The Firefly project

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Introduction

When the first GWR passenger train left Bristol Temple Meads for Bath at 8.00 pm on 31st August 1840 it was hauled by *Fire Ball*, a 'Fire Fly' class Locomotive, one of 62 similar engines including *Fire Fly* — which was the first to be delivered to the Paddington end of the line in March 1840.

The project to build and run a replica of the *Fire Fly* * was conceived in 1981 whilst I was engaged on the restoration of the Brunel buildings at Temple Meads, now handed over to the Brunel Engineering Centre Trust. It began to take shape after discussions with British Rail and the Bristol City Museum led to sponsorship proposals from both these organisations. The then General Manager of the Western Region, Leslie Lloyd, responded enthusiastically and with the help of his Chief Mechanical and Electrical Engineer, John Butt, a number of experienced, recently-retired railway engineers became interested in the project.

* *The original locomotive was called* **Fire Fly**. *To make it clear that the 'replica' is not an exact copy it is to be called* **Firefly**.

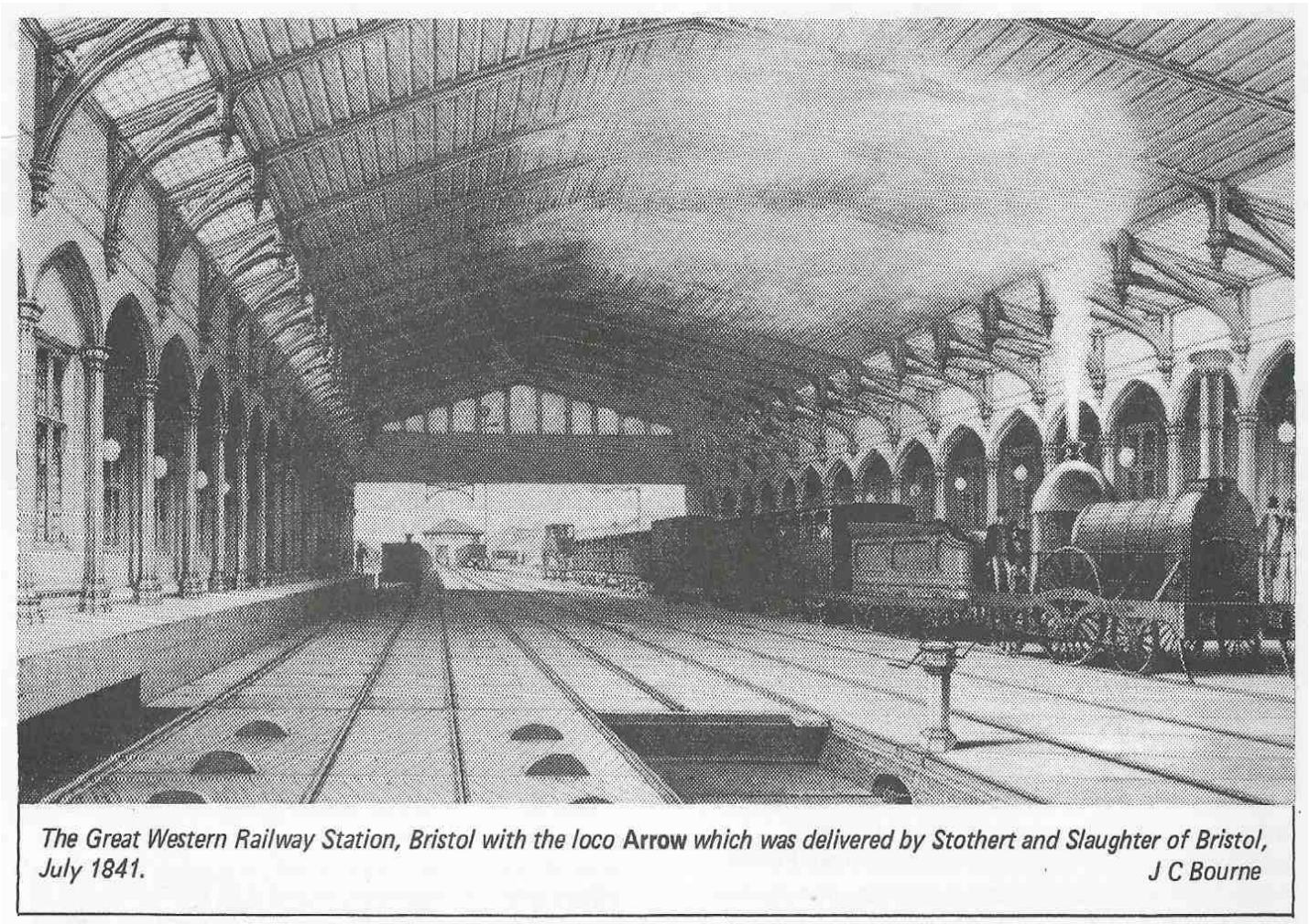
These included Leslie Slade, who was recently Design Manager of British Rail Engineering Ltd at Derby, and S A S Smith, the well-known former Manager of Swindon Works. In addition, J Earle Marsh, a former Swindon apprentice engineer, with first-hand boiler experience, whose father was the Chief Engineer of the London, Brighton and South Coast Railway, also joined the team - together with Alan Wild, a Senior Inspector with BREL at Swindon, and Paul Elkin of the Bristol Industrial Museum.

The project has thus gained all of the technical expertise required to design and build the replica and, following feasibility studies which have confirmed the viability of the scheme, it is now actively seeking funds.

Development and Brief History of the 'Fire Fly' Class

Anyone familiar with Bourne's prints of the Great Western Railway, published in 1846, will recognise that most of the engines illustrated there are those of the 'Fire Fly' class.

Daniel Gooch, who had been appointed in 1837 at the age of 21, as Locomotive Superintendent of the line, was responsible for the design of the 'Fire Fly' class, following a series of failures with the collection of engines that had



The Great Western Railway Station, Bristol with the loco **Arrow** *which was delivered by Stothert and Slaughter of Bristol, July 1841.* *J C Bourne*

been built to the specifications of l K Brunel. Gooch states in his diary that for many weeks after the line opened, he spent his nights in a carriage at the Paddington engine house, as repairs had to be carried out each night in order to provide a service for the next day.

Only six engines which had been built by the Vulcan Foundry and the *North Star*, built by Robert Stephenson & Co, could be relied on and, with so many engine failures, the Directors anxiously called for a report. It says much for Daniel Gooch that he succeeded in putting forward a report which, although it explained that Brunel's specification was at fault, it did not entirely offend him and it was in consequence of this that Gooch was asked to prepare a design for a standard locomotive suitable for taking passenger traffic at the high speeds and with the reliability which the use of the broad gauge had promised.

Most of the early stock of locomotives were later rebuilt or sold. However, *North Star*, one of the first locomotives to be delivered to the GWR, had proved to be reliable from the outset. It was *North Star* which headed the first passenger train on 31 st May 1838 from Paddington to Maidenhead. The design, which was unaffected by Brunel's specification, was one on which Daniel Gooch had worked whilst he was at Robert Stephenson & Co's works for a short while in 1836, He states in his diary that he was pleased with the additional room available to accommodate the motion which the original 5 ft 6 in gauge provided. There is some doubt as to whether this design was for the New Orleans Railway or for Russia, but it appears that *North Star* was originally intended for the former and that, as a result of financial problems, it became available for the GWR. A second engine of the same type, *Morning Star*, was also purchased in 1838 from Stephenson & Co and in response to a follow-up order, a further ten engines were built, of which three were delivered by July 1840. Once these were put into service, Gooch's daily problems became easier and he turned his attention from emergency repairs to regular maintenance and the production of the prototype ***Fire Fly***.

in the design of the '**Fire Fly**' class, Daniel Gooch, profiting from his experience, decided that priority must be given to reliability and ease of maintenance, together with ample boiler power and, whilst acknowledging the value of Stephenson's 'Star' class, he set out to obtain independence from any one manufacturer. Altogether the 'Fire Fly' and the contemporary 'Sun' class, which was built to a similar pattern but with smaller driving wheels, represented a major advance in production engineering, predating even the early mass production of muskets at Harpers Ferry in the Unites States in 1850. Although the older Brunel, with Maudsley, had set up mass production of block making for the Navy some thirty years earlier, that was no more than rapid manufacture of components and it was followed by similar production of boots for the Army. The 'Fire Fly' design set the precedent for interchangeability of both components themselves and assemblies. The drawings were lithographed, so that reproduction copies were available, and parts required to be interchangeable were fitted to standard sized cast iron mandrels. The maker was, in addition, required to accept liability for workmanship and materials for the first 1,000 miles of operation with proper loads.

These ideals were certainly realised in practice for Daniel Gooch, writing to R W Hawthorn & Co, the builders of the Sun states 'l cannot pass the engine in her present state - she not being in conformity with our Drawings and Specifications, and thereby totally defeating our main object in furnishing drawings and templates, viz, to get our engines so that one part of any engine will fit another'.

Altogether 62 'Fire Fly' and 21 'Sun' class engines were built between 1840 and 1842 by eight different manufacturers, situated as far apart as Manchester, London and Bristol.

The 'Fire Fly' class was a great success and, together with its sister class of 'Sun' locomotives and the 'Star' class, worked all of the early traffic. Queen Victoria made her first railway journey behind a 'Fire Fly' locomotive in June **1842** and the first rail postal service in the world was opened in **1855** by engines of this class. They made regular workings at speeds up to **60** miles per hour and gave the new Great Western Railway a reputation for being the fastest railway in the world. The last of the class to survive, the *Ixion*, was not withdrawn until **1879** after over thirty seven years in service. Many continued longer as the 'Priam' class or, after rebuilding, as saddle tank engines, but nothing now survives, except for the drawings. These are still available, together with a portrait photograph of *Fire Fly* taken in 1846, from the joint BR and Oxford Publishing Company venture. This photograph shows that towards the end of her working life, she was fitted with link gear.

Mechanical Arrangement

The general arrangement of the 'Fire Fly' class followed that of *North Star*, which in turn was based on the Stephenson's ***Patentee*** Locomotive of 1834. Each had a 2.2.2 wheel arrangement, with large driving wheels fixed directly to a crank axle, supported by internal framing. There were four inside frames or stays, spanning from the cylinder casting in the front to the firebox at the rear, so that each crank shaft was contained by a pair of stays, and each driving wheel was placed within the outer stay and the outside frame. This gave a high degree of safety in the event of a crank axle failure and it also gave a most important feature to the design, which was to permit a change of gauge during manufacture. In **1834** when the ***Patentee*** locomotive was built, railways gauges were not standard and it was a distinct manufacturing advantage to be able to provide a standard boiler and motion which could be adapted to different gauges. This principle carried through to the early broad gauge engines which had boilers and motions of similar size to those of standard gauge but were fitted with outside frames to accommodate the greater axle width. The *North Star*, for instance, was originally intended for the 5ft 6ins gauge of the New Orleans Railway or the 6 ft gauge of the Russian railways, whilst the 'Fire Fly' design was modified from 7ft 0¼ ins gauge to the standard 4ft 8½ for the '69'

class when, in **1854**, the GWR acquired the Shrewsbury railways. In this latter case there was even interchangeability of parts between the 'Fire Fly', the 'Sun' and the '69' class.

The *Fire Fly* predated Stephenson's link gear for the control of steam admission and the driving arrangements consisted simply of a regulator valve, a reversing lever and, on one side of the tender only, screw down brakes. Bourden's pressure gauge had not been invented either at this date and all early locomotives relied on spring balanced pressure gauges. The water level was discovered by means of a series of cocks which when opened blew either water or steam.

Early 'Fire Fly' locomotives were fitted with Gab Gear to control forward and reverse working, but later locomotives had Gooch's design of valve gear which permitted expansive working, and greatly increased economy of operation.

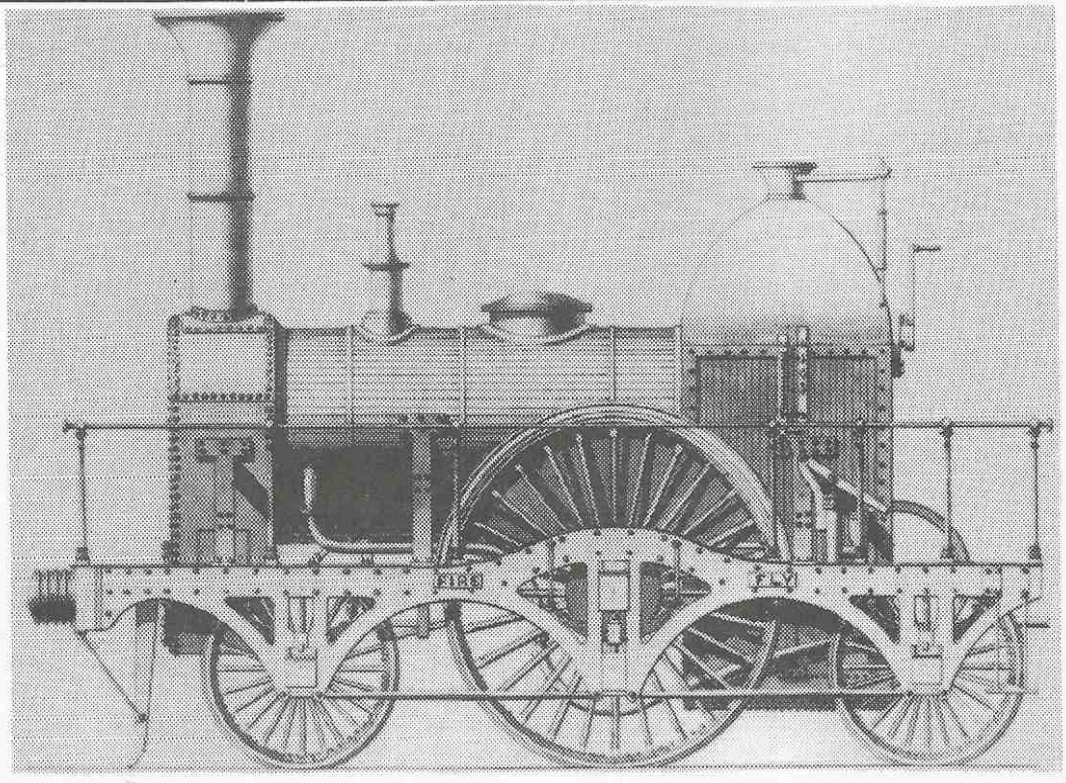
Another noticeable difference between the early and later engines of the 'Fire Fly' class is that the forward mounted safety valve was omitted in the later version, and the boiler access plate was sited on the front of the firebox. Bourne's prints show engines of this type and their working arrangements can be clearly distinguished.

The driving wheels were built up of wrought iron forgings from as many as 140 parts, all hammer welded to form a single unit which was steel tyred, using a patent process registered by Daniel Gooch in 1840. The boiler pressure was 50 lbs per square inch, later possibly increased to 75, and the cylinder, originally 15ins by 18ins stroke, was later increased to 16ins. The outer frames followed Stephenson's practice, being built up of two plate frames lightened by triangular openings and separated by a timber member. The timber was initially ash or oak but, after experience of loose bolting caused by acid action from the timber, teak was employed. The outside frames were securely fixed to the boiler with inclined stays, so making the boiler a principal member in the longitudinal strength of the engine.

The boiler, of 4ft diameter,was fitted with 131 tubes and had a heating surface area of around 700 square feet. Daniel Gooch had early on realised the importance of free steaming, and ample grate area was provided. After experiments in which Brunel took part, the performance of the class was improved by alterations to the blast pipe, and the *Ixion* was specially tuned for the Broad Gauge Trials, but taken all in all, this was from the first a very successful design. This it is best summed up in Daniel Gooch's own words: 'I may with confidence, after these engines have been working for 28 years, say that no better engines for their weight have since been constructed either by myself or others. They have done, and continue to do, admirable duty' .

Manufacture

The rapid development of railways was accompanied by an equally rapid increase in the number of firms capable of building engines. In general they were companies which had already had some experience of the essential skills of



The 'client's drawing' of the loco, probably made by Gooch's assistant Thomas Russell Crampton. Not all details are as actually built, including the wheels and the firebox which was more hemispherical, but most features were as this drawing.

working metal - casting, forging and machining. Henry Stothert of Bath was typical of the enterprise of his day and in 1837 he is reported as having purchased land in Bristol where he set up a manufactory for building locomotives. George Stothert junior had visited Penydarren in 1804 to see Trevithick's high pressure steam locomotive, and one of the four engines in use at the Bristol end of the GWR in 1840, shortly after the line was opened to Bath, was the *Arrow*, built by Stothert, later to be followed by a second 'Fire Fly' locomotive, *Dart*. Altogether seven companies participated in the construction of 'Fire Fly' locomotives, thus ensuring a healthy independence from any one manufacturer. Not all of the work was carried out at the manufacturer's premises. Many parts were sub-contracted as forgings or castings then machined and fitted at the main contractor's yard. Henry Stothert's firm in Bristol was joined by Edward Slaughter and the enterprise grew to the point where not only did they manufacture a large number of engines for several companies but, for a period of almost two years, they worked the line from Bristol to Gloucester until it was taken over by the Midland Railway in 1845.

The Place of *Fire Fly* in our Locomotive History

A natural development of the principle of independence from a single manufacturer which the 'Fire Fly' class had pioneered, was the setting up of facilities for the construction of engines at Swindon. This decision was also influenced by the result of trials by the Gauge Commissions in 1845, when it became clear that, for sustained high speed running, the heavier broad gauge engines were superior. The *Great Western* was the first locomotive to be entirely built at Swindon and it was the prototype for the famous 'Iron Duke' class which, with rebuilding, served the company from 1847 through to the end of the broad gauge era in 1892.

The 'Great Western' design was a straightforward development of the *Fire Fly* , but with 18 inch cylinders, 24 inch stroke, and 8 ft driving wheels. The boiler had 278 two-inch tubes and a heating surface of 1,733 square feet; its appearance was similar to the *Fire Fly* with the 'Gothic' domed firebox casing, and the 2-2-2 wheel arrangement. However, the weight on the forward wheels proved to be excessive and, after an axle breakage, the engine frame was rebuilt to accommodate two leading wheels. This 4-2-2 wheel arrangement was carried forward to the 'Iron Duke' design which was virtually the same as the 'Great Western', without the domed boiler.

Following the success of the 'Great Western' and the 'Iron Duke' classes, few outside contracts were given for locomotives, and at the end of Gooch's period as Locomotive Superintendent in 1864 the company had 360 engines on its books of which 305 had been built at Swindon. All had been designed by Daniel Gooch.

The 'Fire Fly' class was important, not only because it was the first major production engineering project, but because it was a very satisfactory work-a-day locomotive, and was reliable, fast and easy to maintain. It set standards which subsequent designs bettered only in terms of horse power.

The Firefly Project:

During late 1981 and 1982 a series of design studies and research was carried out to establish the feasibility of constructing a replica of the *Fire Fly* and by 1983 the idea had gained support from the Newcomen Society. BIAS, the Great Western Society, the Broad Gauge Model Railway Society, the Brunel Society, the Science Museum and the Brunel Engineering Centre Trust. It had also aroused the interest of the West Country Tourist Board. It is expected that construction of the replica locomotive will commence in 1985 and the Trust will set up a drawing office at Swindon to prepare specifications and drawings for the work. The replica will be built to 7/8ths full size so as to conform with the standard British Rail loading gauge and the framing will be arranged so that, by means of a wheel change, the running gear is adaptable from broad gauge to standard gauge. This will enable working on broad gauge track or on the national network of standard gauge track, as well as on continental or American railroads - an essential feature if the project is to pay its way by means of passenger receipts.

It is also hoped to secure agreement to regular working with replica broad gauge carriages on the line from Temple Meads to Wapping Wharf and discussions towards this end have been opened with Bristol City Council, British Rail, The SS Great Britain Project, and the 'Exploratory'. The Trust will also wish to arrange special trains to run on the anniversaries of important dates in the history of the GWR, such as the date of the first train out of Paddington, and from Temple Meads - hopefully worked by the replica. However, all efforts at the moment are being directed towards forming a strong and active membership of the Trust, and in fund raising so as to achieve the objectives that have been set.

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