnson, of Hemet, California, donated to the Baltimore & Ohio Railroad the corroded remains of two iron *LOCOMOTION* nameplates. They remain in the collection of the Baltimore & Ohio Railroad Museum in Baltimore.[243] As part of this study, enquiries were made of the museum to ascertain if any paperwork survives that would determine the origin and provenance of these nameplates. However, no paperwork survives to provide this information. It would seem that Dr. Johnson's grandfather, William Johnson (born in Darlington in 1804), may have been the person who obtained, under unknown circumstances, the nameplates after *LOCOMOTION* was taken out of service in 1840/41. He emigrated to the United States in 1848 with his wife, Jane, and their children, including their fourth child, Catherine Hannah (1836-1907) and settled in Illinois. Catherine Hannah Johnson was Jessie Johnson's mother, so an apparent link has been established, although specific evidence that both the weighty nameplates went with the emigrant family has not been confirmed. That Dr. Johnson apparently knew of the origin of the plates is indicative that their origin had been relayed to her by her grandfather and mother.

Fig. 8.2 Photographs of the *LOCOMOTION* nameplates included in the B & O R/R Museum's collection.

[NRM, Historic Photos file 812 (2)]

When *LOCOMOTION* was placed on the pedestal, a wooden-framed and wooden-bodied replica tender with cast iron wheels was matched up with it, on which was mounted a square wrought iron water tank. Its chassis was based on the standard Shildon freight vehicle of the era, and bore no resemblance to the large-barrelled vehicle of the 1825 locomotive.

On an unknown occasion, apparently within just a few years of the vehicle being placed on the pedestal, the omission of a *LOCOMOTION* nameplate was apparently pointed out, and moves were taken to fit a replica nameplate in the centre of the boiler's left-side, but possibly not on the right-side, that space being occupied by the boiler feed-pump. A further photograph, apparently taken in the late 1850s or early 1860s shows the new nameplate in place, but with the omission of the '1'. It is possible however that '1' was painted on the leading end of the boiler cladding on the right-side.

In the 1860s, the Patent Office Museum, founded a decade before under its energetic 'Assistant to the Commissioners of Patents', Bennet Woodcroft FRS (1803-1879),[244] began its collection of historic machinery to add to its initial collection of patent models. In April 1862, the year that it collected Robert Stephenson's *ROCKET* and Wylam Colliery's *'Puffing Billy'* for its collection, an approach was made by Francis (later Sir Francis) Pettit Smith (1808-1874), the museum's Curator, on behalf of Woodcroft to visit Darlington to enquire about the acquisition of *LOCOMOTION* for the Museum's collection.[245] The Stockton & Darlington Railway however did not agree to either its loan or acquisition into the museum's collection, and the artefact remained in the railway's possession upon its plinth in Darlington.

Fig. 8.3 Photograph taken in the late 1850s or early 1860s showing the replica nameplate fitted to the boiler. (The newly planted tree ahead of the pedestal is helpful in dating the picture)

[York HQ Photos Box 9, PRO 5581]

In 1863, the Stockton & Darlington Railway became a separate operating division of the North Eastern Railway. The locomotive and tender remained on the pedestal for 18 years, from 1857 to 1875. At some time in the 1860s or early 1870s, a chaldron wagon was added behind the tender, no doubt to emphasise the role played by the locomotive during its working life.

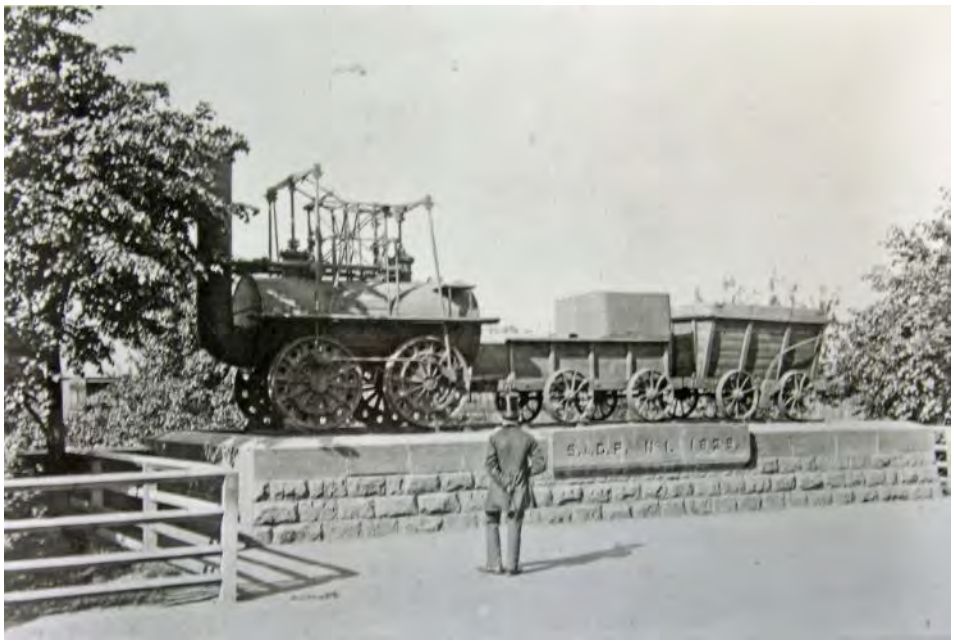
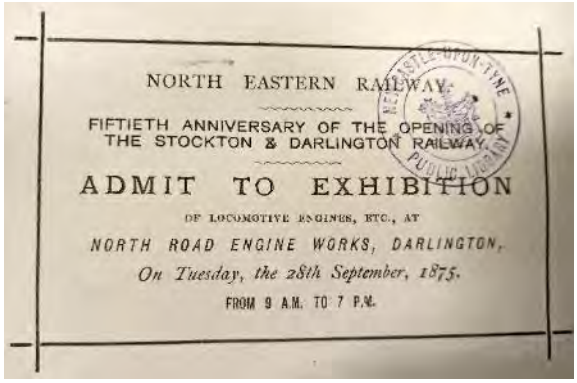


Fig. 8.4 Early-mid 1870s photograph, showing a chaldron wagon placed behind the tender. The number '1' has now been painted on the cladding above the nameplate. (The tree ahead of the pedestal has ten years or more growth since Fig. 8.3) [NRM Historic Photos file 812, C11254]

In 1875 the North Eastern Railway commemorated the 50th anniversary of the opening of the **Stockton and Darlington** line with a **'Jubilee'** celebration in Darlington.[246] The arrangements for the Jubilee were undertaken by a committee of three senior personnel from the railway's division, Messrs. W. Snaith, George Graham and William MacNay who were charged to assist William Bouch, who was directing the occasion, in making preparations.[247] The Jubilee took place over two days, Monday and Tuesday 27th and 28th September.[248] A collection of locomotives from the North Eastern Railway and other railways was brought to the town, including the historic Stephenson-built *INVICTA*, on loan from the South Eastern Railway. They were placed on display at the company's North Road Locomotive Works in the town, some workshops of which were cleaned and decorated for the occasion.


NORTH EASTERN RAILWAY.

FIFTIETH ANNIVERSARY OF THE OPENING OF THE STOCKTON & DARLINGTON RAILWAY.

ADMIT TO EXHIBITION

OF LOCOMOTIVE ENGINES, ETC., AT

NORTH ROAD ENGINE WORKS, DARLINGTON,

On Tuesday, the 28th September, 1875.

FROM 9 A.M. TO 7 P.M.

Fig. 8.5 Ticket for the 1875 Railway Jubilee

[Newcastle City Library, Tomlinson Collection, Cr 6749-6753]

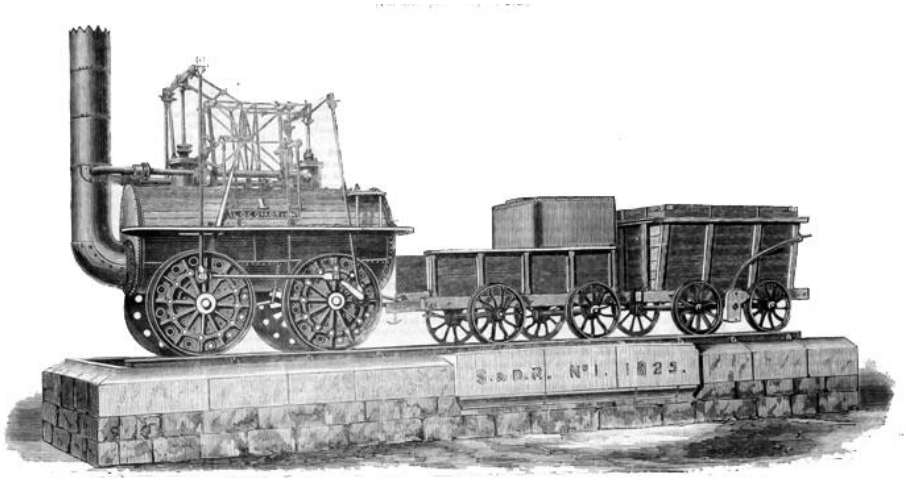


Fig. 8.6 *LOCOMOTION* shown just before its appearance at the Jubilee in 1875, with, on its left side, the replica 1850s/1860s nameplate and painted No.1 above. [*The Engineer*, 24th September 1875, p.218]

LOCOMOTION was removed from its pedestal and moved the few hundred yards to the Engine Works to join the gathering. It was placed next to No. 1068, a 2-4-0 tender locomotive that was newly completed at the Works, to highlight the progress in locomotive design in the intermediate 50 years. No.1 was:[249]

> mounted on baulks of timber with the wheels clear of the rails; the pistons had been drawn and packed, the gear generally cleaned up, tightened, and put in order, the glands packed, and steam was led to the cylinders – not the boiler - by a pipe, and so the wheels once more revolved under the influence of steam.

The steam was provided from the works boiler through pipes leading to replacement valve chest covers to which the pipe flanges were bolted. The tender of No.1 formed a dais from which the Chairman of the 'Darlington Board of Directors', Henry Pease MP, gave his speech to invited guests on the Monday.

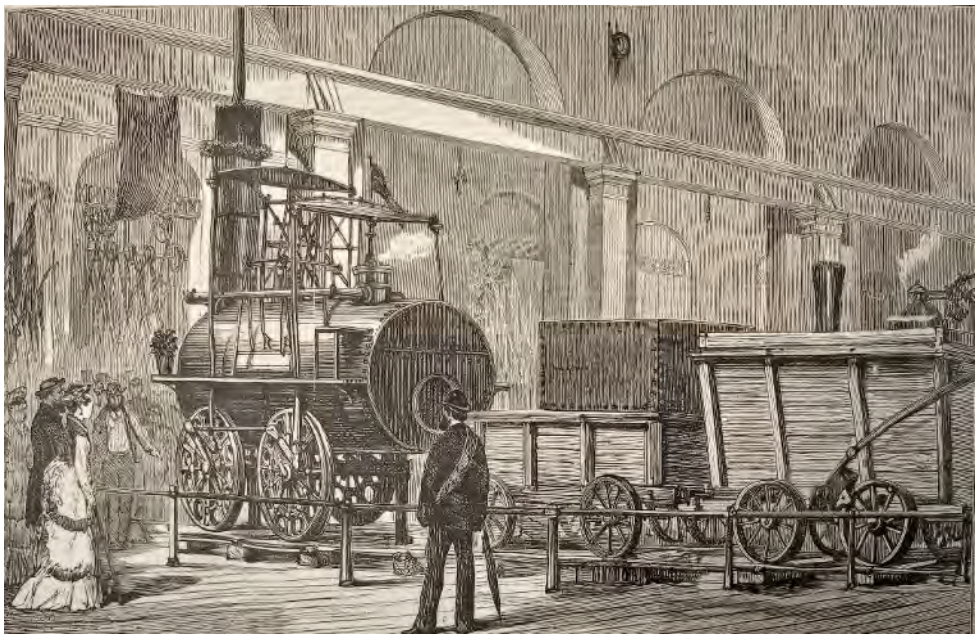


Fig. 8.7 *LOCOMOTION* on display at the Railway Jubilee, Darlington, 27th September 1875

(*The Graphic*, 2nd October 1875)

It has been written that the locomotive's nameplate on its left side was replaced by a later version, incorporating 'No.1' and '1925'.[250] However, all the contemporary photographs and drawings show that it retained its replica 1850s/1860s *LOCOMOTION* nameplate, with number '1' painted on the boiler lagging just above it. On the right side of the boiler no nameplate was placed, whilst the number '1' was painted on the lagging towards the upper leading end. The locomotive, together with its tender and chaldron wagon, was returned after the event to its place on the North Road pedestal.

The Jubilee events were witnessed by many thousands of visitors to the town as well as Darlington's own townsfolk, and descriptions in the local newspapers were extensive.[251]

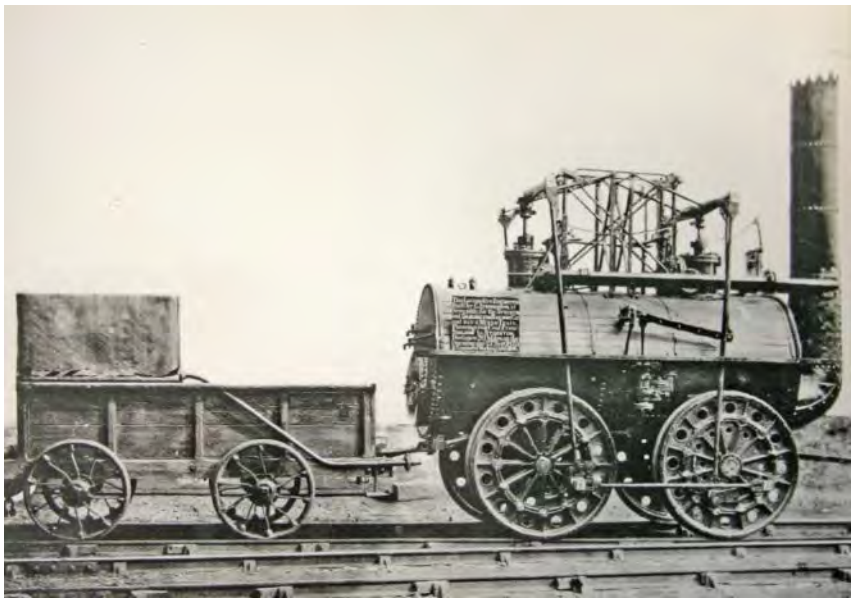


Fig. 8.8 Right-side view of *LOCOMOTION* taken for the 1875 Jubilee in Darlington. No name is carried on this side, but the number '1' is painted on the top right of the boiler cladding.

[NRM, Historic photos file 812, CCE 18343]

Fig. 8.9 Colour print of a painting of *LOCOMOTION* (mis-spelt *LOCOMOTIVE*) hauling a train, published for the Jubilee in 1875 by J. Urwin of Darlington. The 1850s/1860s nameplate is shown, but the painted number is omitted.

[NRM, 1977-7665]

In 1876, the United States of America celebrated that country's **centennial event** in Philadelphia. A major 'Exposition' was held at Fairmount Park in the city, and it has been

said that *LOCOMOTION* was sent from Darlington to appear at the event.[252] There was however, no report in the newspapers of either Great Britain or the United States that would confirm the loan or shipment of the locomotive. A search through the exposition's extensive catalogue makes no mention of No.1 visiting the city, although the preserved Stephenson-built locomotive, *John Bull* was displayed.[253] Seven years later though, in 1883, No.1 was sent to Chicago for display at the Exposition of Railway Appliances, (see below) and it would seem that at some stage in the curating of this artefact, an error has occurred in the object file.

On Thursday, June 9th 1881, a major celebration took place in Newcastle-upon-Tyne and Gateshead to commemorate the **centenary of George Stephenson's birth**.[254] The city had a programme of events, with processions, lunches, a banquet, an exhibition, a parade of modern locomotives, and a line-up of historic locomotives. The line-up, which took place at the Infirmary Sidings, to the west of Newcastle's Central Station, included *LOCOMOTION* brought up from Darlington for that day. It was displayed adjacent to a chaldron wagon, presumably that which normally accompanied it on the pedestal at Darlington.

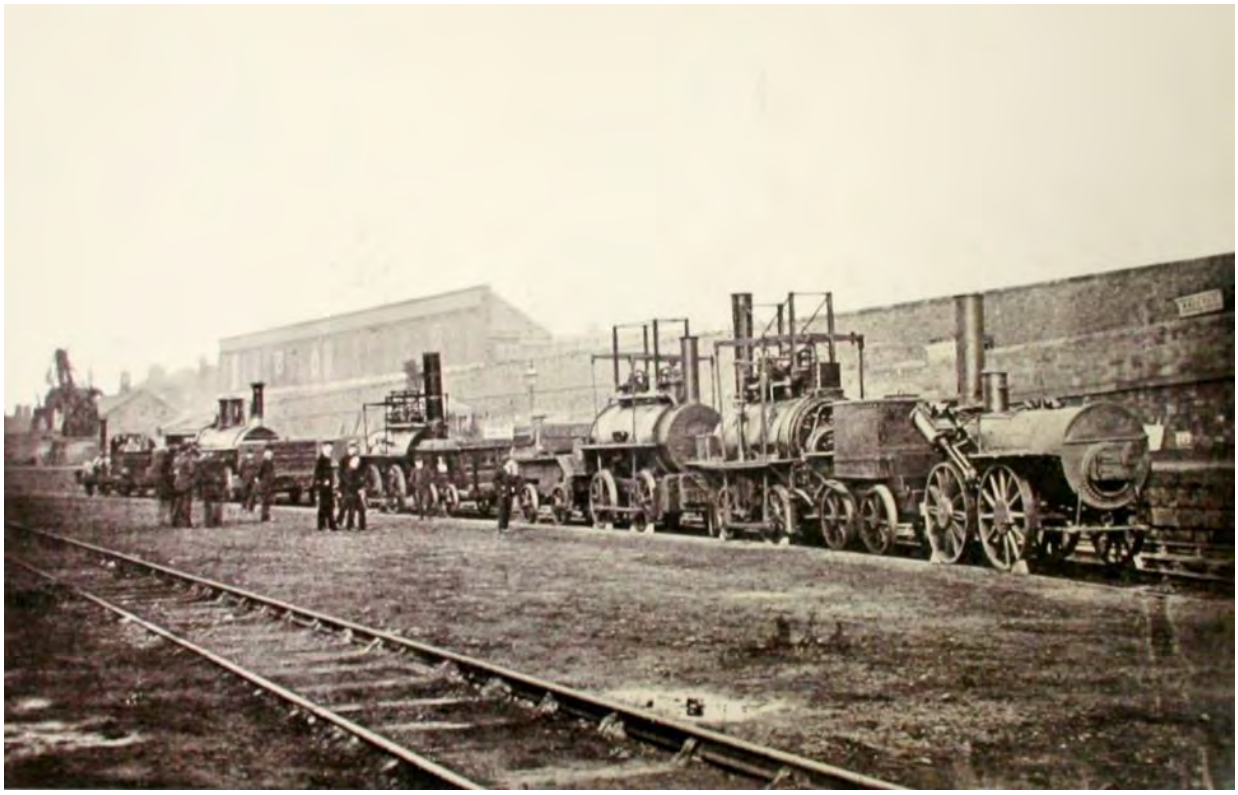


Fig. 8.10 Line-up of historic locomotives at Infirmary sidings, Newcastle on 9th June 1881. *LOCOMOTION* stands fourth from the camera, with a chaldron wagon in front.

[NRM, Bleasdale Collection]

The event was attended by no less than 70,000 people from the Tyneside area and further afield.[255] The visitors included Samuel Ford, the Chief Mechanic of the Patent Office Museum, who reported to Lt. Colonel H. Stuart Wortley (1832-1890), the museum's then Curator. He again discussed the possibility of transferring *LOCOMOTION* to the Patent Office Museum's collection, this time with John Armstrong Haswell (1820-1894), the Assistant Locomotive Superintendent of the North Eastern Railway.[256] Significantly, the argument he used was that the artefact had been deteriorating in the twenty-four years since it

had been placed on the open plinth outside North Road Station. Haswell agreed to place the matter before senior officers of the North Eastern Railway, and on July 4th, Colonel Wortley wrote to Henry Reader Lack, Clerk to the Commissioners of Patents, that the locomotive was being offered to the Patent Office Museum, and that "I hope you would allow me to accept it."[257] However, for unknown reasons, the offer was not proceeded with, and, as in 1862, nothing resulted from this approach.

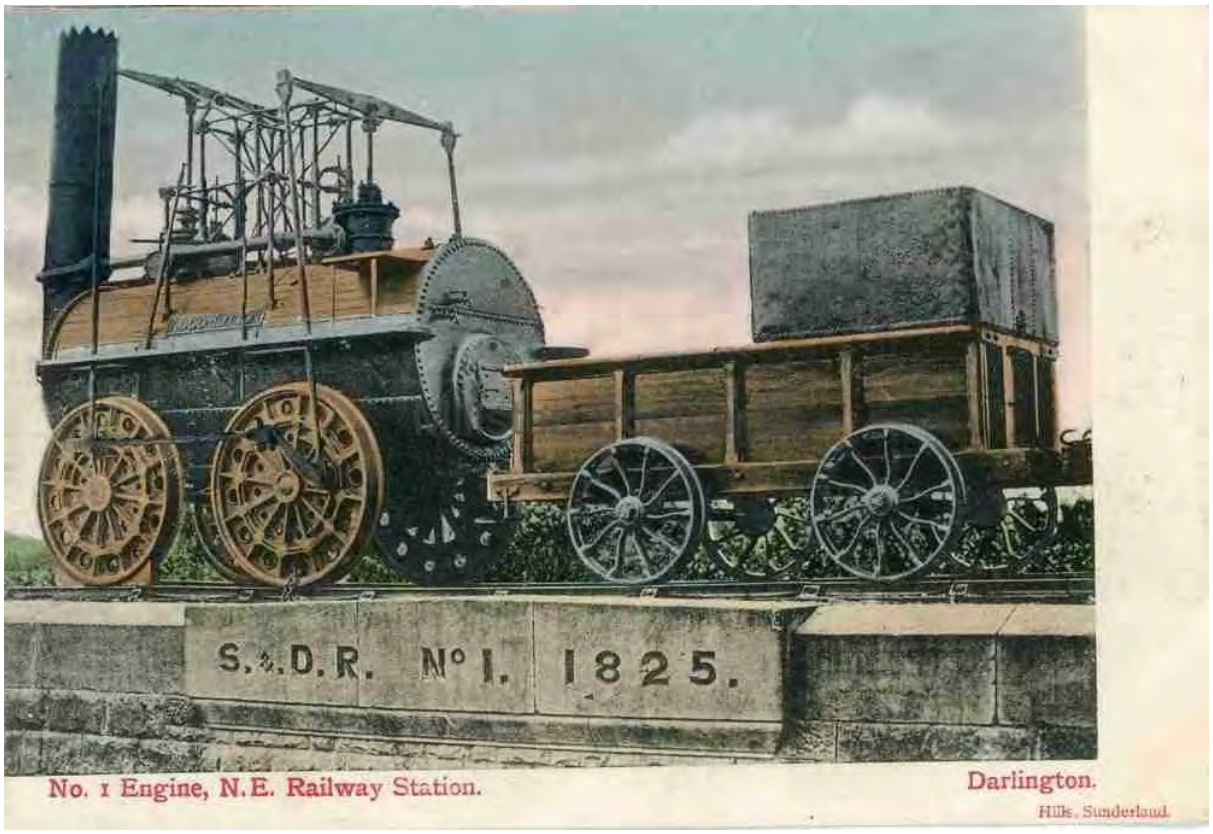


Fig. 8.11 Colourised photographic postcard of *LOCOMOTION* from the late 1870s/early 1880s [Published by Hills of Sunderland]

Also attending the Newcastle event in 1881 was a delegation from Chicago, Illinois, in the United States of America. The city was then planning the **Chicago National Exposition of Railway Appliances** for two years later, and an approach was subsequently made by the organisers to the North Eastern Railway Company, asking if *LOCOMOTION* could be made available for display at the Exposition. When this was agreed to in March 1883,[258] arrangements were made to ship the artefact across the Atlantic, and then onwards by rail to Chicago. The Exposition took place between Thursday, May 24th and Saturday, June 23rd 1883 at the 'Inter-State Exposition Building'.[259] During this month, No.1 was given a cast brass bell, which was fitted above the crown of the boiler at its leading end. It has remained in place since that time. The date of No.1's return to Darlington went unrecorded.

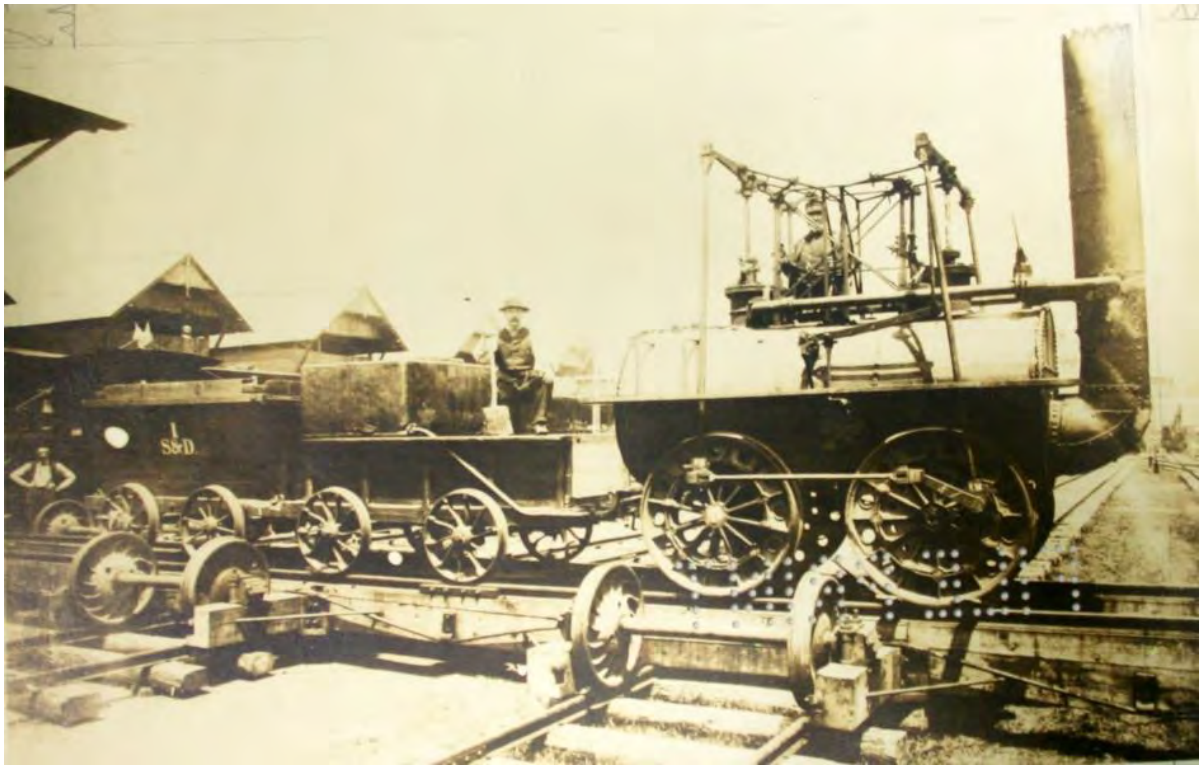


Fig. 8.12 ***LOCOMOTION*** **posed on a traverser during its visit to Chicago in 1883. The brass bell is fitted at the leading end of the boiler.**

[Photograph made available by John H. White Jr., Smithsonian Institution, as shown in Brian Reed, ***Loco Profile 25: LOCOMOTION*****, p.16]**

When plans were being made for its dispatch to Chicago, the Patent Office Museum pursued its interest in putting *LOCOMOTION* on display in London on its return.[260] This was partly prompted by reports that the condition of the locomotive and tender were deteriorating. A contemporary press report even mentioned that "…a portion of the tender has decayed and fallen way."[261] Col. H. Stuart Wortley, being aware of the locomotive's excursion away from Darlington, wrote to the Mayor of that town, referring to the discussion that Samuel Ford had had with him on the occasion of the Stephenson Centenary two years earlier. The discussion had been "as the desire of yourself I believe, that owing to the effect of long continued exposure to weather upon it, the engine might be sent for exhibition where it would always be under cover." The Mayor's response to this approach is not recorded however, but Wortley appears either not to have understood that the North Eastern Railway was the legal owner, or perhaps he believed that the Mayor had undue influence over the locomotive's affairs.

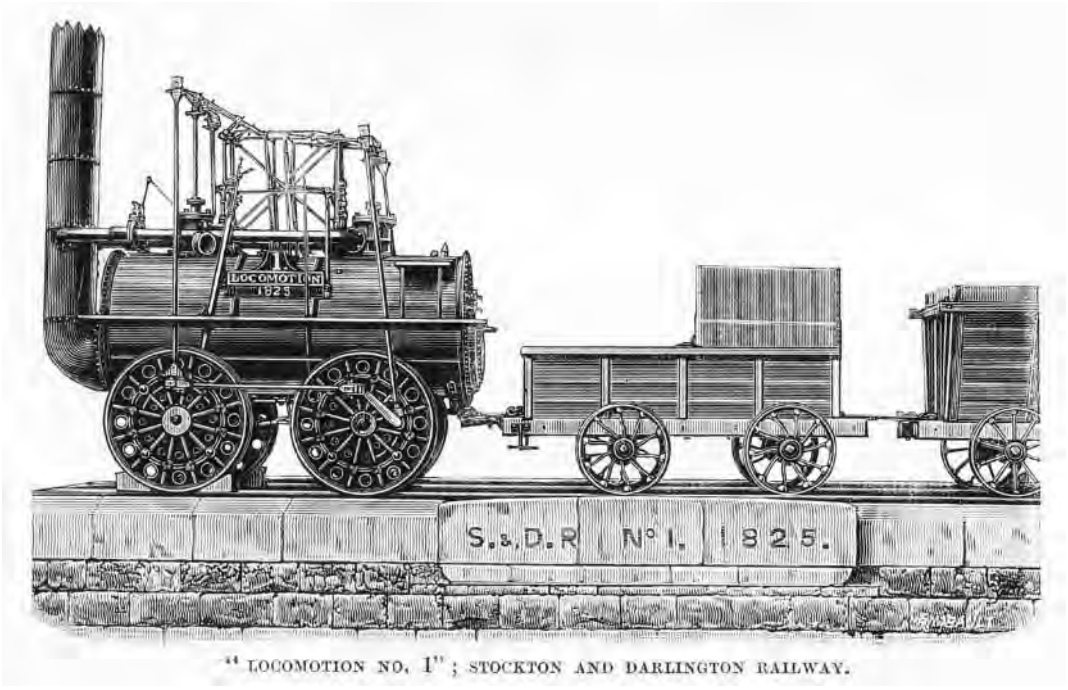
In 1886, a request was made to the North Eastern Railway for No.1 to be displayed at the **Liverpool International Exhibition of Navigation, Travelling, Commerce and Manufacturing Industry**, that was held between Tuesday, 11th May and Monday, 8th November that year. The Exhibition was opened by Queen Victoria and was housed in a large Exhibition Hall brought from Antwerp and erected in Wavertree Botanic Gardens. No.1 was displayed at the Exhibition throughout this period. Other exhibits included the

GREAT EASTERN steamship moored in the River Mersey. During the 156 days of the exhibition, it was attended by 2.7 million visitors.

In the following year, *LOCOMOTION* was again called for exhibition, this time in Newcastle-upon-Tyne at **The Royal Mining Engineering Jubilee Exhibition**.[262] This was held on the City's Town Moor and was opened by the Duke of Cambridge on Wednesday, 11th May 1887. The exhibition, which continued until Friday 28th October 1887, attracted some 2.1 million visitors during its 170-day duration, and included displays of historic locomotive manufacturing drawings loaned by Robert Stephenson & Co., as well as No.1.

Two years later, *LOCOMOTION* was called upon once more to be an exhibit at an international event. This time it was in Paris at the **Exposition Retrospective du Travail**, which was put on to coincide with the capital's major **Exposition Universelle** held in the city between Sunday, 5th May and Thursday, 31st October, 1889, an event which was dominated by the newly-built Eiffel Tower. Part of the Exposition Retrospective du Travail was dedicated to the 'Retrospective Exhibition of Means of Transport', of which 'Transportation by Railway' formed the third division.

LOCOMOTION was a leading exhibit in this division, and was accompanied by other early British artefacts, including the Hazledine stationary engine boiler, and the new replica of *ROCKET*, both loaned by the London & North Western Railway at Crewe, together with models, maps and plans, including early locomotive arrangement drawings made available by Robert Stephenson & Co.[263] No.1, now fitted with new nameplates on its left side incorporating No.'1' and '1825', departed Darlington on Sunday 14th April for its journey to Paris.[264] It was accompanied by its tender and the chaldron wagon.



"LOCOMOTION NO. 1"; STOCKTON AND DARLINGTON RAILWAY.

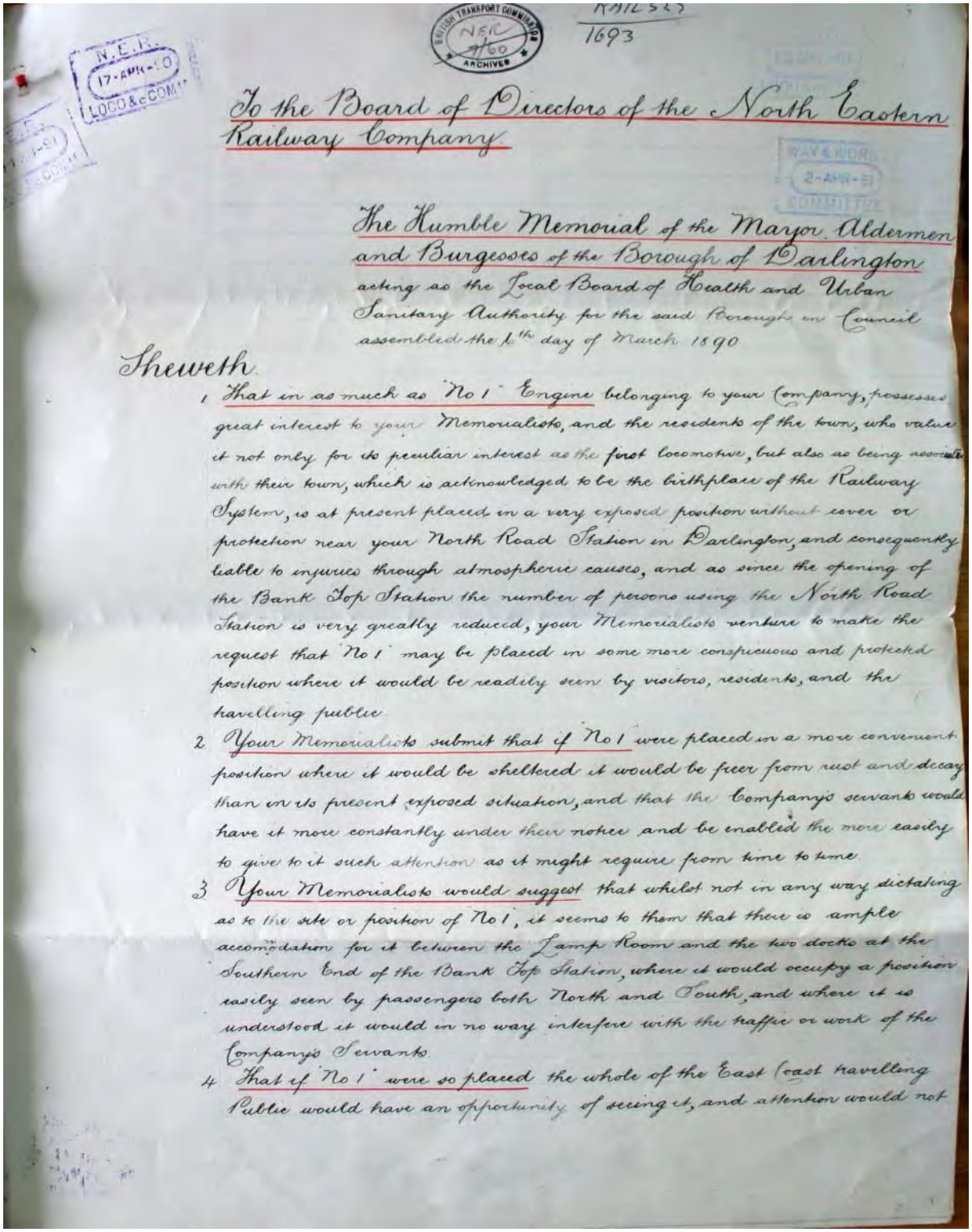
Fig. 8.13 Woodcut image of *LOCOMOTION* prepared prior to its dispatch to the Exposition Retrospective du Travail in Paris in 1889. A new brass nameplate has been fitted showing both its number and date of manufacture, as well as its name. The locomotive is believed to have been painted olive green and black at this time. [*Engineering*, Vol. 47, (1889), p. 707]

In 1890, *LOCOMOTION* was finally exhibited at the **International Exhibition of Electricity, Engineering, General Inventions and Industries** in the Meggetland district of Edinburgh.[265] It was opened by the Duke of Edinburgh on Thursday, 1st May and closed on Saturday 1st November, during which time some 2.4 million visitors attended. No.1 was joined at the exhibition by the North Eastern Railway's 4-2-2 compound locomotive No. 1329, to emphasise the progress made in locomotive design in the intermediate 65 years. No.1 was also joined by 'Wylam Dilly', loaned by the Royal Scottish Museum in Edinburgh. The Crewe replica of *ROCKET* was also exhibited, together with the Hazledine stationary engine boiler. The locomotives and other railway artefacts were displayed in the 'railway annex' to the Exhibition's 'Machinery Hall'.

Preceding *LOCOMOTION*'s exhibition in Edinburgh, the North Eastern Railway received 'A Humble Memorial from the Mayor, Aldermen and Burgesses of the Borough of Darlington acting as the Local Board of Health and Urban Sanitary Authority' pleading for the railway to place the artefact on display under cover on Bank Top station, where it could be "placed in a more convenient position where it would be sheltered and would be freer from rust and decay than in its present exposed situation….".[266] The Memorial, sealed in wax with the town's 1867 emblem incorporating an image of *LOCOMOTION* and wagon, was signed by Joseph A. Pease, the Mayor, and F.T. Stevenson, the Town Clerk (Figs. 8.15-8.17).

On its return from Edinburgh, the North Eastern Railway accepted that *LOCOMOTION*'s condition had deteriorated unacceptably.[267] The locomotive and its tender were restored and re-painted in the North Road Locomotive Workshops in Darlington during 1891/2. The colour scheme was altered from olive green and black, to blue, red, yellow, white and black, with the brass bell and nameplate remaining unpainted.[268] The artefact was no longer made available for exhibition elsewhere, and in April 1892 was placed on permanent and prominent display on a new plinth under the platform roof at the southern end of Darlington's Bank Top station.[269] For this purpose an additional name/number/date plate, similar to that carried on its left side, was added to the locomotive's right side. The chaldron wagon that had formerly been displayed with it on the pedestal at North Road no longer accompanied it.

Fig. 8.14 *LOCOMOTION*, newly restored and repainted, and displaying its 'Paris' nameplates on its left side, together with a similar set on the right side, on the plinth at Bank Top station, Darlington. [SSPL Collection]



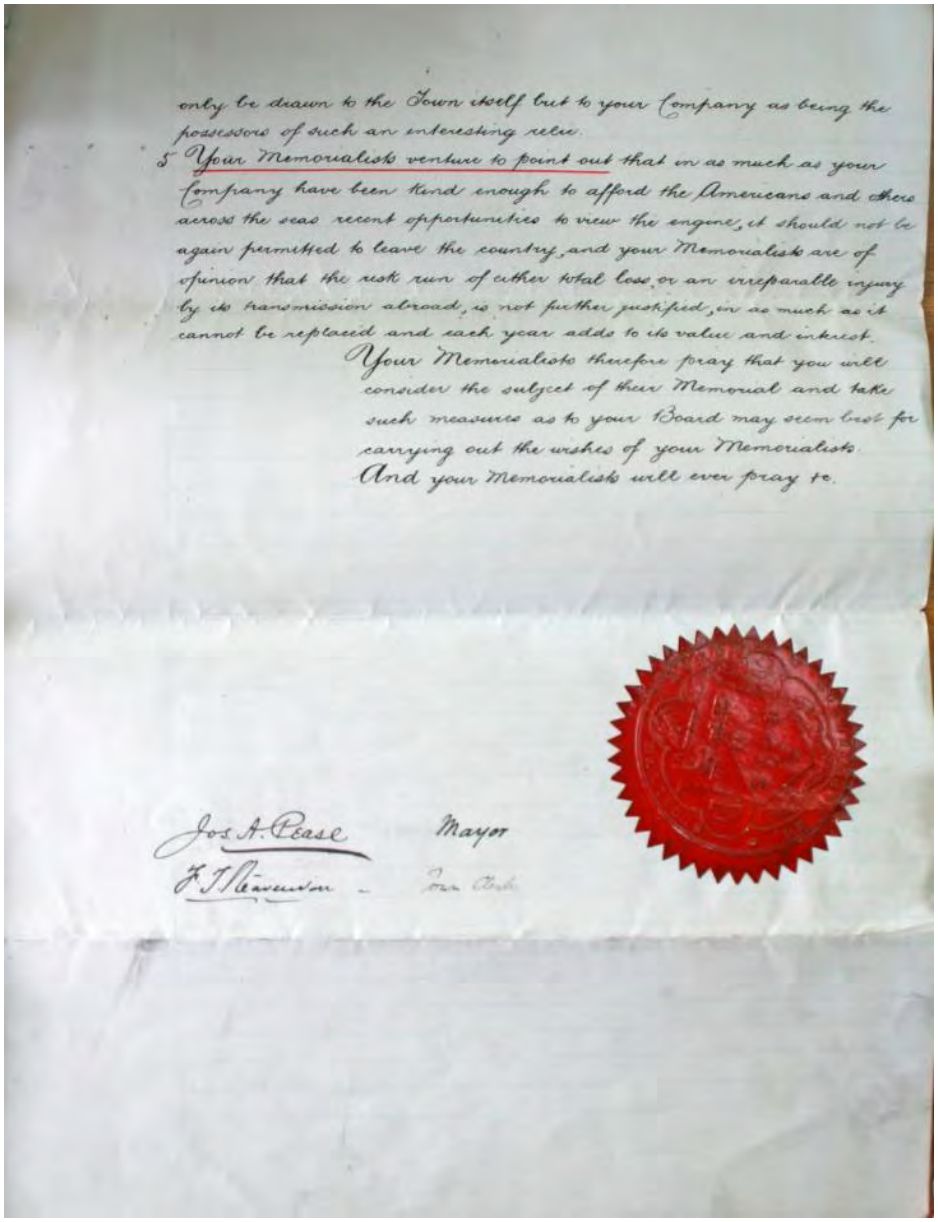
To the Board of Directors of the North Eastern Railway Company.

The Humble Memorial of the Mayor, Aldermen and Burgesses of the Borough of Darlington acting as the Local Board of Health and Urban Sanitary Authority for the said Borough in Council assembled the 6th day of March 1890

Sheweth

1. That in as much as 'No 1' Engine belonging to your Company, possesses great interest to your Memorialists, and the residents of the town, who value it not only for its peculiar interest as the first locomotive, but also as being associated with their town, which is acknowledged to be the birthplace of the Railway System, is at present placed in a very exposed position without cover or protection near your North Road Station in Darlington, and consequently liable to injuries through atmospheric causes, and as since the opening of the Bank Top Station the number of persons using the North Road Station is very greatly reduced, your Memorialists venture to make the request that 'No 1' may be placed in some more conspicuous and protected position where it would be readily seen by visitors, residents, and the travelling public.
2. Your Memorialists submit that if No 1 were placed in a more convenient position where it would be sheltered it would be freer from rust and decay than in its present exposed situation, and that the Company's servants would have it more constantly under their notice and be enabled the more easily to give to it such attention as it might require from time to time.
3. Your Memorialists would suggest that whilst not in any way dictating as to the site or position of No 1, it seems to them that there is ample accomodation for it between the Lamp Room and the two docks at the Southern End of the Bank Top Station, where it would occupy a position easily seen by passengers both North and South, and where it is understood it would in no way interfere with the traffic or work of the Company's Servants.
4. That if 'No 1' were so placed the whole of the East Coast travelling Public would have an opportunity of seeing it, and attention would not

Fig. 8.15 Memorial from the Mayor, Aldermen and Burgesses of Darlington, 6th March 1890 (Title page) (NA, RAIL 527/1693)



only be drawn to the Town itself but to your Company as being the possessors of such an interesting relic.

5 Your Memorialists venture to point out that in as much as your Company have been kind enough to afford the Americans and others across the seas recent opportunities to view the engine, it should not be again permitted to leave the country, and your Memorialists are of opinion that the risk run of either total loss or an irreparable injury by its transmission abroad, is not further justified, in as much as it cannot be replaced and each year adds to its value and interest.

Your Memorialists therefore pray that you will consider the subject of their Memorial and take such measures as to your Board may seem best for carrying out the wishes of your Memorialists.

And your Memorialists will ever pray &c.

Jos A. Pease Mayor

F. J. Stevenson Town Clerk

Fig. 8.16 Memorial from the Mayor, Aldermen and Burgesses of Darlington, 6th March 1890 (Signatory page)

(N.A., RAIL527/1693)

Fig. 8.17 Close up of Darlington's 1867 emblem seal with image of *LOCOMOTION*, tender and wagon.

(NA, RAIL 527/1693)

LOCOMOTION remained undisturbed at Bank Top station for 32 years. Ownership passed to the London & North Eastern Railway (LNER) with the railway grouping in 1923. In 1924, the major **British Empire Exhibition** was held at Wembley. In anticipation of its appearance there, *LOCOMOTION* was removed from its plinth at Bank Top station at the end of December 1923 and transferred into the North Road locomotive works for restoration prior to its journey to Wembley.[270] Britain's four new railway companies anticipated major marketing opportunities by their participation at the Exhibition. In the 'Palace of Engineering', the LNER exhibited its pacific locomotive *FLYING SCOTSMAN*, with *LOCOMOTION* alongside. It was reported that "both engines are fitted with gearing worked by electric motors to show running methods".[271] No.1 was also fitted with a replica fire-bucket on its tender, illuminated by electricity.[272] The British Empire Exhibition was opened by King George V on the 23rd April 1924. Some 17 million visitors attended the exhibition before the closing ceremony on the 1st November, presided over by the Duke of York.

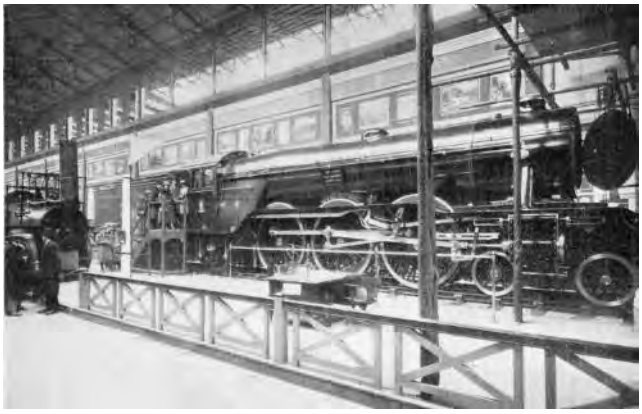


Fig. 8.18 *LOCOMOTION* displayed alongside *FLYING SCOTSMAN* at the British Empire Exhibition, 1924.
[*The Railway Magazine*, Vol. 54 (1924), p.473]

Fig. 8.19 *LOCOMOTION* returned to Darlington (Faverdale Works) showing the Electric motor and gearing for operating the driving and valve motions.
[NRM, York HQ photo collection Box 1]

LOCOMOTION was returned from Wembley at the close of the Exhibition and called into York, on its way back, to be exhibited, again alongside *FLYING SCOTSMAN*, at the small **York Cottage Hospital Benefit Exhibition** thought to have been held in the 'Saloon' Shed, the former 1851/52-built roundhouse of the York and North Midland Railway.[273] The shed was near to the former Queen Street Works buildings, then being considered as the site for the forthcoming York Railway Museum. The exhibition was held during the weekend of 29th/30th of November 1924. *LOCOMOTION* was not sent to Wembley for the follow-on British Empire Exhibition held in 1925.

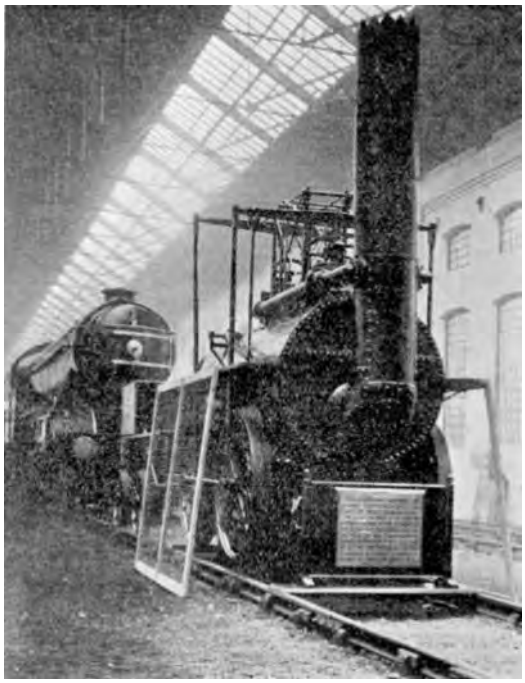


Fig. 8.20 On display at York Cottage Hospital Benefit Exhibition, thought to be at the 'Saloon' Shed, York on the 29th/30th November 1924.

[P. Ransome-Wallis, *The Railway Magazine*, Vol.56 (1925), p.43]

Even before the end of the 1924 Wembley exhibition, the LNER began planning a major public event to celebrate the **centenary of the opening of the Stockton & Darlington Railway**, to take place in July 1925, based on Darlington. There was an early proposal for *LOCOMOTION* to be steamed and take its place at the head of a parade of historic and modern steam locomotives. However, it was later realised that the engine would require such modification that it would remove the historical integrity of the artefact. Instead, the parade was headed by the 0-4-0 locomotive, formerly named *LYON*, that had been retired from the Hetton Colliery Railway, and which was thought to have been built by George Stephenson in 1822. A recent archaeological study of this locomotive revealed that it had in fact been built for the colliery in c1848. It was modified at North Road Locomotive Works to enable it to return to steam, and led the parade.[274]

LOCOMOTION was itself taken into the North Road Locomotive Works in Darlington at the end of 1924 and assessed for running in the parade. It was decided to make a replica tender fitted with a petrol engine to provide the motive power for its train of chaldron wagons. Drawings prepared by the Works, showing the tender drawings incorporating the petrol engine, are dated 23rd October 1924.[275]

The parade took place on Thursday the 2nd July 1925, between Stockton and Darlington, passing a specially-built v.i.p. grandstand near Dinsdale, to the east of Darlington, the guests of honour being the Duke and Duchess of York. 53 locomotives, some drawing trains of vehicles, passed in front of the assembled crowds. *LOCOMOTION* and its replica train was the finale to the parade, carrying the final number 54 (The intended No. 31 had stood down at short notice and did not participate). With the petrol engine providing traction and oily rags burning in the flue, the train, with no continuous brakes, made an inelegant stop by the grandstand causing disharmony to the on-board band and laughter amongst the assembled crowd. After the pause the train re-started with a bump and a jolt to the strains of 'For Auld Lang Syne'.[276]

Fig. 8.21 *LOCOMOTION* on the 2nd July 1925 at the head of the final parade train formed of chaldron wagons and a replica coach. [NRM Historic photo file No. 812]

The Duke of York was given a silver model of *LOCOMOTION* and its tender, whilst the Duchess of York received a silver model of the Stockton & Darlington Railway passenger coach.

The locomotive then took its place in the **Stockton & Darlington Railway Centenary Exhibition** which was set up in Darlington's Faverdale Wagon Works, and which ran from Friday, 3rd July to Saturday 18th July 1925. Some 99 locomotives and rolling stock were displayed on outside tracks, whilst a further 3 locomotives and 650 other artefacts were displayed in the workshop buildings.[277]

On the day of the actual centenary, Sunday the 27th September 1925, it was arranged for *LOCOMOTION* and its train of chaldron wagons to be transported to Manchester for display at Belle Vue for the **Railway Employees' Centenary Celebrations**, an event undertaken by representatives of the employees themselves.

Fig. 8.22 *LOCOMOTION* displayed at Belle Vue, Manchester on the 27th September 1925

[NRM, York HQ Photos Box 1, x37932]

LOCOMOTION was thereafter returned to Darlington and replaced on its plinth at the southern end of Bank Top station.

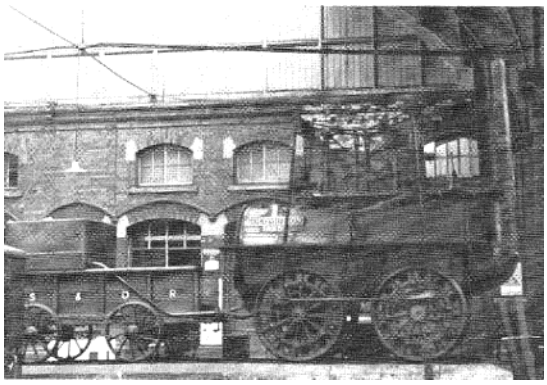


Fig. 8.23 *LOCOMOTION* displayed on its plinth at Bank Top station, Darlington, in 1934. View showing the nameplate on its right side at the rear of the boiler.

[NRM, York HQ Photo Box 9, 1067]

It remained on the pedestal up to the second world war but, for security reasons, it was moved in June 1941 to the locomotive shed at Stanhope in upper Weardale. It remained there, greased and under a tarpaulin, until 1946 before being returned to Darlington and replaced on its plinth on Bank Top station, again with its right side facing south.

Fig. 8.24 *LOCOMOTION* being unloaded from a well-wagon at Stanhope on June 29th 1941.

[ARPT]

Fig. 8.25 A 1950-view of No. 1 following its return to Bank Top station after the war.

[H.C. Casserley; as shown in Brian Reed, *Loco. Profile 25: LOCOMOTION*, p. 24]

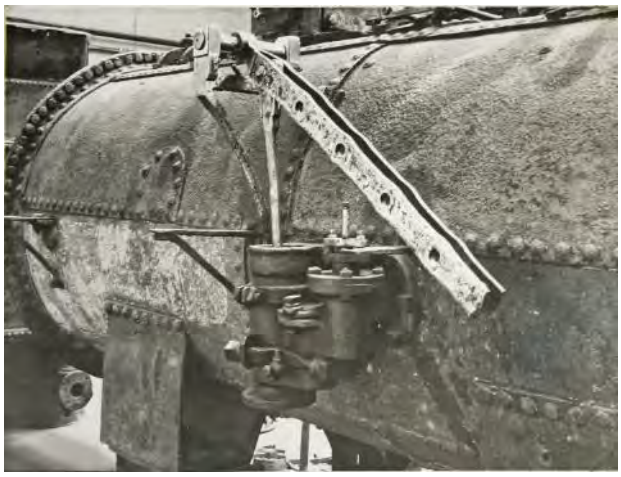
Ownership of the artefact passed from the LNER to the British Transport Commission (BTC) on its formation in January 1948. In 1951, the BTC created the post of Curator of Relics to oversee the future of the relics it had inherited. John Scholes (1914 -1977), the Curator of the Castle Museum in York, was appointed as the BTC's Curator of Relics, together with a 'small staff'. In that year, No.1 was sent from Darlington to York to attend the **Exhibition of Railway Rolling Stock** held in connection with the Festival of Britain. The Exhibition was held in the original York station, within the city walls, between Monday 4th June and Saturday 16th June.[278]

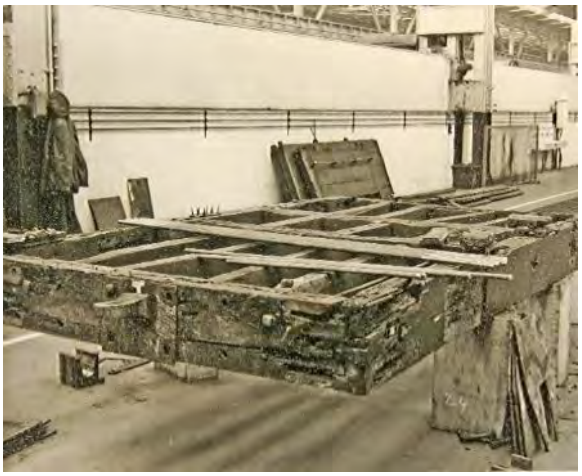
LOCOMOTION was afterwards returned to Bank Top Station, Darlington, and remained on its pedestal for a further nine years. In 1961 the condition of both locomotive and tender had deteriorated, and arrangements were made to move it into the North Road Locomotive Works on the 19th March for a restoration and re-paint.[279]

Both vehicles spent several weeks in the works and some component replacements were made, in addition to the restoration of other components.

Fig. 8.26 *LOCOMOTION* being lifted from its plinth at Bank Top station on the 19th March 1961, prior to its restoration.
[NRM Historic Photos File 812]

Fig. 8.27 *LOCOMOTION* being transferred to North Road Locomotive Works on a 'Weltrol' wagon drawn by J94 0-6-0ST, No. 68060.
[ARPT]





Figs. 8.28 & 8.29 Boiler and tender stripped down during the restoration programme in Darlington Locomotive Works, March to June 1961.

[NRM – York HQ File, 8646 (1); and Historic Locos File 812, R170-1]

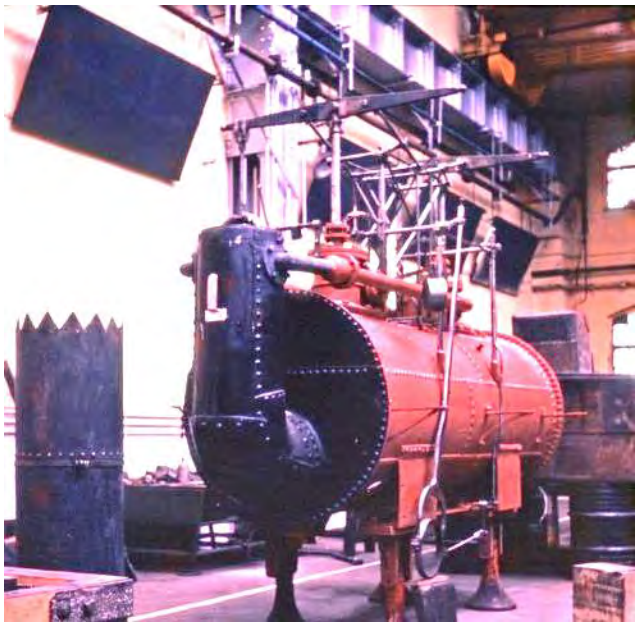


Fig. 8.30 A fresh coat of protective paint applied to the boiler at North Road Locomotive Works, Darlington, during the restoration of *LOCOMOTION*, in June 1961. [ARPT]

The restoration programme was completed in June 1961, and the locomotive and tender returned to the plinth on Bank Top station. The complete identification plaques were not, however, re-installed on the boiler-sides. Only the brass '*LOCOMOTION*' nameplates were screwed to the boiler cladding. The earlier backing plates and the numbers'1' and the dates '1825' were retained in North Road Works. This had been arranged with the knowledge of the Works Manager, Peter Gray MBE, who kept them safe. On his transfer to another appointment in 1965, the staff at the works mounted the four brass sections onto a commemorative plaque and presented them to him. This plaque is now owned by his Grandson, David Gray, who kindly made the plaque available during the course of the authors' project.

Fig. 8.31 *LOCOMOTION* and tender after the the restoration in North Road Locomotive Works June 1961. Now carrying plain nameplates without '1' and '1825'.
[NRM – York HQ Photos Box 9, 8792]

Fig. 8.32 The recovered plates '1' and '1825' mounted on the plaque for Peter Gray MBE in 1965. [Courtesy: David Gray]

LOCOMOTION, now carrying nameplates only, without number or date, but retaining its bell, remained on the plinth for the next 14 years. In January 1963, ownership passed to the British Railways Board, which became responsible for the cleaning, maintenance and display of the artefact.

In July 1963 a check was made on the condition of *LOCOMOTION* by R.J. Hunter from the York Railway Museum on behalf of John Scholes, the BRB's Curator of Relics.[280] So soon after its restoration, he was alarmed to find a "very bad breakdown of protective lacquers" with rusting already showing on the motion components. He suggested that with attention being focussed on the future of the North Road Locomotive Works, then being considered for closure, little attention was being paid to the condition of *LOCOMOTION* and *DERWENT*.

In January 1966, the two locomotives were closely examined by two members of the BRB staff, Messrs. Cogger and Hunter.[281] Their report identified that rust was already "quite widespread" and noting that steel, brass and copper components had all deteriorated "considerably". Noting that North Road Locomotive Works was due to close in April that year, concern was expressed about the future arrangements for cleaning the artefacts.

In June 1970 the locomotive was closely inspected by R. Gosling, in the company of John Scholes.[282] The condition of the artefact was continuing to cause concern, and there appeared to have been no action since the 1966 survey. Rusting of many of the components was evident, even breaking through the polyurethane coating it had received in 1961. The cause was identified as being the diurnal temperature variation and the other atmospheric conditions including diesel fumes. Gosling recommended that the locomotive (together with *DERWENT*) should be removed from the pedestals and "placed in in a closed building where temperature and humidity changes can be kept to a minimum."

In 1974 ownership passed again to the National Museum of Science & Industry (Accession No. 1978-7010). On September 27th 1975 it was removed from its plinth for the celebrations

for the **150th anniversary of the opening of the Stockton & Darlington Railway**.[283] It was first moved to Preston Park, Eaglescliffe, and lined up with its operational replica, newly completed by Locomotion Enterprises Ltd. under the leadership of Mike Satow (1916-1993). The replica had headed up the 150th anniversary parade on Sunday, 31st August 1975.

The locomotive's display in Stockton preceded its move back to Darlington to be placed, on long term loan, in the new North Road railway museum, now known as the 'Head of Steam' Museum. It remained on display in this Museum for the next 46 years, during which time ownership again changed, in 2012, to the Science Museum Group. It was transferred on Monday, the 8th March 2021 to the Group's 'Locomotion' Museum in Shildon, where it is now on display.

Fig. 8.33 *LOCOMOTION* lined up ahead of its replica at Preston Park, Stockton, 25th September 1975.

[NRM – Historic Photos file]

Fig. 8.34 *LOCOMOTION* and tender on display in the Head of Steam Museum, Darlington in 1995. [Michael R. Bailey]

PART II –

COMPONENT HISTORY AND ARCHAEOLOGY

9. Frame and Springing

COMPONENT HISTORY

In the years preceding the manufacture of *Active,* the Killingworth smiths made iron frames for the locomotives on that line. George Stephenson's introduction of 'steam springs' from 1816 required a simple frame to be adopted. This was a c2 in thick iron rectangle, formed of longitudinal components – c5 in wide, but widened to 1 ft 4 in to accommodate the steam spring flanges. They were 13 ft 6 in long, linked by 4 ft 4 in wide front and rear cross-members.[284]

It is probable that, although a frame was also adopted for *Active*, the use of steam springs had been abandoned in favour of a rear tilting axle tube and front fixed boiler brackets. The contemporary sketch of the opening day of the S & D R however shows an erroneous tubular bracket arrangement, which has apparently been copied from the c1821 Killingworth-type illustration.

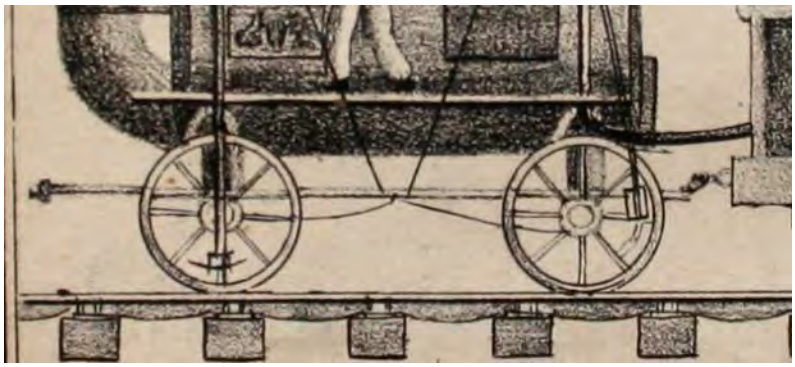


Fig. 9.1 Opening day illustration of *Active*. Copied from the c1821 image of a Killingworth-type locomotive. Note erroneous presence of a rear boiler bracket.

[Fig. 1.4 - detail. Account of the Stockton and Darlington Railway, Newcastle, 1826]

It is probable that Stephenson's concept plan for replacing the rear steam springs with a tilting axle tube, to preserve a three-point contact with the track, was adopted. In this plan, a c5in x 2 in frame is shown. This would have run the length of the boiler and supported leading tubular boiler brackets which themselves were substituted for the front steam springs.

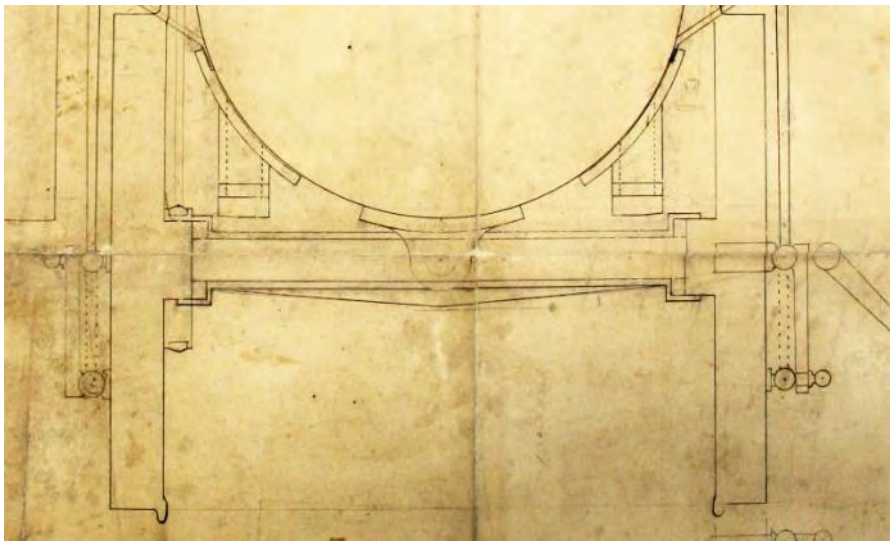


Fig. 9.2 Rear end view of the proposed tilting axle tube.

[Fig. 1.2 – detail. NRM, R. Stephenson & Co. drawing, ROB/3/2/1]

The later four Stephenson locomotives were similarly fitted with rectangular frames, as depicted in the Brewster illustration. The inclusion of coupling rod driven overhead valve-motion strongly indicates that steam springs had been replaced by fixed brackets for them as well. The frame is shown to have been stayed to the upper boiler end plate. These early frames were not used to draw the train loads which was undertaken by more robust drawbars rivetted to the underside of the boiler.

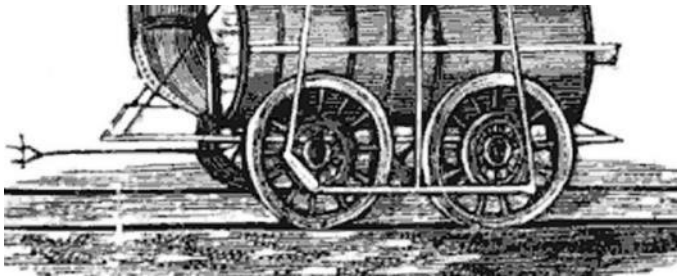


Fig. 9.3 Front three-quarter view of the frame of the later Stephenson locomotives. The front end has diagonal stays from the upper boiler end plate.

[Fig. 2.3 – detail. Brewster, 1829]

Plate springs were introduced onto the Killingworth locomotives from the end of 1827, and Timothy Hackworth went to see the trials of the first examples in December that year.[285] He then introduced springs onto the S & D R fleet as new locomotives were built, and as opportunity arose to re-build the earlier locomotives, including No.1. It is very likely therefore that when No.1 was put back into service at the end of 1828, after its disablement six months previously, it was fitted with four plate springs acting on its framework, similar to those adopted for the Killingworth locomotives.

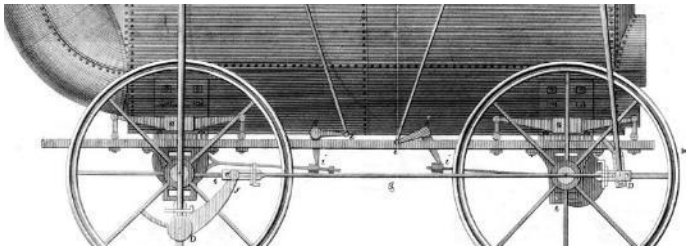


Fig. 9.4 Early form of plate springs and frame arrangement adopted on the Killingworth-type locomotives.

[Nicholas Wood, 1831, Plate VII - detail]

When the locomotive was rebuilt in 1834, it is likely that a frame was dispensed with in order to reduce further the weight of the locomotive. Accordingly, replacement spring-sets would have been fitted, inside the 'U'-form boiler brackets, acting on to the tops of the horns.

Surviving maintenance records for *LOCOMOTION* commence in April 1837. They show that in that month repairs were made installing "a sett of new springs" and 3 spring pins were also replaced.[286] In the following three years there are no further records of spring repairs, suggesting that the steel spring-sets had become more robust and that the locomotive/track dynamics had much improved over the earlier years of operation.

No further reference to *LOCOMOTION*'s frame and springs has been found in the S & D R archives. It is probable that the 1834 arrangement continued, but without its springs, when it was re-used for stationary pumping duties at Pease's West Colliery in 1850. On its return to Shildon in 1856 it remained without its frame and spring-sets, in the form now seen on the preserved artefact.

ARCHAEOLOGY

The boiler's support brackets are now bolted directly to the axle-box horns, without either a frame or spring-sets present. However, it is apparent that this interface has been badly affected by corrosion during the time of the locomotive's display in the open at North Road station. The bottom plates of the boiler brackets have corroded, and each has been strengthened by the insertion of a new plate placed over the top, thus preventing the opportunity to see evidence of the former spring-set hangers and pins. The insertion of the additional plates was probably undertaken during the 1892 restoration at the North Road Works in Darlington.

10. Wheels and Axles

COMPONENT HISTORY

The first cast iron wheels employed on the *Active* were of 4 ft diameter and could have been cast at the foundry of I & J Burrell, adjacent to the Stephenson works in Newcastle, or at the Stephenson works themselves (Section 1).[287] The works acquired land on which to start trading with their own foundry at the end of December 1824, and trading commenced from July 1825, perhaps with insufficient time to undertake the casting of the four wheels for the S & D R's first locomotive. Experience with this form of wheel had been gained on the locomotives used on the Killingworth railway. Initially of 3 ft diameter with eight spokes, the increase to 4 ft., again with eight spokes, had been successfully demonstrated by Nicholas Wood in 1824.[288]

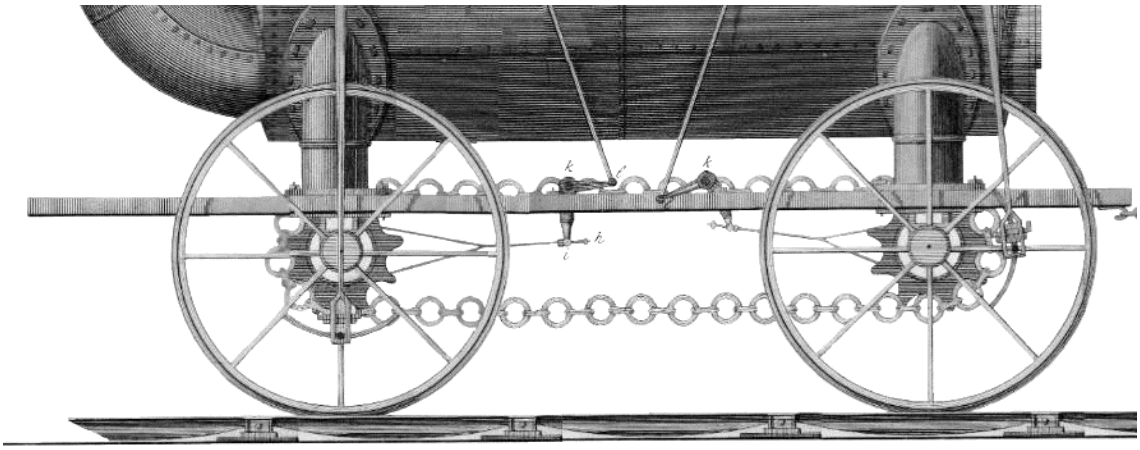


Fig. 10.1 Cast iron wheelsets fitted to the Killingworth Colliery locomotives by Nicholas Wood in 1824. [Nicholas Wood, 1825, Plate V - detail]

That this form of wheel had been adopted also for the works' first locomotive is suggested in a contemporary engraving.

Fig. 10.2 Contemporary view of the opening day of the S & D R. showing spoked wheelsets adopted on *Active*.

[Fig. 1.6 – detail]

The wheels began to give trouble as early as November 1825, just a few weeks after the opening of the line. Timothy Hackworth wrote to the Stephenson Company from Brussleton:[289]

> Gent[m]
>
> I am desired to inform you that one of the wheels belonging to the Locomotive Engine is so much wore tis unsafe to venture with it another journey it nearly got of the axle to day while on her way to Darlington we expected to have had a duplicate set of wheels & axles before now as Huntley knew the state we were in before he left. if they are ready do not lose one moment in sending them off. If the ventelator is done send it with them.
>
> soon as Mr. Stephenson reaches N Castle tell him that I have something particular to communicate.
>
> Yours &c
>
> Timothy Hackworth

The need for an adequate supply of duplicate wheels and axles was requested from the Stephenson Company three days later.[290]

George Stephenson was clearly troubled by the problems being experienced with the wheels and initiated an improved design, although the detail of this improvement has not been referred to in surviving evidence. He wrote to Timothy Hackworth in January 1826: "How does the new plan of wheels do? Is there any appearance of working loose?"[291]

It is possible that the improvement was the addition of a strengthening wrought iron concentric ring around each hub. Such wheels were apparently fitted to one or more of the later Stephenson locomotives as depicted by Brewster.[292] The crank pins were fitted to these rings, suggesting that stresses had arisen with the first wheels from the earlier crank pin fittings.

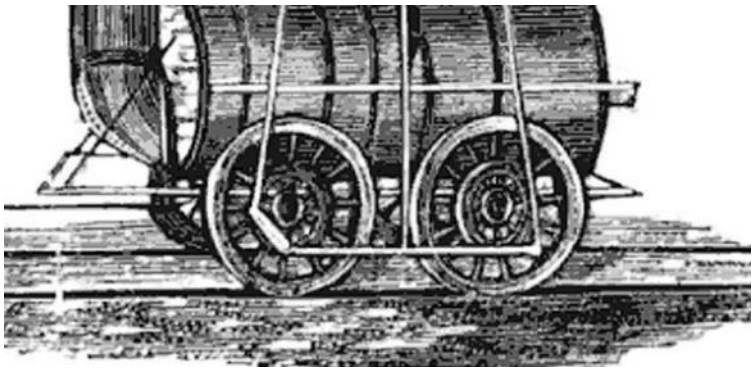


Fig. 10.3 One of the later Stephenson locomotives delivered between 1825 and 1827, showing spoked wheels with strengthening rings around the hubs.

[Fig. 2.3 – detail. Brewster, 1829]

The locomotive wheels continued to cause problems through 1826 and following on-going problems of breakage of the wheels arising from the dynamic forces from their movement along the track, a new design of wheel was considered. This was to form the wheels in two parts, again cast in iron. An inner part around the hub, and a rim, which were closely fitted

together using beech or oak plugs, offered the opportunity for either centres or rims to be more easily replaced should they crack in service, allowing the locomotives to be returned to service as quickly as possible with reduced down-time and cost.

Such wheels were retrofitted to the two Springwell Colliery locomotives made by the Stephenson Company in 1826.

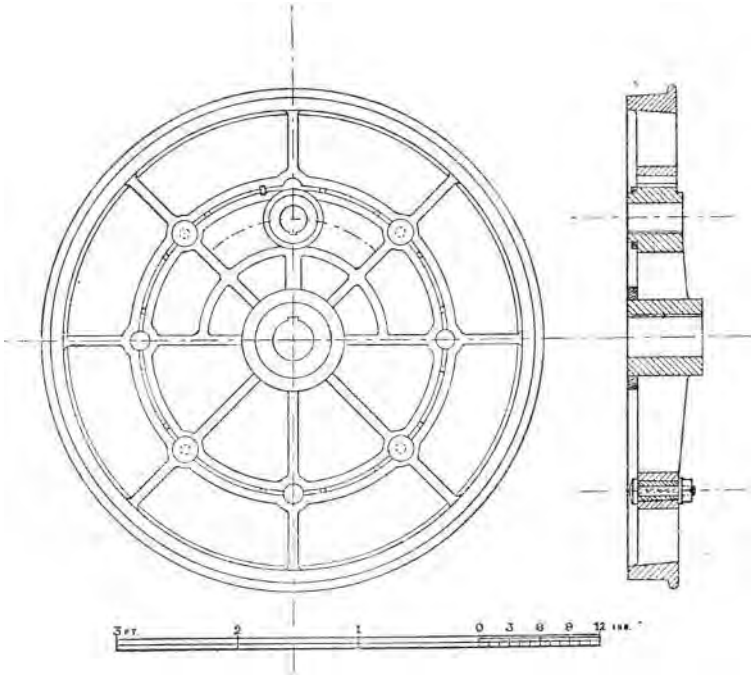


Fig. 10.4 Probable design of two-part cast iron wheel used from 1826.

[E.A. Forward, The Stephenson Locomotives at Springwell Colliery, 1826, *Trans. of the Newcomen Society*, Vol. XXIII, p. 120.]

The two visiting Prussian engineers noted the details of these wheels in their account of their visit to the railway in May 1827:[293]

> After many trials, the wheels have been constructed in a lasting manner…. These consist of two parts, an inner and an outer part, of cast iron and fastened together with wooden wedges. The naves are round, internally bored accurately to the diameter of the axles, and they are fastened by wedges in holes bored half in one and half in the other. The diameter of the inner part of the wheel is 30 in; the outer part with the tread is 47 in diameter. The depth of the nave is 5 in.; the width of the inner part of the wheel is 4 in.; this has twelve spokes 7/12 to ¾ in. thick, which increase in width towards the middle. The spokes are bound together by a ring from 17 to 18¾ in. diameter. In the outer circumference, semi-circular notches of 1 5/6 to 2 in. diameter are arranged in the direction of each spoke so that exactly similar notches in the inner circumference of the outer part of the wheel coincide, and wooden wedges are driven in, so as to bind together the two parts. In new wheels the tread is 4 1/6 wide, and conical, diminishing towards the front 1/6 in.; the thickness of metal in front is 1¼ in. and behind 1 5/6 in. The flange projects ¾ in. and the whole breadth of the wheel, inclusive of the flange, totals 5 5/6 in.; in some old wheels this only 4½ in. In the inner part a hole is arranged in which to set the crankpin, to which the connecting-rod of the cylinder is attached; the length of the crank arm is 11¾ in.; in another locomotive engine it is 10 in.

The Prussian engineer's detailed description of the wheels then in use suggests that wheels of this description were also fitted to No.1 in 1827. Later that year wheels of this type were fitted to the Stephensons' *EXPERIMENT* locomotive.

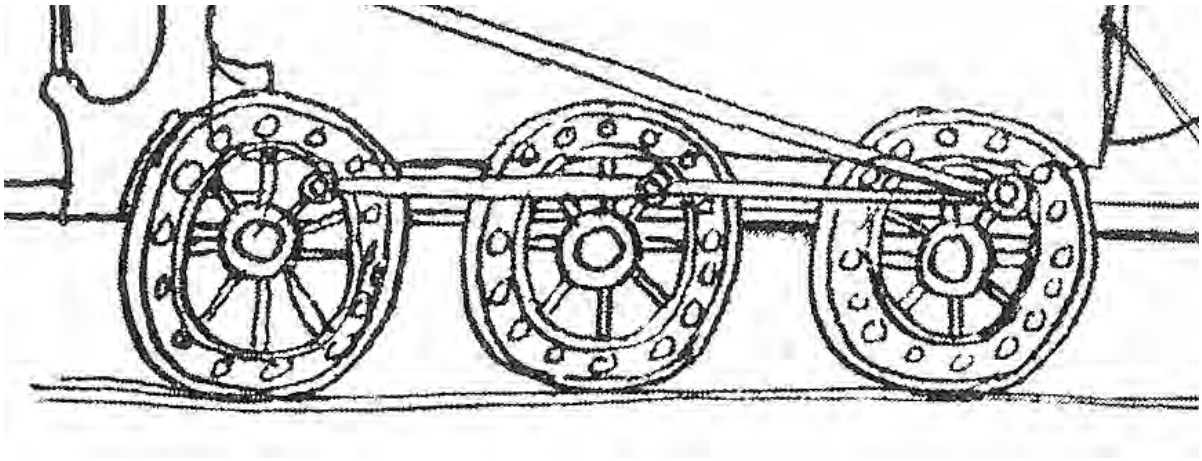


Fig. 10.5 Two-part wheels fitted to S & D R No. 6 (*EXPERIMENT*) locomotive. Detail from John Rastrick's sketch of the locomotive in 1829.

[J. Rastrick's notebook, 1829, Goldsmith Company's Economic Library, University of London]

The rims were cast with the flanges, but the number of breakages remained high. From December 1827,[294] experiments took place for the trial use of wrought iron tyres, formed by hand forging at the Bedlington Iron Works, to fit over the cast iron wheel rims.[295] Although the resulting tyres were not of uniform thickness, the resulting improvement in wear was seen to be beneficial for the locomotives of the Killingworth wagonway, providing a much more robust running surface than had been experienced in the first two years of the S & D R's operation. The trial was so satisfactory that the Bedlington Iron Company developed a pair of rollers to roll future lengths of iron which were then welded into 'hoops' (tyres) and shrunk on the wheel rims.

It was therefore decided to adopt these wrought iron hoops for the S & D R locomotives, the first being provided for No.4 locomotive on February 5th 1828.[296] The successful adoption of wrought iron tyres was a major improvement in wheel design and use, that substantially reduced maintenance costs. In February 1829, John Rastrick wrote to Timothy Hackworth to say that he had become aware that "Mr. Nich[l] Wood of Killingworth has had a set of Wt Iron Tyre on the 4 ft Cast Iron Wheels of one of their locomotive Engines in wear for 9 months and I did not perceive any perceptible wear."[297] It is likely that No.1 was so fitted with wrought iron tyres from the end of 1828, following its restoration after the July 1828 incident.

Also in 1828, following continued problems with wheel breakages, further measures were considered in an attempt to find a more robust form of driving wheel for the railway's locomotives. Consideration was given to the use of both wrought iron and timber wheels. A sketch in Timothy Hackworth's notebook, dated 26th February 1828, showed a detailed, measured drawing of the inner part of a two-part wheel, but it is described as a "malleable (iron) centre". This would have been expensive to make in wrought iron by comparison with cast iron, but was perhaps influenced by the success of the new rims.

Fig. 10.6 Design of wrought iron inner locomotive wheel prepared by Timothy Hackworth, dated February 26th 1828.

[T.H. notebook, NRM, HACK 1/3/1]

However, timber wheels, with wrought iron rims, tyres and crank pin rings, were also tried by the Stephenson Company from the spring of 1828. Two locomotives ordered by Marc Séguin for trial use in France (travelling engines Nos. 9 & 10) were delivered with 4 ft diameter wooden spoked wheels in March and April that year.

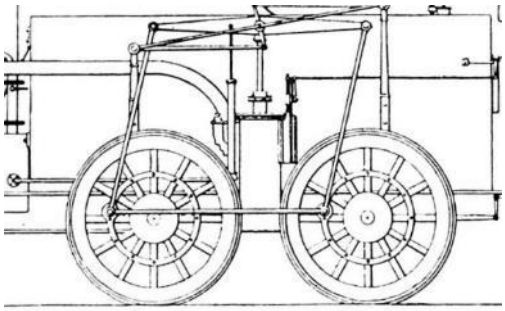


Fig. 10.7 Two locomotives for France, completed by Robert Stephenson & Co. in the spring of 1828, showing spoked wooden wheels with an iron crank pin ring.

[Copy drawing from an original, in 'Stephenson Locomotives for the St. Etienne-Lyon Railway, 1828', by E.A. Forward, *Transactions of the Newcomen Society* Vol. XXIV (1943-45), pp.89-98, Plate X]

Their successful introduction was immediately made known to the S & D R, and in that latter month four wooden wheels "with malleable Iron Tyres and Cast Iron Naves" was recorded by Hackworth as being made for the railway in his notebook.[298] Hackworth further noted in July that the Stephenson Company had delivered "4 Wooden Trav[ling] Engine wheels & 2 wrought iron axles fit up" for £91.10.0. The axles were later noted to have been charged at £8.5s, and the price per wheel was thus £20. 16. 3.[299] These were probably the same wheels, although the invoice had been delayed until the summer.[300] Hackworth later noted that "The Wooden Wheels put under the No. 3 Locomotive set off with a first journey August 1 – 1828."[301] There was no immediate note by Hackworth as to the outcome of the trial of the wheels on

No. 3, but it would seem that were initially seen as an improvement on the cast iron wheels as they remained in use for some time.

Improvements to the wheels continued to be sought by Hackworth, and on December 17th 1828, Michael Longridge wrote from the Bedlington Iron Works to the S & D R that he was ready to try fitting wrought iron tyres to the latest cast iron wheels that had been prepared at the Stephenson factory in Newcastle, but there is no indication as to any design improvement that was being tested.[302] Hackworth travelled to Bedlington shortly afterwards to see the fitting being carried out.[303]

Wooden wheels were, in particular, adopted for the railway's new passenger locomotives, commencing with *GLOBE* that was made by the Stephenson Company to Hackworth's design in 1830. In June of that year the Bedlington Iron Company wrote to apologise "that the wood wheels for your Locomotive Engine have been so long delayed …. but we have now begun to turn the last of the four wheels and expect to finish them this week."[304] In September the following year Bedlington Iron Works were assuring the S & D R that they were getting on with machining the tyres for their wooden wheels.[305]

IN August 1834, John Graham recommended to the directors that the cone of the tyres should be regulated to follow that adopted on the waggons, "viz. ⅛ of an inch for 3¼ Inches breadth of Tred of Wheel."[306] This stipulation was duly passed to the contractors to implement.

Graham also kept a check on the sideway movements of the wheelsets on each locomotive, and in 1836 he reported to the railway's Sub-Committee that there was a 1 in play on *LOCOMOTION*'s rear wheelset, whilst the play on the front wheelset was 1⅛ in. This compared with a play of more than 2 in on some of the other locomotives with outside cylinders.[307]

An unknown number of the S & D R locomotives continued to operate with wooden wheels, fitted with wrought iron tyres until at least 1837. In January 1835 John Graham reported that most of the engines still had them, but there were signs of deterioration in one of them and he recommended that iron wheels should be substituted.[308] The annual valuation of the S & D R's locomotive stock was undertaken by James Kennedy in April 1837. He recorded that in the Shildon Works Yard there were 6 wheelsets formed with wooden wheels, 12 further wooden wheels and six axles, 4 more wooden wheels without axles, a wooden wheelset without tyres and a wooden wheel without a tyre that had never been used.[309]

By that date it is likely that only the passenger locomotives were using wooden wheels, but it remains a possibility that, after its return to service at the end of 1828, and into the 1830s, No.1 may also have been fitted with wooden wheels with wrought iron tyres. In the mid-1830s however Hackworth re-introduced the two-piece cast iron form of wheel, but with webbed, rather than spoked, castings and with wrought iron tyres.

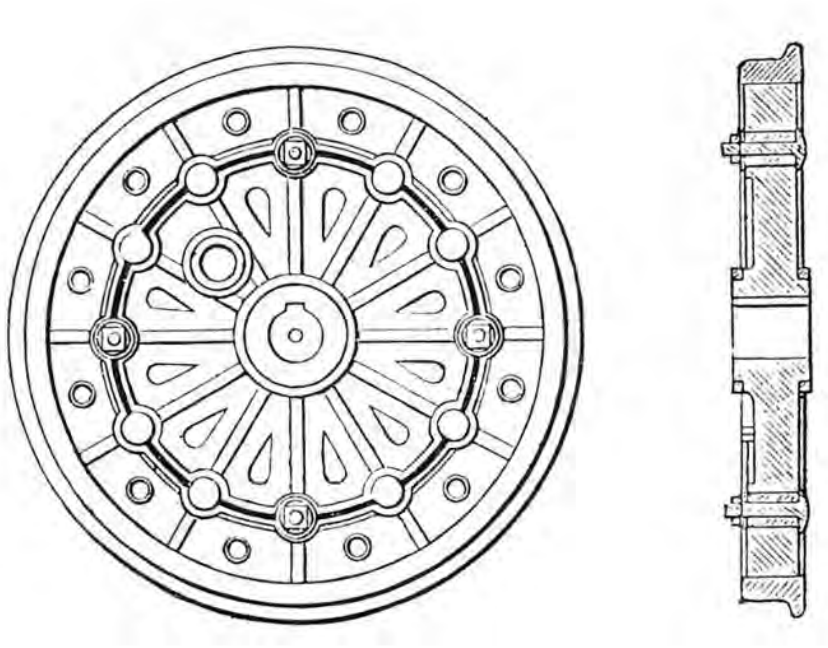


Fig. 10.8 Timothy Hackworth's design for a two-piece cast iron wheel introduced in the 1830s. [Zerah Colburn, 1871, p.42]

Hackworth's locomotive maintenance records for the late 1830s confirm that two-piece cast iron wheels were in use on *LOCOMOTION* by that time. In July 1837, it was re-fitted with a set of four new 'Metal rims' that were 'hooped' with tyres which weighed a total of 1 ton 6 cwt. They were accompanied by three new wheel centres that each weighed 8 cwt 3 quarters and 23 lb.

The new 'centres' were fitted to *LOCOMOTION*'s wheels, requiring the boiler to be lifted and each wheel dismantled by drifting out the oak plugs, removing the rim and then removing the 'centres' from the axles, before re-forming the wheels with new centres keyed to the axles and then replacing the rim and re-fitting the plugs.[310] A replacement pair of centres and a new axle were fitted in the October.[311] A further centre was fitted in December, whilst in January 1838, a further 3 wheel centres had to be replaced, possibly after the derailment at Aycliffe Lane in November (Section 5). It was recorded that they weighed just over 3 cwt each and, charged out at 14/6d per cwt, the material cost was £6.10.10½d.[312] A fourth centre was replaced later in the following month.[313]

In March 1838, *LOCOMOTION* received damage to one of its wheelsets, requiring the Shildon workshop to remove it, straighten its 'bent' axle and replace two of the wheel-centres which were apparently damaged in the incident.[314] In September 1838, the wheelsets were removed from the locomotive and the rims were turned, indicating that a 4 ft wheel lathe was then available at the Shildon Works.[315] In July 1839, further work on the wheels was reported. A replacement axle was required, and wheel centres were replaced, again suggesting that the locomotive had sustained impact damage from the track.[316]

When *LOCOMOTION* became a 'duplicate' locomotive from the mid-1840s, it was probably left intact and on its wheels in the Shildon Works yard. However, there is one further reference to the locomotive and its wheels that appears in Wishaw's volume for 1840.[317] In

the chapter dealing with the S & D R, Wishaw refers to "the catalogue of 1839". This was a listing of all the locomotives in the railway's fleet in that year. The entry for "No. 1. *Locomotion*" described it:

> It is mounted on six solid cast-iron wheels, with case-hardened tires; each wheel represents a disc with several circular perforations (See Plate 17) formed at equal distances from each other and also from the centre of the wheel. The six wheels weigh together about 54 cwt.; and each three are connected by two coupling bars, each of which is attached to the two contiguous wheels.

It is difficult to reconcile this description with the contemporary evidence about the use of the locomotive and its wheels. There is no suggestion in Hackworth's Shildon records that the locomotive had been rebuilt on six wheels, and it is difficult to understand how such a text came to be written. The inaccuracy of the story is compounded by the fact that there is no Plate 17 included in the volume. Plate 19 however does include images of both cast iron and wrought iron wheels in use on locomotives at that time. One of them shows a cast iron wheel that appears to be that to which Wishaw had referred to in the text. Wheels of this type are not otherwise known to have been adopted by the S & D R, and its origin remains a mystery.

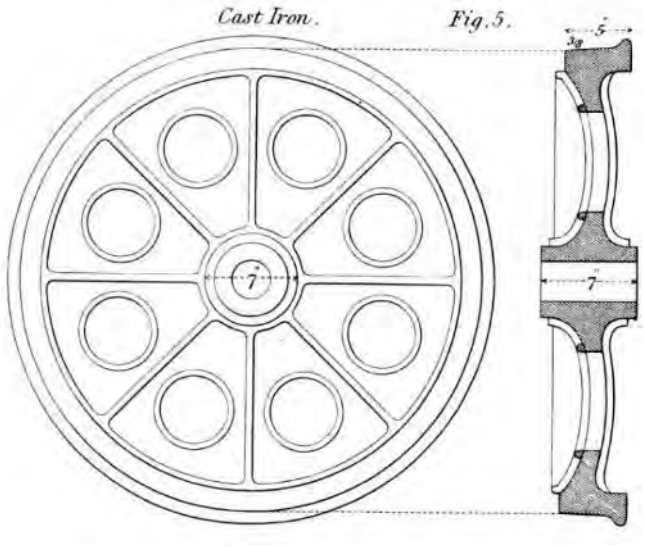


Fig. 10.9 Single-piece cast iron wheel attributed to *LOCOMOTION*. [Wishaw, 1840, Plate 19, Fig. 5]

When, in 1850, *LOCOMOTION* was re-used as a stationary boiler serving a pumping engine at Pease's West Colliery, it is likely that it remained on its wheels for this role. The retention of its wheels would have allowed it to be returned to Shildon in 1856.

There is however no evidence that has been traced that would indicate whether or not the wheelsets that have been preserved with the locomotive have remained with it since its operating days, or whether a fresh pair of wheelsets were assembled from duplicate wheels and axles that survived in the Shildon Works yard. The locomotives delivered new to the S & D R from the mid-1840s began to introduce more durable wheels leading to the phasing out of the two-piece cast iron wheels from that time. A supply of duplicate wheels of this type would therefore have been available if *LOCOMOTION*'s own wheels were required to be replaced.

ARCHAEOLOGY

All four wheels are of the two-piece cast iron type adopted on the S & D R during the mid-1830s. There were a number of variations to the patterns adopted by the railway. The surviving wheels may have been fitted to the locomotive during its operating life, or were subsequently fitted, perhaps in 1856/7, from duplicate wheelsets from the Shildon Works stockpile.

They are formed of centre castings and rim castings separated by concentric facing rings up to ¼ in apart, a gap maintained by eight wooden plugs, with four round-headed bolts and nuts to ensure the correct vertical alignment.

Fig. 10.10 Front right-side wheel, outer face and inner face.

Centre Castings:

Three of the wheels are cast from the same pattern, but the rear right side wheel was cast from a different pattern.

The three common centre castings are formed around axle hubs which are 6 in diameter and bored out to fit 3¾ in diameter axles to which they are keyed. The hubs are 8 in long.

Radiating from the hub there are twelve ½ inch wide spokes, the outer faces of which are a constant 2 in proud of the wheel web whilst the inner faces are profiled to provide a greater depth at the hub than at the facing ring. Their depth increases from 3½ in thick at the facing ring to 6 in at the hub. A 1¼ in wide and 8 in diameter wrought iron reinforcing ring has been fitted to the outer face of the hub, whilst a similar 1¼ in wide ring is added to the inner face of the hub.

Between five of the spokes, a ⅝ in wide concentric arc is incorporated on either side of a crankpin socket, to strengthen the wheel at this vulnerable point. The arcs are 2¼ in from the

inner edge of the facing ring. The three common wheels have their crankpin sockets between the spokes, but the rear right wheel incorporates its crankpin socket into one of the spokes.

The outer facing ring, to match with the rim castings, is ⅝ in wide and 5 in deep.

The spaces between the spokes are webbed with ⅝ in thick flat iron, cast at the mid-depth of the spokes. These webs are lightened by 1½ inch diameter holes, the centres of which are 6 in from the external face of the facing rings. The four lightening rings located between the hub and the strengthening arcs are 1⅜ in diameter.

The rear right side wheel has been formed differently from the other wheels and may be of an earlier form. The outer face of its hub has no strengthening ring, the end of the axle fitted up to it, whilst on the inner face the strengthening ring is 2⅜ in wide. Its twelve spokes, ¾ inch wide, are 4½ in deep and located on the outer face of the wheel only. The centre's inner face has a flat surface radiating from the hub.

It has segmental shaped lightening holes between the spokes, that are 4 in wide at their widest point and 8¼ in deep at their deepest point. It has smaller 4¼ in deep 'pear-drop' holes for the four smaller gaps between the strengthening arc and the hub, in addition to which there are circular (1½ in diameter) or elongated (1 in wide and 4 in long) holes between the strengthening arc and the facing ring.

Fig. 10.11 Rear right-side wheel, outer and inner faces, showing the three forms of lightening holes.

Wheel Rim Castings

All four rim castings are alike, being 9 in wide overall, and have been cast with twelve ½ inch wide 'spoke' extensions on the outer face only. The spokes are 5¾ in long between the ⅝ in wide inner facing rings and the outer rim face. The web casting is ⅞ in thick, with the spokes 3 in deep. The facing ring is ⅝ in thick and has twelve hemi-circles at the end of the spokes. The 4½ in wide wheel rim is ¾ in thick.

Between the spokes are centrally located lightening holes, 3½ in in diameter, with broadened rims which are 1¼ in deep.

Fig. 10.12 Front-right wheel rim casting

Wheel assemblies

Twelve hemi-circles are formed at the ends of the spokes, on the outer edge of the centre castings and the inner edge of the rim castings. Eight of the resulting sockets allow for the insertion of 2¾ in diameter oak plugs that maintained a constant gap between the centres and the rims. To ensure that the fitting is constant, two or more iron or steel wedges have been hammered into the plugs.

The other four of the hemi-circle pairs house ¾ in diameter round-headed bolts of 3⅜ in head diameter, and with 3 in diameter washers on the inner face, to maintain the vertical alignment of the wheels. The rear left side wheel is not properly located and the union between the centre casting and rim casting has been displaced by up to ¾ in.

Wrought iron flanged tyres have been shrunk on to the wheel treads. They are 5¼ in wide and a have a maximum height of 2 in. The contact surface has been coned. The diameter of the wheels is actually 47½ in rather than the 48 in that has been regularly quoted. Machining marks still visible on all the tyre treads indicate that they were trued up in 1856/7 and that they were previously worn by up to ⅜ in.

The track gauge of the wheels is 4 ft 8 in, with the back to back dimensions of the leading wheels being 4 ft 5¼ in and that for the rear wheels being an ⅛ in less.

1½ - 2¼ in wide washers have been inserted between the wheel-hubs and the horns to restrict axial movement.

Axles

The 65 in long wrought iron axles are 4 3/16 in diameter, being machined to 4 in for the journals, with the ends turned down to 3¾ in diameter to fit into the wheel-hubs. They have ⅜ in x 1 in keyways at their outer ends and corresponding keys hammered in to maintain a secure fitting with the wheels.

11. Horns and Axle-Boxes

COMPONENT HISTORY

The Killingworth-type locomotives on the Killingworth and Hetton colliery railways, built up until 1822, had horns fitted to the underside of wrought iron frames directly beneath the 'steam springs' to which they were bolted through the whole assembly.

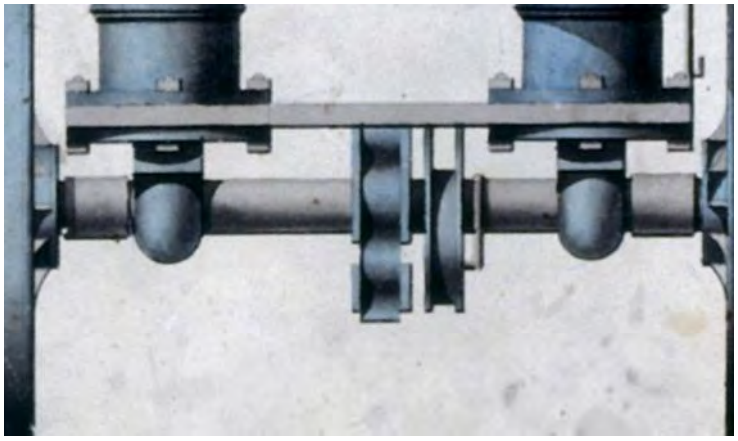


Fig. 11.1 Killingworth-type horns beneath 'steam springs'.

[Simon Goodrich drawing – detail, London Science Museum, Ref. 1967-0200]

The intention for the *Active* when it was built was to replace the steam spring arrangement completely and adopt a tilting tubular sleeve ('cannon box bearing') for the rear axle fitted to the underside of the boiler barrel. The schematic pre-production drawing illustrates the cannon box bearing, which was probably made as, or similar to, that shown. The sleeve would have needed guiding at its ends, and would have been formed with a square or rectangular section acting in light angle-iron horns. Lubrication would have required access for whale oil to be applied through the exterior of the sleeve.

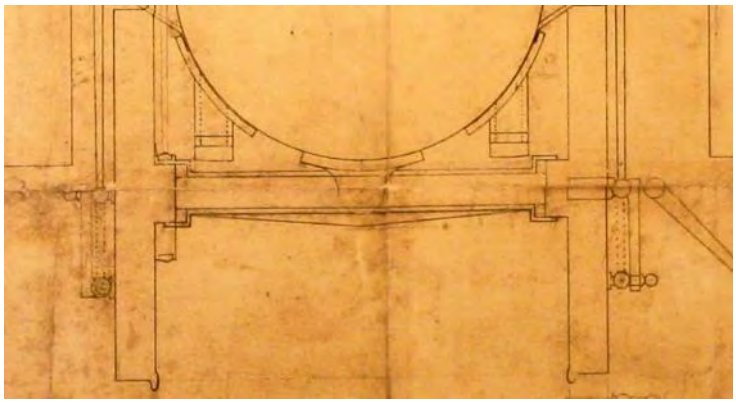


Fig. 11.2 Cannon box bearing for the rear axle from early schematic drawing.

[Fig. 1.2 – detail]

The front axle was to have remained spring-less to allow for the valve and drive motion to operate without the need to accommodate any spring deviation. The axle-box bearing would have been bolted directly to the frame. Again, lubrication by whale oil would have been applied externally (Section 26).

The probable introduction of plate springs on No. 1 from 1828 would have required horns and bearings similar to those adopted for the Killingworth colliery fleet.

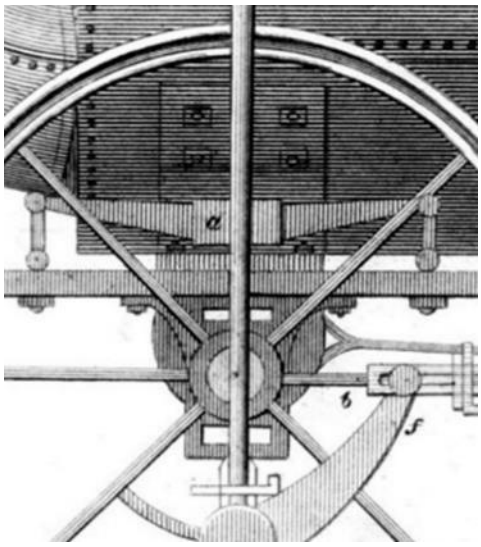


Fig. 11.3 Horn block fitted to Killingworth colliery locomotive by 1831.

[Wood, 2nd Edition, 1831, Plate VII]

ARCHAEOLOGY

The surviving horns show no evidence of the former spring-sets that were fitted within the boiler brackets from 1834. It is likely however that a new, identical set of horns, omitting details associated with the original spring suspension, were cast during the 1892 restoration to replace those previously fitted following the serious corrosion that occurred during the locomotive's external display from 1857 (Section 8).

In the absence of a frame, the four boiler support brackets rest directly on the tops of the horns, to which they are bolted with two x ¾ in diameter bolts at each end. The horn tops are 22½ in long and 8⅜ in wide and have upstanding shoulders at their ends. The vertical horn legs are 12⅜ in tall and 4 in wide, with each leg being 1¼ in thick. They are cast with ¾ in wide curved webs to stiffen the horn slides against fore-and-aft forces from the axles. Wooden spacers, 4¾ in high, are inserted between the bottoms of the legs beneath the axle-boxes, the assembly being drawn together by a 1 in diameter long bolt.

Fig. 11.4 Forward-facing end view of the left rear horn and axle box assembly.

The surviving cast iron axle-boxes have ‘birdbath’ reservoirs formed in their upper surface to allow the application of lubricants.

Fig. 11.5 Upper surface of the front left axle-box showing the ‘birdbath’ lubricant reservoir and hole down to the bearing.

The axle-boxes are 12¼ in from side to side and 5½ in wide across the axle, formed of the upper bearing block which overlaps a lower keep which meet at the mid-point of the axle. The 7¾ in high castings each have two extensions on each side (7½ in wide overall), either side of the horn legs, which are drilled to accommodate 1 in diameter bolt holes to allow the bearings and the 1⅝ in deep keeps to be drawn together around the 4 in diameter axle journals, and tightened. The axle-boxes thus provide generous bearing surfaces of 12¼ in long by 4 in diameter.

Fig. 11.6 Forward facing end view of right rear axle-box assembly with the keep drawn up to the bearing block.

The axle-boxes are separated from the wheels by wrought iron spacers between 1¼ in and 2¼ in wide and 5¾ in diameter. The front left side spacer is however replaced by the 3½ in wide valve drive eccentric and a spacer (Section 20).

12. Boiler Support Brackets

COMPONENT HISTORY

George Stephenson's undated sketch with explanatory notes, which described his ideas for *Active* (Section 1 and Fig. 1.1), included the sentence 'I think 2 floating Cyllinders will do would put the same form on the other end but not to work mearly to support the Boiler'. This proposed that the boiler be supported off its frame by cylinders, the ones at one end functioning as 'steam springs' with the (normally bottomed) pistons acting on the tops of the axle-boxes, as on the Killingworth locomotives, and those at the other end being sealed and empty. In both cases the cylinders would have been rivetted via flanges to the boiler and bolted to the frame, also via flanges. The proposed use of steam springs on one axle only was perhaps a recognition that the S & D R track would be more even than that at Killingworth.

In the event, steam springs were not used (Section 11), but the 'tilting axle' concept was adopted instead. However, it is still possible that cylindrical supports were used in 1825, as proposed above. The later, pre-production, drawing shows these, with substantial oval flanges at the top for riveting to the boiler and rectangular flanges at the bottom, the same width as the frame plates, for bolting to the latter. These boiler support cylinders scale at only 5 in outer diameter and so their use as steam springs would have been ineffective, as well as unnecessary. The cylinders were short because the 'tilting axle' design required the boiler to sit just above the axles.

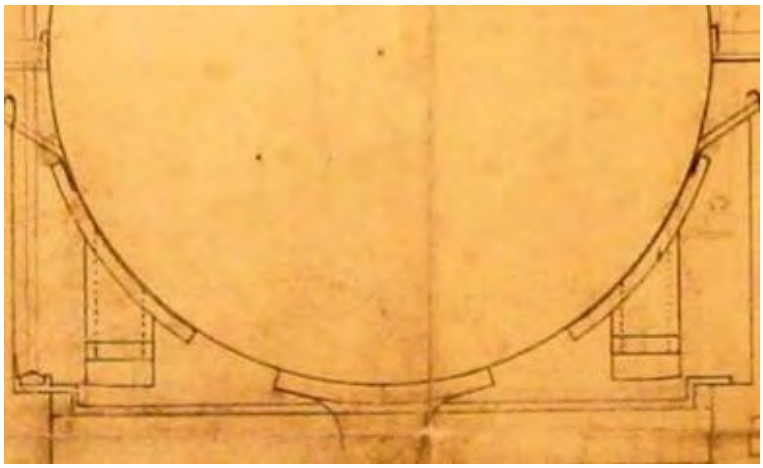


Fig. 12.1. Cylindrical boiler supports on early schematic drawing. [Fig. 1.2 – detail]

If *Active* was fitted with cylindrical boiler supports in 1825, this practise was not continued by the Stephenson Company through to No.5 (later *DILIGENCE*) in 1827. The surviving boiler on *LOCOMOTION* is from this latter locomotive (Section 5), and the (unused) rivets in triangular arrays above the axles on this boiler barrel (Section 13) are set too close together to accommodate the above oval flanges. The arrangement would have been more suited to boiler supports formed from iron plates flanged at the top for riveting to the boiler and at the bottom for bolting to the frame.

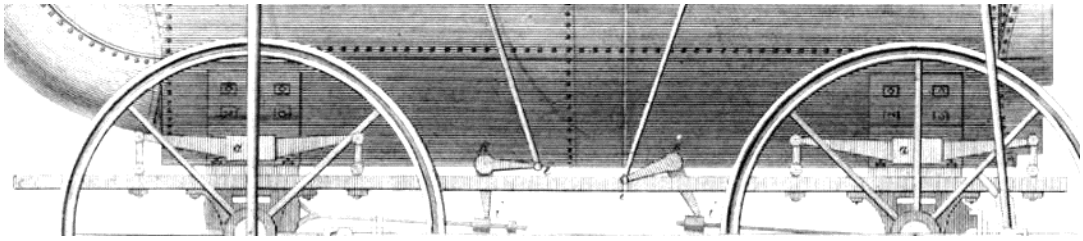


Fig. 12.2. Boiler support brackets behind springs, with flanges bolted to frame beneath springs on Killingworth locomotive. [Fig. 9.4 – detail]

Plate springs were fitted during the 1828 re-build and the boiler support design needed to fit round them. It is therefore likely that the supports were again in the form of flanged plates. This arrangement survives on Killingworth *Billy*.[318]

Springs were retained in the 1834 re-build during which the boiler from *DILIGENCE* was fitted (Section 13) but with the original boiler supports removed and replaced by the surviving set. It is possible that the original supports were not compatible with the insertion of springs, *DILIGENCE* having probably been built with solid suspension. The existing arrangement does not provide much space for springs but it is clear that they were located within the brackets (Section 9).

The particular geometry of these brackets caused the boiler barrel to corrode locally (Section 13) and the right-hand brackets had to be temporarily removed to allow patching of the barrel. It is likely that corrosion also damaged the bottoms of the brackets around the bolts securing the brackets to the horns. Plates have been inserted inside the bottoms of the brackets so that the corroded areas are now sandwiched between these plates and the horns (Section 11).

ARCHAEOLOGY

The four boiler support brackets, one above each end of each axle, all differ slightly. They are formed from ½ in thick wrought iron plate and consist of flat-bottomed U shapes, with the tops bent outwards to match the slopes of the boiler. The higher, outer, arms are nominally vertical and are 19 in long, of which 3 in are bent over to provide flanges for riveting to the boiler. The shorter, inner, arms are sloping and are 12 in long, of which the top 3 in are bent over, as above. The flat bottoms of the brackets are 9¾ in wide internally and have holes for four 1¼ in bolts.

Fig. 12.3. Front right boiler support bracket and bottom reinforcing plate.

The design of the plates at the tops of the horns provides shoulders at each end, separated by 1 ft 9 in into which the bracket was supposed to fit (Section 11) with no allowance for inevitable errors in the positioning of the brackets. Presumably the intention was that the locomotive tractive effort would have been carried from the horns via these shoulders to the boiler (and thence the drawbars) rather than by the above 1¼ in bolts. The brackets themselves are of varying lengths and are incorrectly located longitudinally, relative to the horn top plates. Part of the problem here is that distortion of the boiler and the shapes of the plates have resulted in the bottoms of the brackets being out of alignment with the flanges at their tops. The positions of the latter, and locational errors there, are shown in Fig. 13.6.

Fig. 12.4. 1½ in gap between horn-plate shoulder and rear left boiler support bracket.

The bottom of the front left bracket is the correct 1 ft 9 in long but set ⅝ in too far towards the rear of the boiler. This has required the rear horn-plate shoulder to be cut away by ⅝ in. The bottom of the front right bracket is the same except the rearward error and shoulder cut-away is only ⅜ in. The bottom of the rear left bracket is only 1 ft 6 in long and set ½ in too far towards the front of the boiler, leaving gaps to the horn-plate shoulders at either end. The bottom of the rear right bracket is 1 ft 6⅜ in long and is set 1 in too far to the rear of the boiler, which required the rear horn-plate shoulder to be slightly cut away and leaving a 1⅞ in gap to the front shoulder.

Both of the front brackets have a series of three holes arranged in a diagonal line adjacent to the front edges of the vertical arms. The purpose of these holes is not known.

Fig. 12.5. Rows of three holes in vertical arms of front left and front right boiler support brackets.

A ½ in thick plate has been inserted in the bottom of each bracket (Figs. 12.3 and 12.4). The plate in the front right bracket is too wide and tightening the four bolts has caused the plate to curl upwards slightly.

13. Boiler Barrel

COMPONENT HISTORY

The design of the boilers on early locomotives would have been influenced by the size of plate available. The boiler barrels on the c1818 Killingworth locomotives were made from two rings of six plates, each about 55 in by 27 in, and weighing about 180 lb. This represents a significant advance on *Puffing Billy* (c1814), whose boiler barrel was made up of five rings of six plates, weighing up to 100 lb.[319]

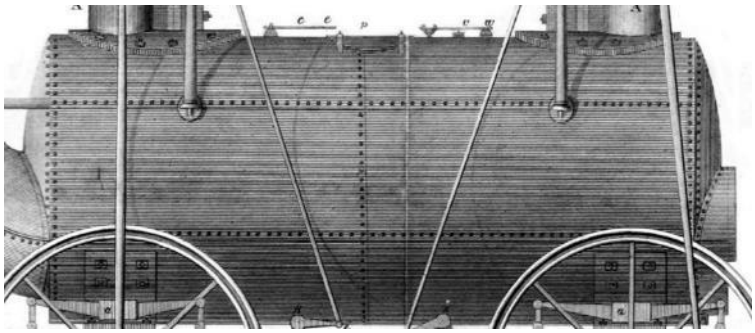


Fig. 13.1. Boiler plates on c1818 Killingworth locomotive. [Wood, 1825, Plate V - detail]

On both boilers a repetitive riveting process would have been used, with the clockwise edges of the plates (when viewed from one end) being outside the neighbouring plate edges. There are two ways in which the Killingworth boiler barrel could have been constructed; either by forming one ring and then working the other ring round it, or by riveting the ends of adjacent plates together longitudinally, and then forming them into the barrel as a single repetitive process.

To further this progression, Section 5 explains that the surviving boiler appears to be that from *DILIGENCE*, constructed in 1827. This must have been built up by the second of these alternative processes. In this case, the clockwise edges of the plates (when viewed from the back end) are outside the neighbouring plate edges. The circumference is made up of seven sets of plates, of which the two largest are 62 in by 30in, weighing 230 lb each.

It is likely that the first boiler on *Active* (Section 1) was similar to the 1818 Killingworth design, which had a barrel 9 ft 2 in long and 4 ft diameter and domed ends (Section 14) each of which would have added some 6 in, resulting in an overall length for the boiler of around 10 ft 2 in.[320] The main difference would have been that *Active* had a shorter wheelbase of just over 5 ft compared with around 8 ft 3 in on the Killingworth locomotives. This shorter wheelbase would not have left sufficient space for the inspection hatch to be positioned between the cylinders, and it would have had to be behind the rear cylinder (as now). In turn this could well have required the boiler barrel to be longer than the above 9 ft 2 in, probably to the 10 ft 2 in at 4 ft diameter of the surviving barrel.

During the re-build in 1828 No.1 was provided with a new, larger boiler. It can be deduced from the data in Section 3 that this boiler without the flue weighed 1.69 tons. The use of a double-return flue (Section 15) would have required the barrel to be at least 4 ft 6 in diameter.

A ranging analysis has shown that the length of the barrel would have been about 10 ft 4 in, at this diameter (Fig. 4.1).

The subsequent desire to reduce the weight of the locomotive led to the second rebuild in 1834 (Section 5) when the original boiler from *DILIGENCE* was fitted. This boiler barrel is shown 'unwrapped' in Fig. 13.2.

All these boiler barrels had angle-iron 'hoops' rivetted to each end for the attachment of the endplates. The angle-irons would have been inside the barrel for domed endplates and outside the barrel for flat endplates, in both cases for ease of riveting.

During the survey, access to the boiler was limited externally because the lagging could not be removed, and internally because the inspection hatch is at the back of the boiler, restricting the viewing range. Although the best use has been made of historic photographs (with the lagging removed) and photographs of the internal features taken during the survey, some aspects of Fig. 13.2 are notional. This was disappointing because, while it is clear that there had been a multiplicity of fixtures to the upper part of the boiler, the details and purposes of these could not always be deciphered. For example, it might have otherwise been possible to find evidence and relevant design information on the use, on the S & D R locomotives following *Active* and probably including *DILIGENCE*, of eccentrics mounted above the boiler, driven by vertical rods from the connecting rods, as shown by Brewster.[321]

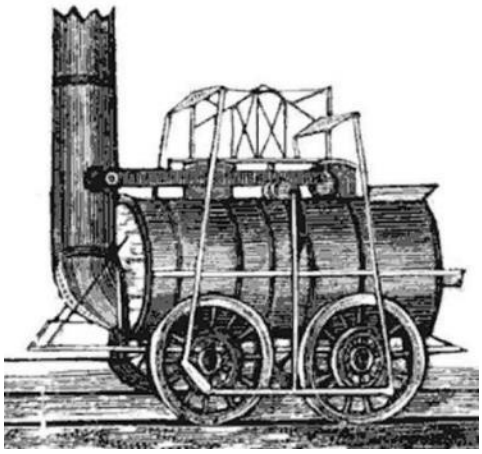


Fig. 13.3 Eccentrics above boiler as depicted by Brewster, 1829.

[Fig. 2.3 – detail]

ARCHAEOLOGY

Boiler Barrel

The boiler barrel is shown unwrapped in Fig. 13.2. The drawing shows in grey the 'footprints' of items fixed to the barrel. Observed unused holes in the barrel, closed by 'blind' rivets, are also shown.

The three longitudinal red lines show the centrelines, those at the left and right of the drawing are both the bottom centreline. It can be seen that the bottom right plates actually extend round the bottom of the barrel by some 3 in.

The rivets joining boiler plates to each other and to the angle-irons at each end are shown indicatively (these amount to some 650 rivets), whereas the fasteners for components attached to the barrel are shown in more detail.

The barrel is 4 ft diameter and 10 ft 2½ in long. It is constructed of fourteen plates, with seven plates making up the circumference. The plates are 7/16 in thick, and are joined with 2 in overlaps by ¾ in round headed rivets at a pitch of around 2 in. Plate widths vary from 21 in to 30 in, with the majority being in the region of 22 to 23 in. Plate lengths vary from 56 in to 69 in, with the most common pairing being a 57 in long plate coupled with a 67 in long plate. Circumferentially, the plates are joined in such a way that the clockwise edge of each plate (when viewed from the rear) is outside the neighbouring plate. Longitudinally, the front sets of plates are telescoped inside the rear sets.

Angle-iron hoops, 3 in by 3 in and ⅜ in thick, are rivetted to each end of the barrel, again by ¾ in rivets at 2 in pitch.

Detailed features of the boiler barrel are described further below. Other miscellaneous aspects of interest include the following. The sets of three large rivets in a triangular formation, located between the flanges of all four boiler support brackets, must have been associated with an earlier boiler support arrangement (Section 12). The axle centrelines are shown in red on the outlines of the boiler support bracket flanges, to show the errors in the longitudinal positioning of these brackets (Section 12). Narrow ligaments of boiler plate remain between the openings for the cylinders and the openings for the downward extensions of the valve-chests, for the regulator system (Section 22). The shapes of the latter openings are notional, based on internal views of the arrangement at the front cylinder (Fig. 22.12) and a limited view at the rear cylinder.

A fragment of the end of a stout bar remains riveted to the front left of the boiler barrel adjacent to the bottom flange of the boiler support bracket. This clearly served no purpose in the normal operation of the locomotive. It is possible that a bar at this location was required to steady the locomotive when it operated at Roddymore Colliery (Section 7).

Fig. 13.4. Remains of bar riveted under the front left of boiler barrel.