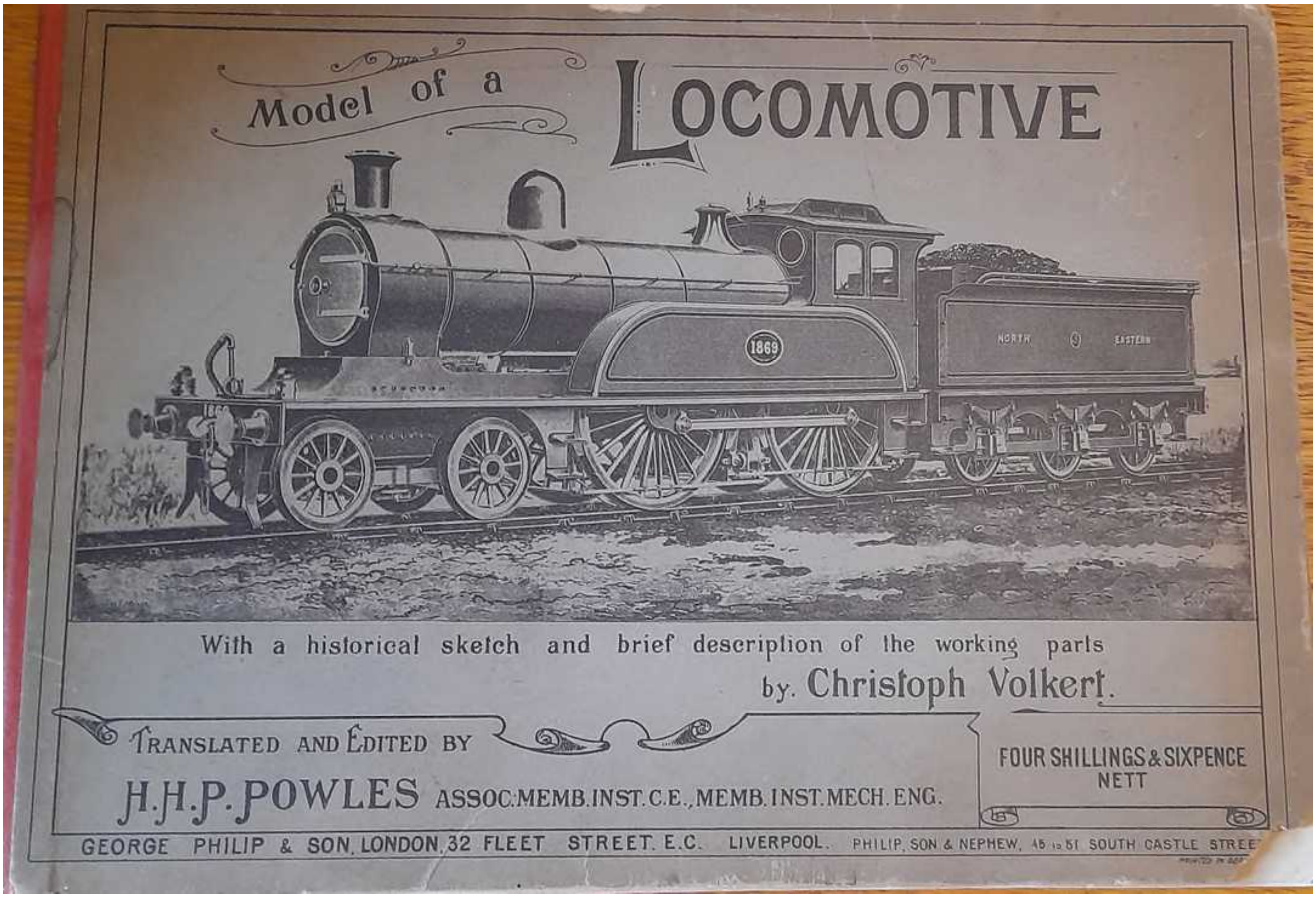


Model of a
LOCOMOTIVE

With a historical sketch and brief description of the working parts
by. Christoph Volkert.

TRANSLATED AND EDITED BY
H.H.P. POWLES ASSOC.MEMB.INST.C.E., MEMB.INST.MECH.ENG.

FOUR SHILLINGS & SIXPENCE
NETT

GEORGE PHILIP & SON, LONDON, 32 FLEET STREET, E.C. LIVERPOOL. PHILIP, SON & NEPHEW, 45 to 51 SOUTH CASTLE STREE

North Eastern Railway No.1869 Worsdell Class D18 (NER Q1) 4-4-0

Modell einer Lokomotive

Nein, es geht nicht um eine Modelleisenbahn, sondern um das „Modell einer Lokomotive“, wie es häufiger um die vorige Jahrhundertwende publiziert wurde. Unter Nr. 134 wurde noch 1957 die „**Dampflokomotivkunde**. Leitfaden zum Lehrfach m3II, Dampflokomotiven - Lokomotivkunde, für Dienstanfängerlehrgänge. **Mit plastischem Schaubild** (Völlige Neubearbeitung und Zusammenfassung der vorherigen Bände 134-139)“ mit zahlreichen Abbildungen auf 628 Seiten durch die Eisenbahn-Lehrbücherei der Deutschen Bundesbahn herausgegeben im Auftrag der Hauptverwaltung der Deutschen Bundesbahn durch die Arbeitsgemeinschaft für Ausbildungshilfsmittel bzw. vom Bundesbahn-Sozialamt - Forschungs- und Versuchscenter für das Betriebliche Bildungswesen in Starnberg beim Josef Keller Verlag. Das aufklappbare plastische Schaubild zeigt eine moderne Dampflok der Baureihe 66.

Jahrzehnte zuvor schuf Christoph Volkert das Modell einer Lokomotive, mit einem historischen Abriß und einer kurzen Beschreibung der Funktionsteile: **„Die Lokomotive. Ein zerlegbares Modell zum Zwecke der Selbstbelehrung und für den Unterricht an Gewerblichen Fachschulen, bearbeitet und mit geschichtlichem und beschreibendem Text versehen.“** Es erschien um 1897 in Fürth bei G. Löwensohn und enthielt 40 Spalten Text sowie 2 Blätter Modell. Das Buch diente zum allgemeinen Gebrauch für technisch Interessierte und Studierende. Die farbige Figur kann in verschiedenen Schichten aufgeklappt werden. Es wurde in verschiedene Sprachen übersetzt, die englische Übersetzung gab Henry Handley Powles heraus, London, Fleet Street: George Philip & Sohn; Liverpool: Philip, Sohn & Neffe, South Castle Street, um 1898, Abb. 14 S.

Bilderbücher von Löwensohn

Die Bilderbücherfabrik **Löwensohn** produzierte von 1882 bis 1937 in der Fürther Sommerstraße Bilderbücher in zahlreichen Sprachen. Sie geht auf die Druckereigründung von Gerson Löwensohn in Fürth im Jahre 1844 zurück. Der Firmenname lautete G. Löwensohn Buchhandlung Lithographische Anstalt & Druckerei. Er produzierte ab 1856 Bilderbogen, Mal- und Bilderbücher. Seine Söhne Theodor und Bernhard bauten den Verlag und eine angeschlossene Buchhandlung nach der Übernahme 1871 weiter aus. 1883 verlegte die Firma ihre lithographische Kunstanstalt von der Blumen- in die Sommerstraße. 1890 erfolgte die Umwandlung in eine OHG. Albert Rosenfelder stieg mit der für damalige Verhältnisse großen Summe von 100.000 Goldmark als Mitinhaber in die Firma ein. 1894 waren über 700 Titel in zehn verschiedenen Sprachen im Verlagssortiment. Bernhard Löwensohn formulierte prägnant in seiner Festrede zum 50-jährigen Firmenjubiläum 1894: „Aus einem Handbetrieb wurde ein Fabrikbetrieb, anstatt einer täglichen Leistung auf der Handpresse von 400 Abdrücken konnte man auf der Schnellpresse 3.000 herstellen.“ Anläßlich ihres Firmenjubiläums haben die Brüder Löwensohn in diesem Jahr eine Arbeiterstiftung mit einem Betrag von je 15.000 Mark begründet. 1919 übernehmen die beiden Söhne von Theodor Löwensohn, Robert und Gustav Löwensohn, zusammen mit Ernst Rosenfelder, der die Anteile an der Bilderbücherfabrik von seinem Vater Albert Rosenfelder nach dessen Tod 1916 erbte, die Leitung der Bilderbücherfabrik.

Arisierung

Die Machtergreifung der Nationalsozialisten 1933 brachte auch dieses jüdische Unternehmen in Schwierigkeiten. Gustav und Robert Löwensohn mussten 1937 den Betrieb an die Kunstanstalten May (KAMAG) in Dresden verkaufen und erhielten lediglich 5% des Kaufpreises, den Rest der Verkaufssumme behielt der NS-Staat. Die Firma wird in eine GmbH umgewandelt und trat nun unter dem Namen Pestalozzi-Verlag auf, den die Firma Löwensohn schon Ende der 1920er Jahre übernommen hatte. Der bisherige Prokurist, Emil Franke, übernahm die Geschäftsführung.

Gustav Löwensohn, sein Bruder Robert und dessen Frau Ella-Ruth wurden deportiert und ermordet. Der letzte Teilhaber, Ernst Rosenfelder, überlebte im Londoner Exil.

Nachkriegszeit

1949 wurden die Eigentumsverhältnisse neu geordnet: Die Überlebenden der jüdischen Eigentümerfamilien erhielten 50%, die anderen 50% verblieben bei den Kunstanstalten May, die ihren Firmensitz nach Fürth verlegt hatten, nachdem der Stammbetrieb in Dresden verstaatlicht worden war. In den 1950er und 1960er Jahren entwickelte sich der Pestalozziverlag zu einem der führenden Kinderbuchverlage und war Marktführer im Bereich von Pappbilderbüchern. Erweiterungsbauten im Hof der Sommerstraße 12 und 14 sollten ab 1964 weitere Raumkapazitäten bieten; letztendlich waren jedoch die Erweiterungsmöglichkeiten auf dem Stammareal begrenzt und man entschloss sich zu einem Neubau in Erlangen-Eltersdorf. Im Januar 1972 wurde die Produktion nach Erlangen verlagert; im April war die gesamte Verlagerung des Betriebes aus Fürth abgeschlossen und damit endete die jahrzehntelange Tradition der Bilderbuchherstellung in Fürth.

Die damals vom Verlag herausgegebenen Serien an Kinderbüchlein im einheitlichen Heftformat vom 12,5 cm x 9 cm mit kindgerechten Texten und herrlichen Illustrationen waren in den 1970er Jahren ein Renner. Die zeittypischen Themen waren u. a. Heidi, Walt Disneys Aristocats, Mogli-Büchlein aus Walt Disneys „Das Dschungelbuch“, Robin Hood. Aus der Micky-Maus-Buchreihe mit Donald Duck und Onkel Dagobert erschienen 52 Büchlein.

Nach der Umsiedlung nach Erlangen kaufte der Pestalozziverlag den Scholz-Mainz-Verlag (1972), den Stuttgarter Boje-Verlag (1983) und den Kinderbuchbereich von Mulder BV (1988). Nach Umsatzrückgängen erwarb 1998 die dänische Egmont-Medienholding den Verlag und führte ihn ein Jahr lang als "Egmont-P." weiter. Seit

1999 gehört er zum Egmont-Franz-Schneider-Verlag in München. Einige ehemalige Erlanger Mitarbeiter betrieben die Druckerei dort als "BoardBook GmbH" weiter.

Leitung

Gegründet von Gerson Löwensohn, fortgeführt von Bernhard und Theodor Löwensohn, zuletzt geführt von Enkel Gustav Löwensohn. 1937/38 übernimmt der langjährige Prokurist Emil Franke die Geschäfte, 1949 setzt ein Verwaltungsrat die Leitung fort (als einziger Überlebender der Eigentümerfamilien ist Ernst Rosenfelder mit vertreten).

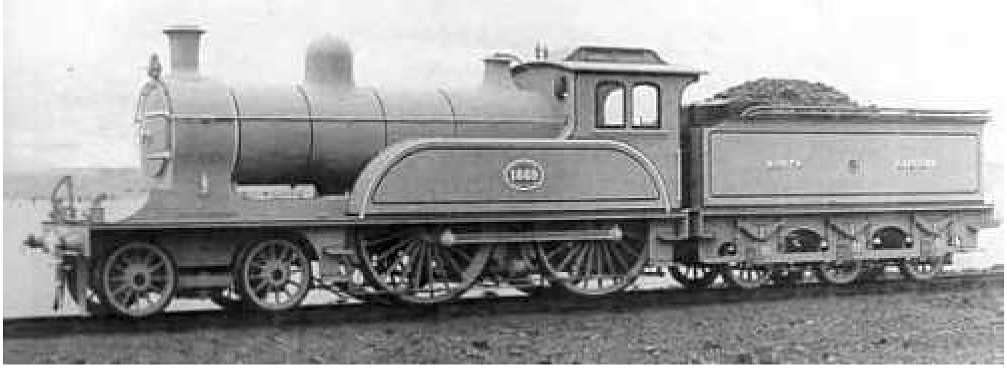
Ehrungen und Auszeichnungen

An das Wirken der Familie Löwensohn erinnert seit 1950 die Löwensohnstraße in Dambach.

Das Titelbild: NER Lokomotive No.1869

Der englische wie der deutsche Buchtitel zeigt die 2’B-Lok der North Eastern Railway No.**1869**, sie war seit Mai 1896 im Dienst. Nach einem Entwurf von Wilson Worsdell wurde die Lok der Baureihe Q1 für die NER bzw. der späteren LNER Baureihe D18 von der Lokfabrik Gateshead Works gebaut. Sie war 34 Jahre und 5 Monate in Betrieb. Im März 1920 wurde ein Überhitzer-Kessel eingebaut, im Mai 1920 erfolgte ein Umbau mit Kolbenventilen, im Oktober 1930 wurde sie z-gestellt und ausgemustert.

Die Lokomotiven der Worsdell Baureihe D18 (NER Q1) 4-4-0



In den Jahren 1888 und 1895 gab es eine Reihe von "Lokomotivrennen" zwischen der Ost- und der Westküstenstrecke nach Schottland. Für den Fall weiterer Rennen wollte die North Eastern Railway (NER) gerüstet sein und baute 1896 die beiden **Q1**-Lokomotiven (LNER **D18**). Die Q1 basierten auf den Lokomotiven der Klasse Q (LNER D17/2) von Wilson Worsdell und waren mit großen Antriebsrädern mit einem Durchmesser von 7 Fuß und 7,25 Zoll ausgestattet. Dies waren die größten gekuppelten Antriebsräder, mit denen eine britische Lokomotive ausgestattet war. Sie waren ein deutlicher Hinweis auf den Zweck der Klasse Q1. Leider wurden die Rennen nie wieder aufgenommen und es wurde auch nie versucht, die Höchstgeschwindigkeit der Q1 zu ermitteln.

Die auf der Baureihe Q basierende Baureihe Q1 wurde 1896 zur gleichen Zeit wie die erste Serie der Baureihe-Q-Lokomotiven gebaut. Beide Typen hatten ein ungewöhnliches Oberlichtdach. Aufgrund der großen Räder der Q1 waren die Führerstandsfenster höher angeordnet als üblich. Neben den größeren Rädern waren die Q1 mit längeren Feuerbüchsen ausgestattet, was zu einer zusätzlichen Rostfläche von 1 Quadratfuß führte.

Die D18-Kessel waren nicht genormt, es war nur natürlich, daß sie durch Standard-D17/2-Kessel ersetzt wurden, wenn sie verschlissen waren. Bei Nr. 1869 wurde der Kessel im August 1910 und bei Nr. 1870 im September 1911 ausgetauscht. Auch bei den D18-Lokomotiven wurden ähnliche Änderungen vorgenommen wie bei den D17-Lokomotiven. Nr. 1869 wurde im März 1920 und Nr. 1870 im März 1915 mit Schmidt-Überhitzern ausgestattet. Nr. 1869 erhielt gleichzeitig mit dem Überhitzer Zylinder mit einem Durchmesser von 19 Zoll Kolbenventile, während Nr. 1870 ihre 20-Zoll-Zylinder bis zur Ausmusterung behielt. Nr. 1870 erhielt im September 1911 Kolbenschieber.

Die D18 waren zunächst dem Betriebswerk Gateshead zugeteilt und wurden auf der Ostküsten-Hauptstrecke nach Edinburgh und York eingesetzt. Die Dienste nach York wurden bevorzugt, da diese Strecke relativ wenig Steigungen aufwies, was den D18 entgegenkam. In dieser Zeit legte die Nr. 1869 die 44,25 Meilen von Darlington nach York in 42 Minuten und 7 Sekunden mit einer Last von 200 Tonnen bei starkem Regen zurück. Dies entsprach einer Durchschnittsgeschwindigkeit von 61,7 mph, mit einer Höchstgeschwindigkeit von 74 mph in Tollerton. Nach 1902 behauptete die NER in ihrer Werbung, sie führe den schnellsten Zug im Britischen Empire (von Newcastle nach Bristol mit einer Fahrzeit von 43 Minuten von Darlington nach York). Diese

Rennlokomotiven wurden jedoch nur selten eingesetzt, da man den leistungsstärkeren D20 den Vorzug gab, die inzwischen eingeführt worden waren. Die D18 wurden bald nach Neville Hill verlegt, wo sie auf den Strecken nach Hull, York und Scarborough eingesetzt wurden. Sie kamen auch auf den Strecken nach Stockton und West Hartlepool über Harrogate und Northallerton zum Einsatz. Dies ist besonders bemerkenswert, da die Strecke durch Harrogate für eine Lokomotive mit so großen Treibrädern besonders hügelig ist. Beide D18 wurden im Oktober 1930 ausgemustert. In ihrem letzten Jahrzehnt erwiesen sich die D18 als kompetente Leistungsträger mit einer Last von bis zu sechs Wagen.

Technische Einzelheiten

Die folgenden Details gelten für Nr. **1869**. Nr. 1870 hatte größere Zylinder mit 20 Zoll Durchmesser und eine entsprechende Zugkraft von 15.500 lb.

Zylinder	(x2): (innen) 19x26 Zoll.	
Antrieb:	Stephenson	
Ventile:	8,75-Zoll-Kolben	
Kessel:	Max. Durchmesser: 4ft 4in	
Druck:	160psi	
Diagramm Nr.:	65	
Heizfläche:	Insgesamt:	1097 sq.ft.
	Feuerraum:	123 sq.ft.
	Überhitzer:	204 sq.ft. (18x 1.1")
	Rohre:	479 sq.ft. (89x 1.75in)
	Heizrohre:	291 sq.ft. (18x 5.25in)
Rostfläche:		19.8 sq.ft.
Räder:	Führend:	3ft 7.25in
	Gekuppelt:	7ft 7.25in
	Tender:	3ft 9.25in
Zugkraft:		13.990lb (bei 85% Kesseldruck)
Radstand:	Gesamt:	46ft 2.75in
	Lok:	23ft 9in
	Tender:	12ft 8in
Gewicht (voll):	Gesamt:	94 Tonnen 14cwt
Maschine:		53 Tonnen 10cwt
Tender:		41 Tonnen 4cwt
Max. Achslast:		19 Tonnen 4cwt

Keine Lok der Baureihe D18 ist erhalten geblieben. Die D18 „1869“ ist zwar auf dem Buchdeckel abgebildet, im Buch selbst findet sich jedoch ein ganz anderes aufklappbares Modell einer 1’B-Dampflokomotive.

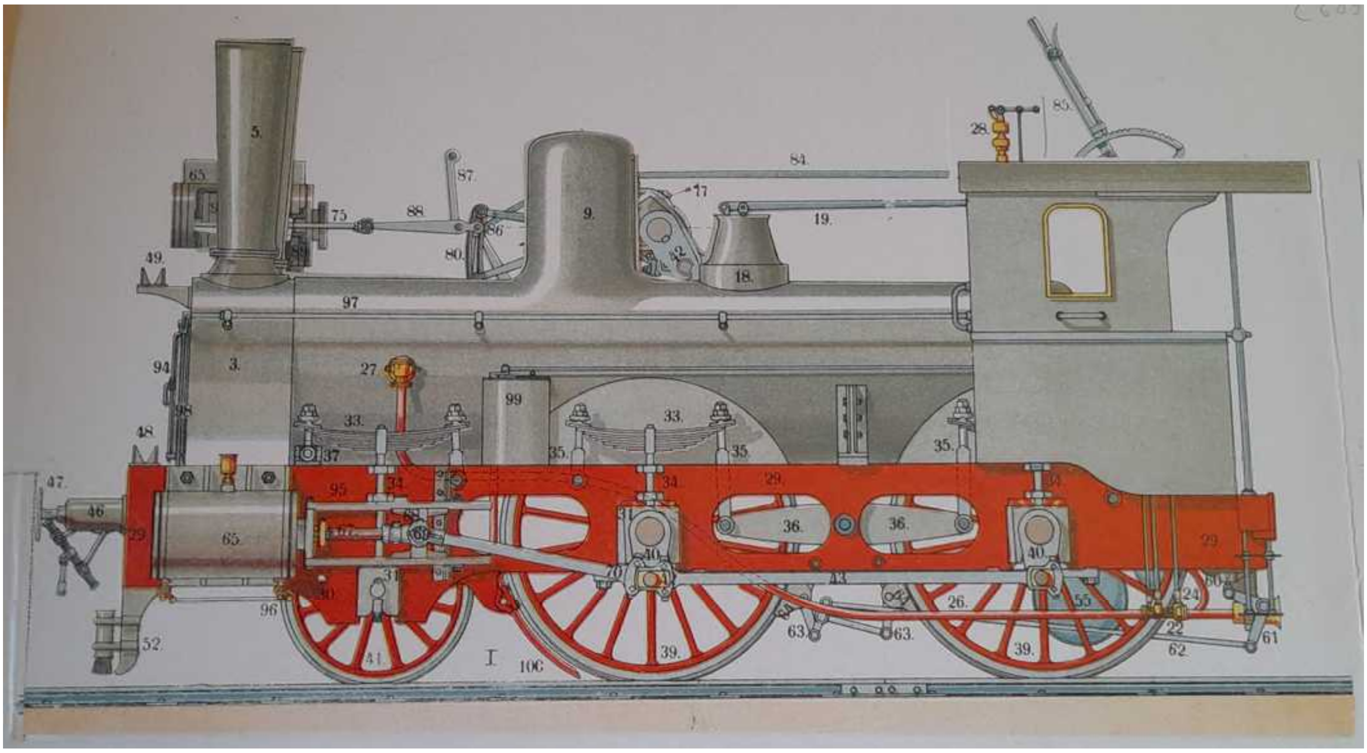
Auszug aus der deutschen Variante des Volkert-Buches:

I. Geschichtliche und allgemeine beschreibende Angabe über die Entwicklung der Lokomotive

Der Gedanke, Straßenfahrzeuge mit Maschinen vorwärts zu bewegen, welche durch die Druckwirkung gespannter Wasserdämpfe in Umtrieb versetzt werden, ist eben so alt wie die Dampfmaschinen, und die ersten darauf bezüglichen Vorschläge rühren von Thomas Savery, dem Erfinder der sogenannten Feuerpumpe oder hydraulischen Dampfmaschine her, stammen also aus dem Anfange des vorigen Jahrhunderts. Auch Robinson in Glasgow, ein mit James Watt befreundeter eifriger Mitarbeiter desselben bei Vervollkommnung der Dampfmaschine, hat vom Jahre 1759 ab, wenn auch ohne sichtbaren Erfolg, im gleichen Sinne wie Savery zu arbeiten versucht.

Der erste jedoch, welcher im Stande war, einen wirklich brauchbaren Straßen-Dampfwagen vorzuführen, war der französische Ingenieur Nicholas Cugnot. Seine auf Kosten der französischen Regierung gebaute Maschine im Jahre 1769 auf den Straßen von Paris mit dem Erfolg vorgeführt, daß das Fahrzeug samt vier Personen Belastung sich mit einer Schnelle von 3,6 Kilometern oder 2 ¼ englische Meilen in der Stunde, also mit der Geschwindigkeit mittelmäßiger Fußgänger vorwärts bewegte. Die im weiteren Verfolg der Cugnot’schen Versuche zu Tage tretenden ungünstigen Wahrnehmungen bewirkten schon sehr zeitig die Einverleibung dieser technischen Neuerung jener Zeit in die Modell-Sammlung des „Conservatoire des Arts et Métiers“ in Paris, woselbst sie noch heute als merkwürdiges Schaustück zu sehen ist. Die Ausführung zeigt (siehe Figg.1 und 2) einen Wagen mit einem vorderen Triebrad (1) und zwei hinteren Laufrädern (2), die verschiebbaren Kolben zweier senkrecht auf dem Wagengestell nebeneinander befestigten Dampfcylinder (3), welche mit dem am Vorderende des Wagens aufgehängten Dampfkessel 4 durch die Röhre 5 abwechselnd in Verbindung gebracht werden konnten, hatten die Bestimmung, durch den im Kessel auftretenden Dampfdruck, welcher den Druck der äußeren Atmosphäre um ein verhältnismäßig nur geringes Maß überwog, die Bewegung des Triebrades zu veranlassen.

Zu dem Ende erfolgte der Niedergang je eines der beiden Kolben (6) unter Dampfdruck und gleichzeitig durch Hebelverbindung der Aufgang des anderen Kolbens, den für seinen vorausgehenden Niedergang verbrauchten Dampf in die freie Luft ausstoßend. Bei jedem Kolben-Niedergang wurde mittels Kolbenstange (7), Zugkette (8) und frei um die Triebachse beweglichen Bogenstück (9) durch eine Sperrklinke (10) das Sperr-Rad (11) und das damit verbundene Triebrad (1) um eine Viertels-Umdrehung weiter bewegt. Der Aufgang jedes einzelnen Kolbens geschah unter dem Einfluß des anderen in der Weise, daß die neben den Kolbenstangen weiter nach aufwärts verlängerten Zugketten bei 12 unter sich durch einen um den Zapfen 13 schwingenden Balancier verbunden waren. Die Sperr-Räder und -Klinken sind so gestaltet zu denken, daß je nach Lage der letzteren im Triebrad die eine oder andere Drehrichtung hervorgeht.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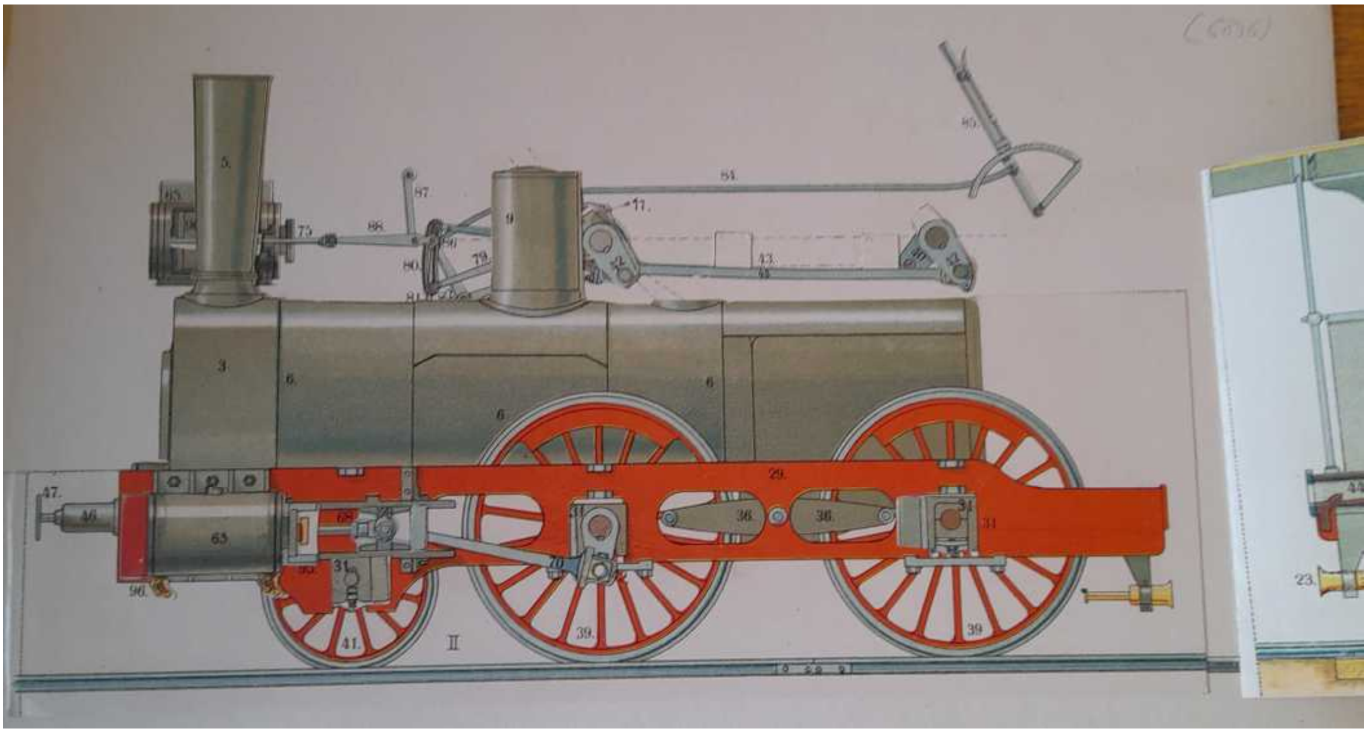
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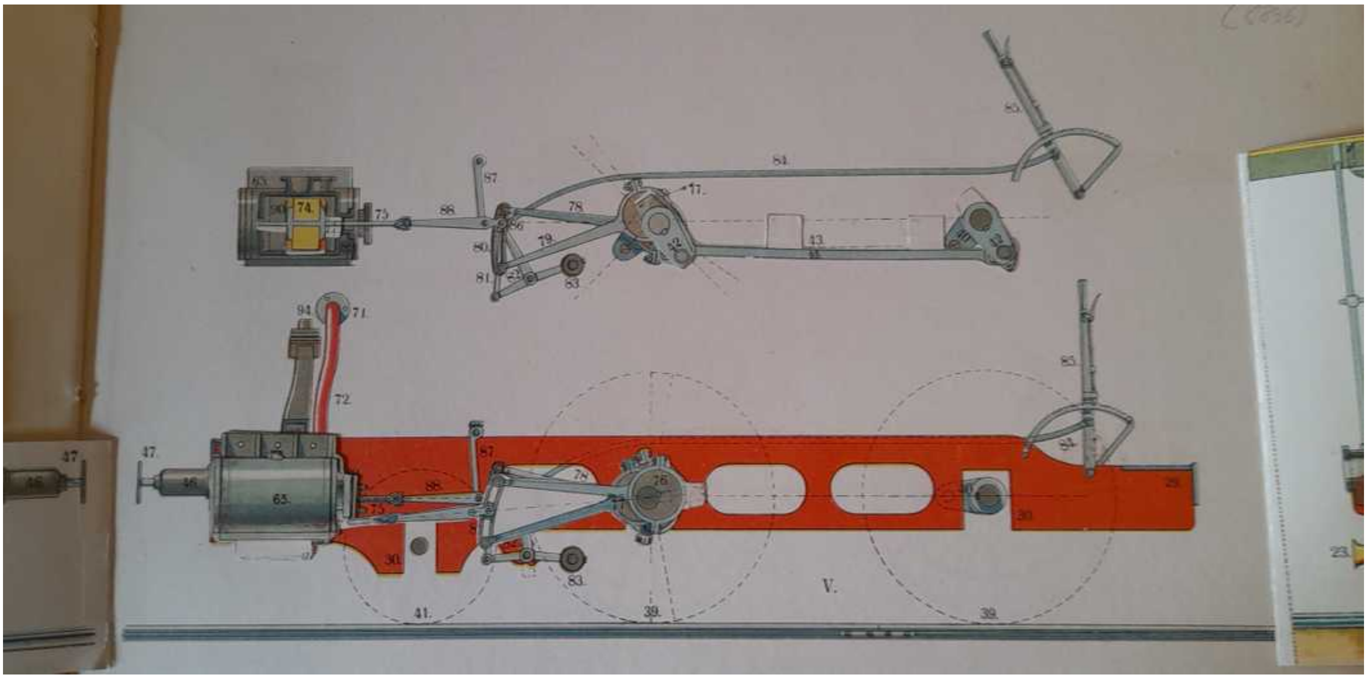
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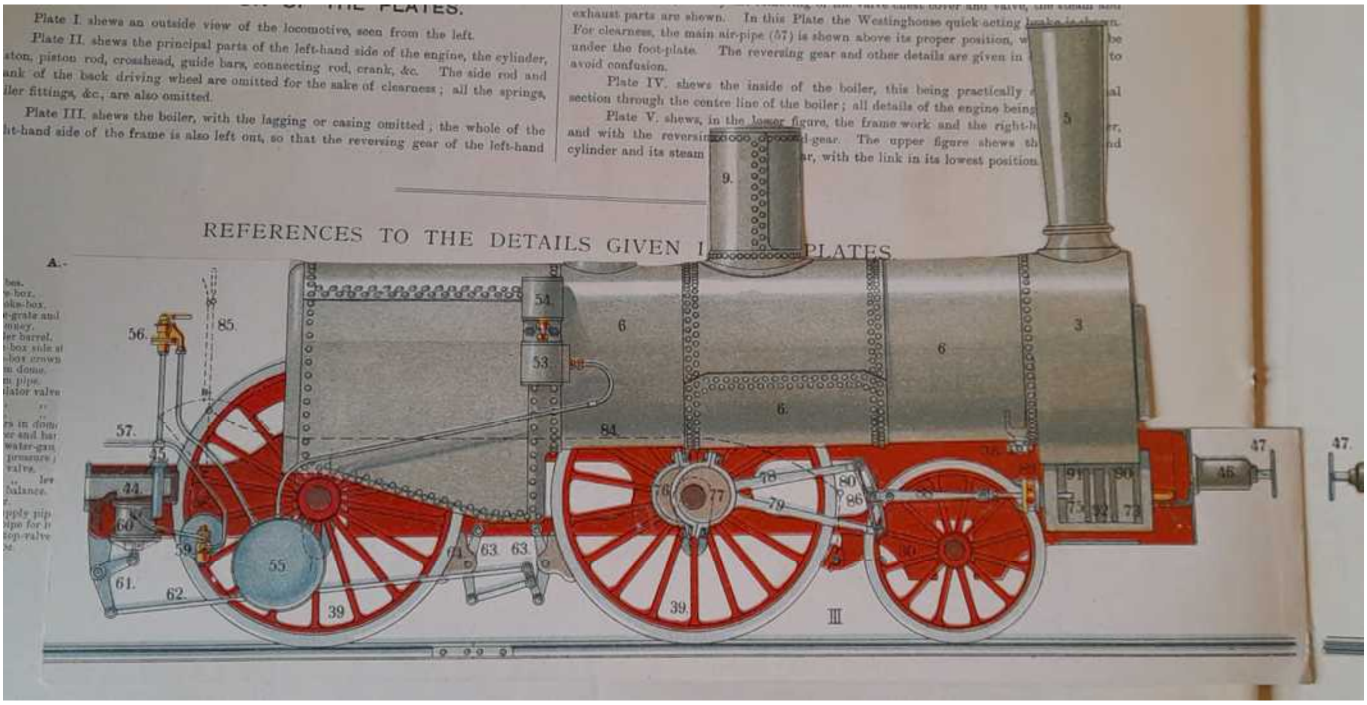

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PLATES.

Plate I. shews an outside view of the locomotive, seen from the left.

Plate II. shews the principal parts of the left-hand side of the engine, the cylinder, ston, piston rod, crosshead, guide bars, connecting rod, crank, &c. The side rod and ank of the back driving wheel are omitted for the sake of clearness; all the springs, iler fittings, &c., are also omitted.

Plate III. shews the boiler, with the lagging or casing omitted; the whole of the ht-hand side of the frame is also left out, so that the reversing gear of the left-hand

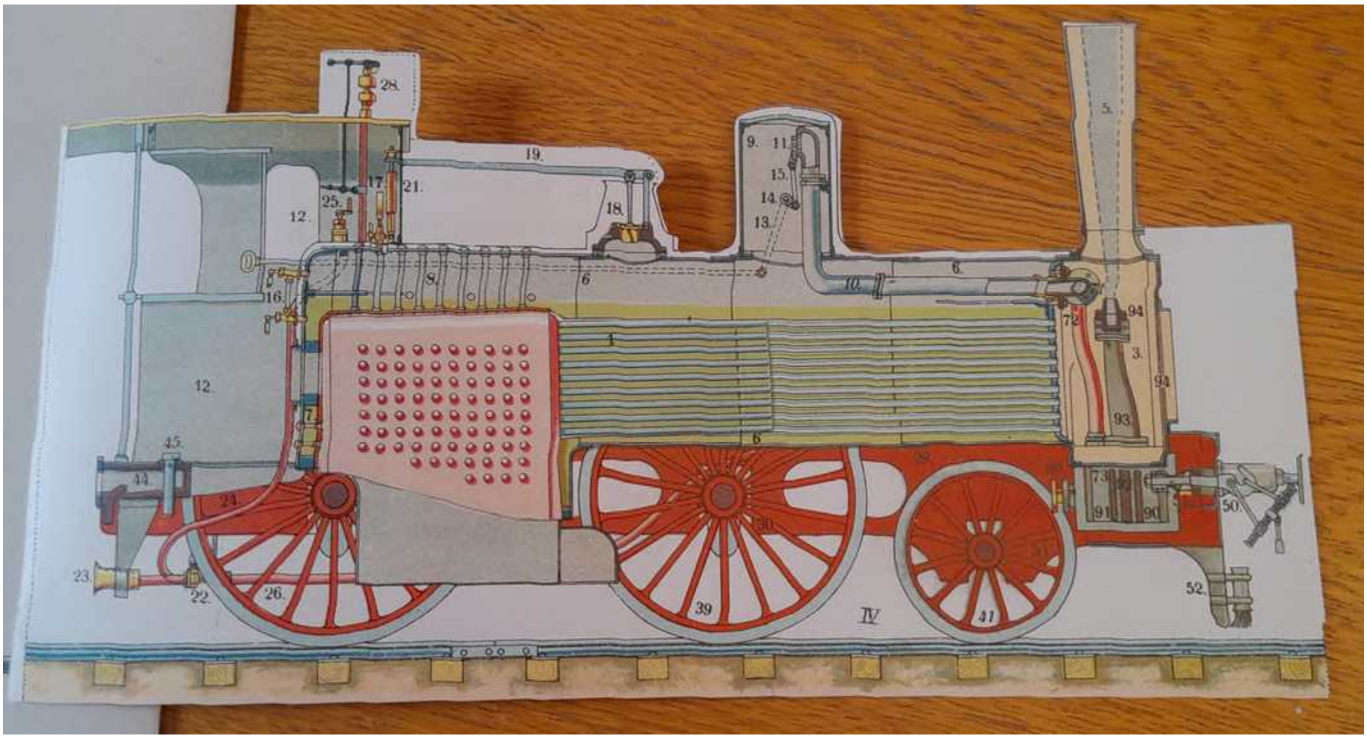
exhaust parts are shown. In this Plate the Westinghouse quick-acting For clearness, the main air-pipe (57) is shown above its proper position, w be under the foot-plate. The reversing gear and other details are given in to avoid confusion.

Plate IV. shews the inside of the boiler, this being practically al section through the centre line of the boiler; all details of the engine being

Plate V. shews, in the lower figure, the frame work and the right-h r, and with the reversi l-gear. The upper figure shews th nd cylinder and its steam ar, with the link in its lowest position.

REFERENCES TO THE DETAILS GIVEN I PLATES.

A.-



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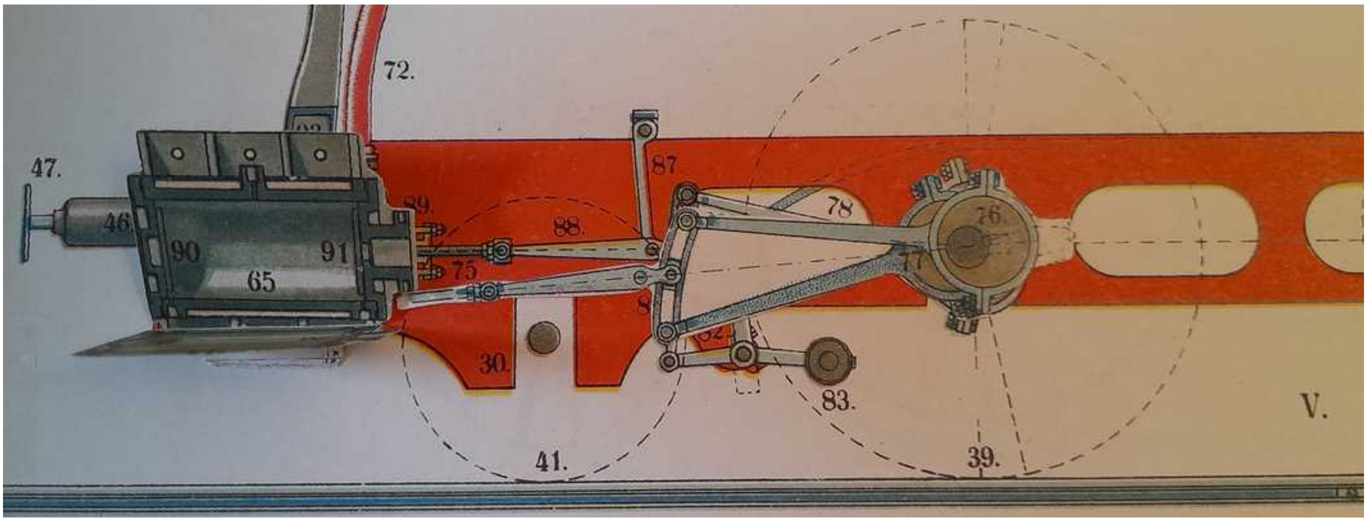
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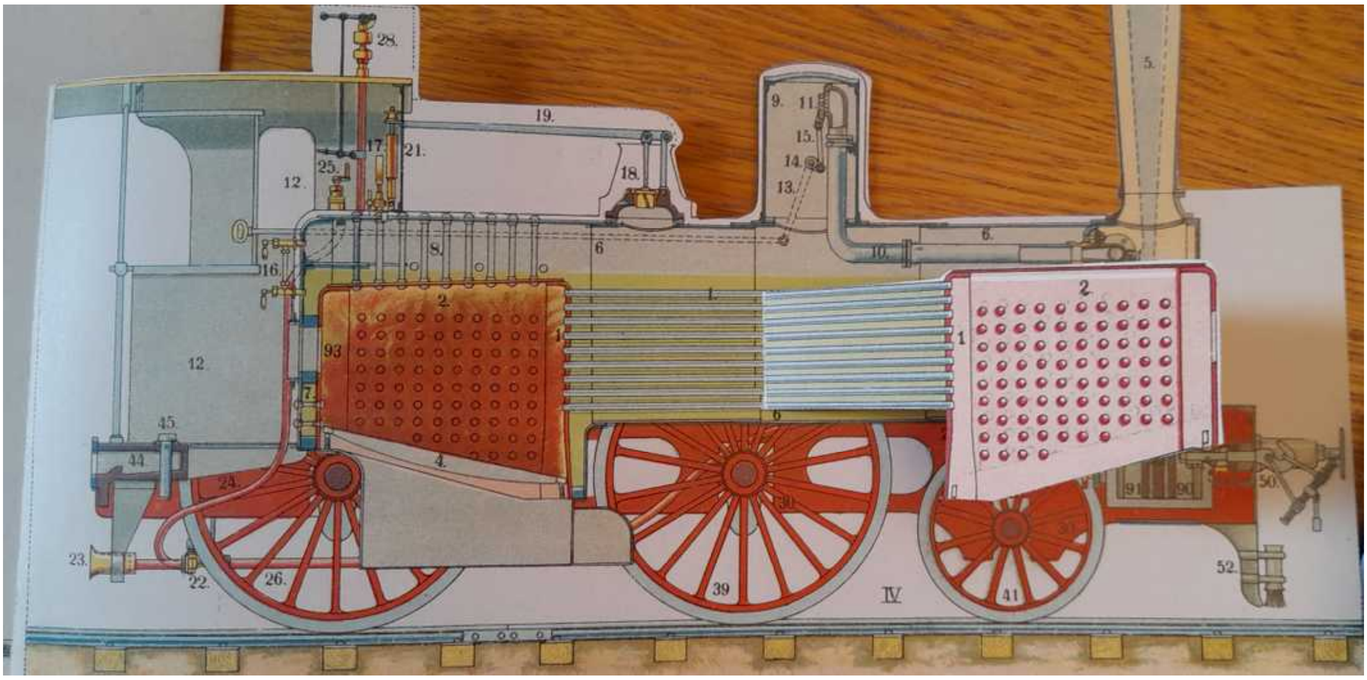
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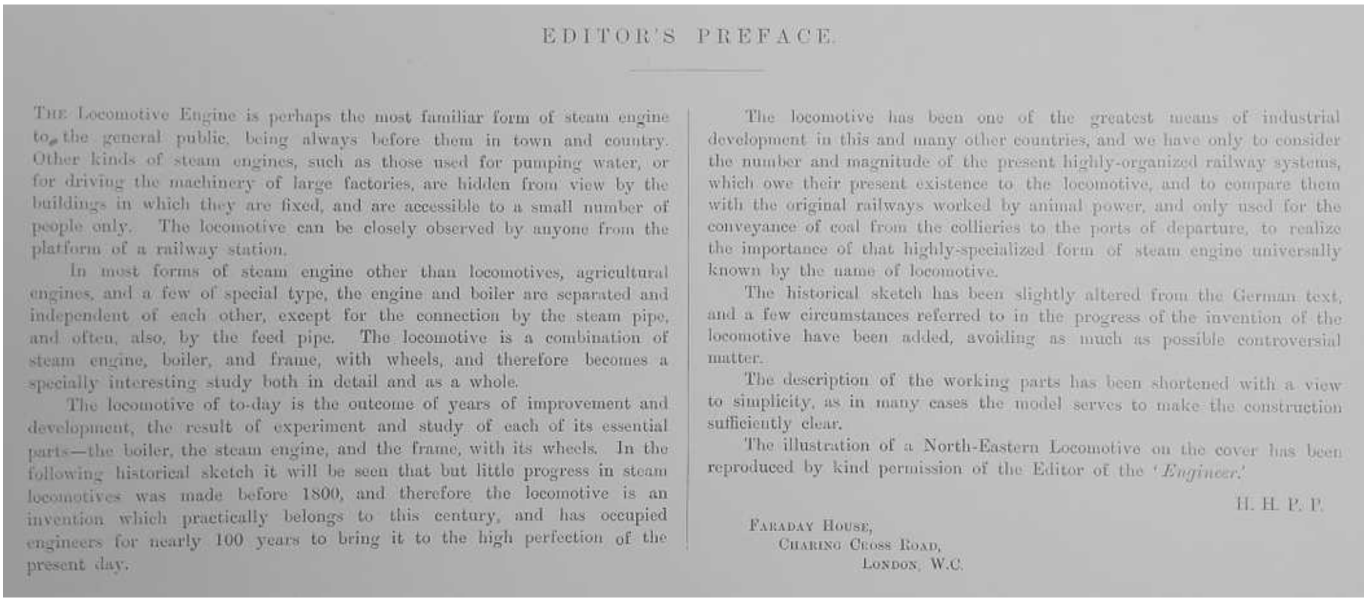
Vorwort des Herausgebers



EDITOR'S PREFACE.

THE Locomotive Engine is perhaps the most familiar form of steam engine to the general public, being always before them in town and country. Other kinds of steam engines, such as those used for pumping water, or for driving the machinery of large factories, are hidden from view by the buildings in which they are fixed, and are accessible to a small number of people only. The locomotive can be closely observed by anyone from the platform of a railway station.

In most forms of steam engine other than locomotives, agricultural engines, and a few of special type, the engine and boiler are separated and independent of each other, except for the connection by the steam pipe, and often, also, by the feed pipe. The locomotive is a combination of steam engine, boiler, and frame, with wheels, and therefore becomes a specially interesting study both in detail and as a whole.

The locomotive of to-day is the outcome of years of improvement and development, the result of experiment and study of each of its essential parts—the boiler, the steam engine, and the frame, with its wheels. In the following historical sketch it will be seen that but little progress in steam locomotives was made before 1800, and therefore the locomotive is an invention which practically belongs to this century, and has occupied engineers for nearly 100 years to bring it to the high perfection of the present day.

The locomotive has been one of the greatest means of industrial development in this and many other countries, and we have only to consider the number and magnitude of the present highly-organized railway systems, which owe their present existence to the locomotive, and to compare them with the original railways worked by animal power, and only used for the conveyance of coal from the collieries to the ports of departure, to realize the importance of that highly-specialized form of steam engine universally known by the name of locomotive.

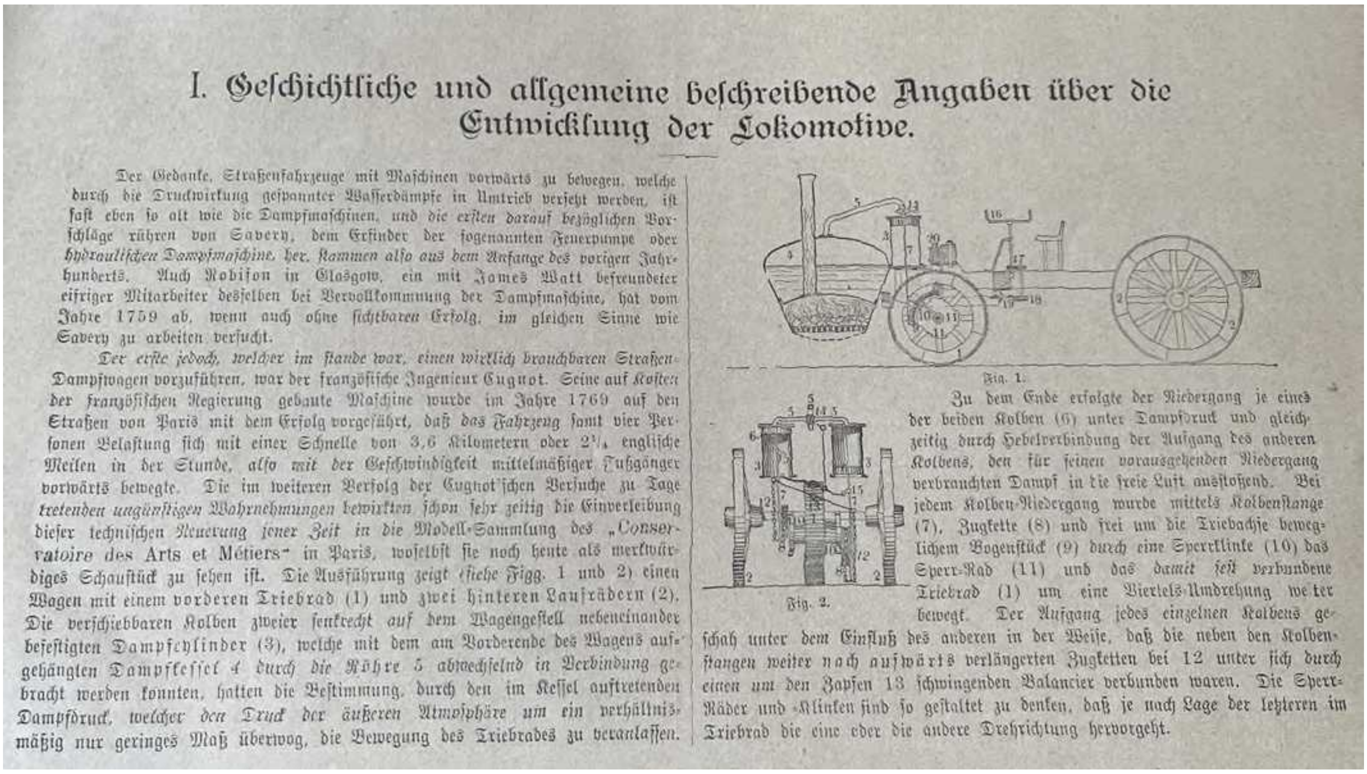
The historical sketch has been slightly altered from the German text, and a few circumstances referred to in the progress of the invention of the locomotive have been added, avoiding as much as possible controversial matter.

The description of the working parts has been shortened with a view to simplicity, as in many cases the model serves to make the construction sufficiently clear.

The illustration of a North-Eastern Locomotive on the cover has been reproduced by kind permission of the Editor of the *'Engineer.'*

H. H. P. P.

FARADAY HOUSE,
CHARING CROSS ROAD,
LONDON, W.C.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I. Geſchichtliche und allgemeine beſchreibende Angaben über die Entwicklung der Lokomotive.

Der Gedanke, Straßenfahrzeuge mit Maſchinen vorwärts zu bewegen, welche durch die Druckwirkung geſpannter Waſſerdämpfe in Umtrieb verſetzt werden, iſt faſt eben ſo alt wie die Dampfmaſchinen, und die erſten darauf bezüglichen Vorſchläge rühren von Savery, dem Erfinder der ſogenannten Feuerpumpe oder hydrauliſchen Dampfmaſchine, her, ſtammen alſo aus dem Anfange des vorigen Jahrhunderts. Auch Robiſon in Glasgow, ein mit James Watt befreundeter eifriger Mitarbeiter desſelben bei Vervollkommnung der Dampfmaſchine, hat vom Jahre 1759 ab, wenn auch ohne ſichtbaren Erfolg, im gleichen Sinne wie Savery zu arbeiten verſucht.

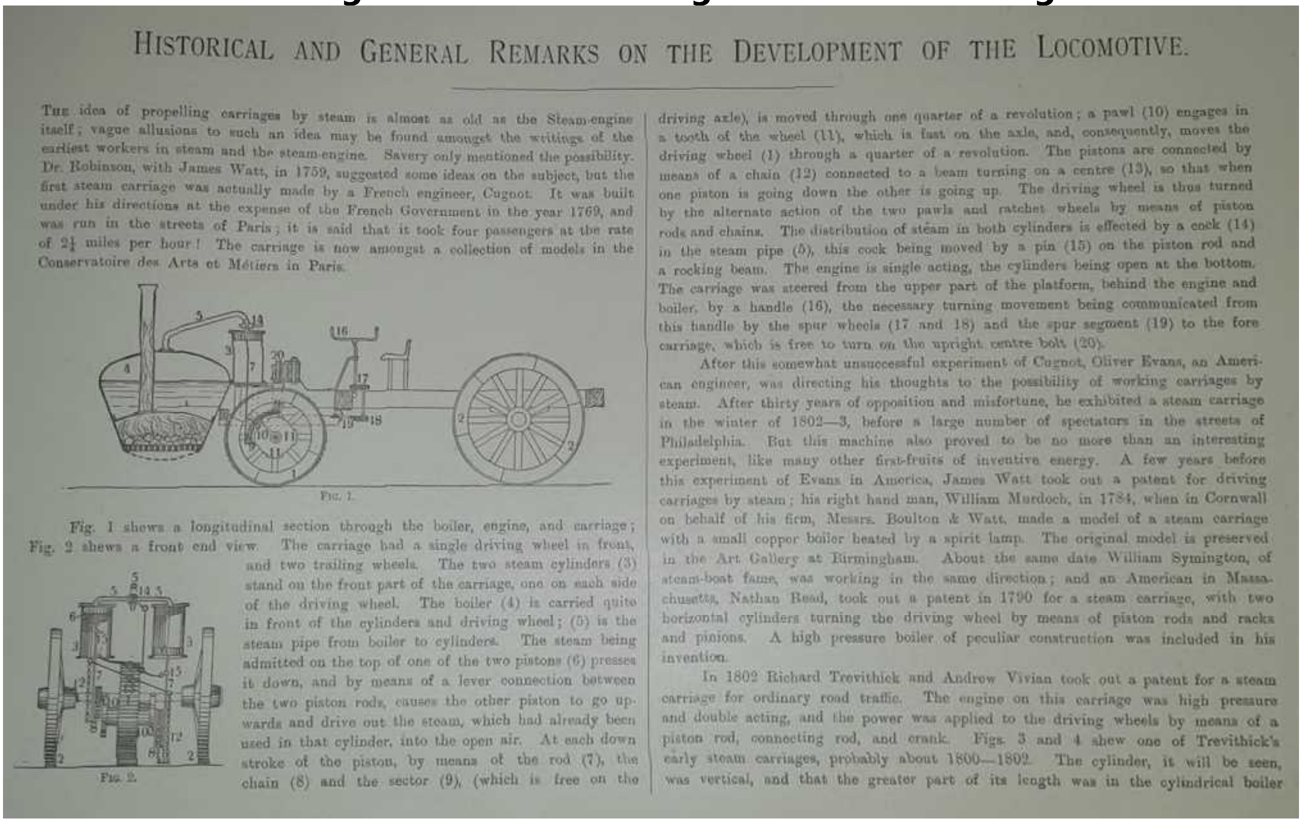
Der erſte jedoch, welcher im ſtande war, einen wirklich brauchbaren Straßen-Dampfwagen vorzuführen, war der franzöſiſche Ingenieur Cugnot. Seine auf Koſten der franzöſiſchen Regierung gebaute Maſchine wurde im Jahre 1769 auf den Straßen von Paris mit dem Erfolg vorgeführt, daß das Fahrzeug ſamt vier Perſonen Belaſtung ſich mit einer Schnelle von 3,6 Kilometern oder 2¼ engliſche Meilen in der Stunde, alſo mit der Geſchwindigkeit mittelmäßiger Fußgänger vorwärts bewegte. Die im weiteren Verfolg der Cugnot'ſchen Verſuche zu Tage tretenden ungünſtigen Wahrnehmungen bewirkten ſchon ſehr zeitig die Einverleibung dieſer techniſchen Neuerung jener Zeit in die Modell-Sammlung des „Conservatoire des Arts et Métiers" in Paris, woſelbſt ſie noch heute als merkwürdiges Schauſtück zu ſehen iſt. Die Ausführung zeigt (ſiehe Figg. 1 und 2) einen Wagen mit einem vorderen Triebrad (1) und zwei hinteren Laufrädern (2). Die verſchiebbaren Kolben zweier ſenkrecht auf dem Wagengeſtell nebeneinander befeſtigten Dampfcylinder (3), welche mit dem am Vorderende des Wagens aufgehängten Dampfkeſſel 4 durch die Röhre 5 abwechſelnd in Verbindung gebracht werden konnten, hatten die Beſtimmung, durch den im Keſſel auftretenden Dampfdruck, welcher den Druck der äußeren Atmoſphäre um ein verhältnismäßig nur geringes Maß überwog, die Bewegung des Triebrades zu veranlaſſen.

Fig. 1.

Fig. 2.

Zu dem Ende erfolgte der Niedergang je eines der beiden Kolben (6) unter Dampfdruck und gleichzeitig durch Hebelverbindung der Aufgang des anderen Kolbens, den für ſeinen vorausgehenden Niedergang verbrauchten Dampf in die freie Luft ausſtoßend. Bei jedem Kolben-Niedergang wurde mittels Kolbenſtange (7), Zugkette (8) und frei um die Triebachſe beweglichem Bogenſtück (9) durch eine Sperrklinke (10) das Sperr-Rad (11) und das damit feſt verbundene Triebrad (1) um eine Viertels-Umdrehung weiter bewegt. Der Aufgang jedes einzelnen Kolbens geſchah unter dem Einfluß des anderen in der Weiſe, daß die neben den Kolbenſtangen weiter nach aufwärts verlängerten Zugketten bei 12 unter ſich durch einen um den Zapfen 13 ſchwingenden Balancier verbunden waren. Die Sperr-Räder und -Klinken ſind ſo geſtaltet zu denken, daß je nach Lage der letzteren im Triebrad die eine oder die andere Drehrichtung hervorgeht.

Historische und allgemeine Bemerkungen zur Entwicklung der Lokomotive



HISTORICAL AND GENERAL REMARKS ON THE DEVELOPMENT OF THE LOCOMOTIVE.

THE idea of propelling carriages by steam is almost as old as the Steam-engine itself; vague allusions to such an idea may be found amongst the writings of the earliest workers in steam and the steam-engine. Savery only mentioned the possibility. Dr. Robinson, with James Watt, in 1759, suggested some ideas on the subject, but the first steam carriage was actually made by a French engineer, Cugnot. It was built under his directions at the expense of the French Government in the year 1769, and was run in the streets of Paris; it is said that it took four passengers at the rate of 2¼ miles per hour! The carriage is now amongst a collection of models in the Conservatoire des Arts et Métiers in Paris.

Fig. 1.

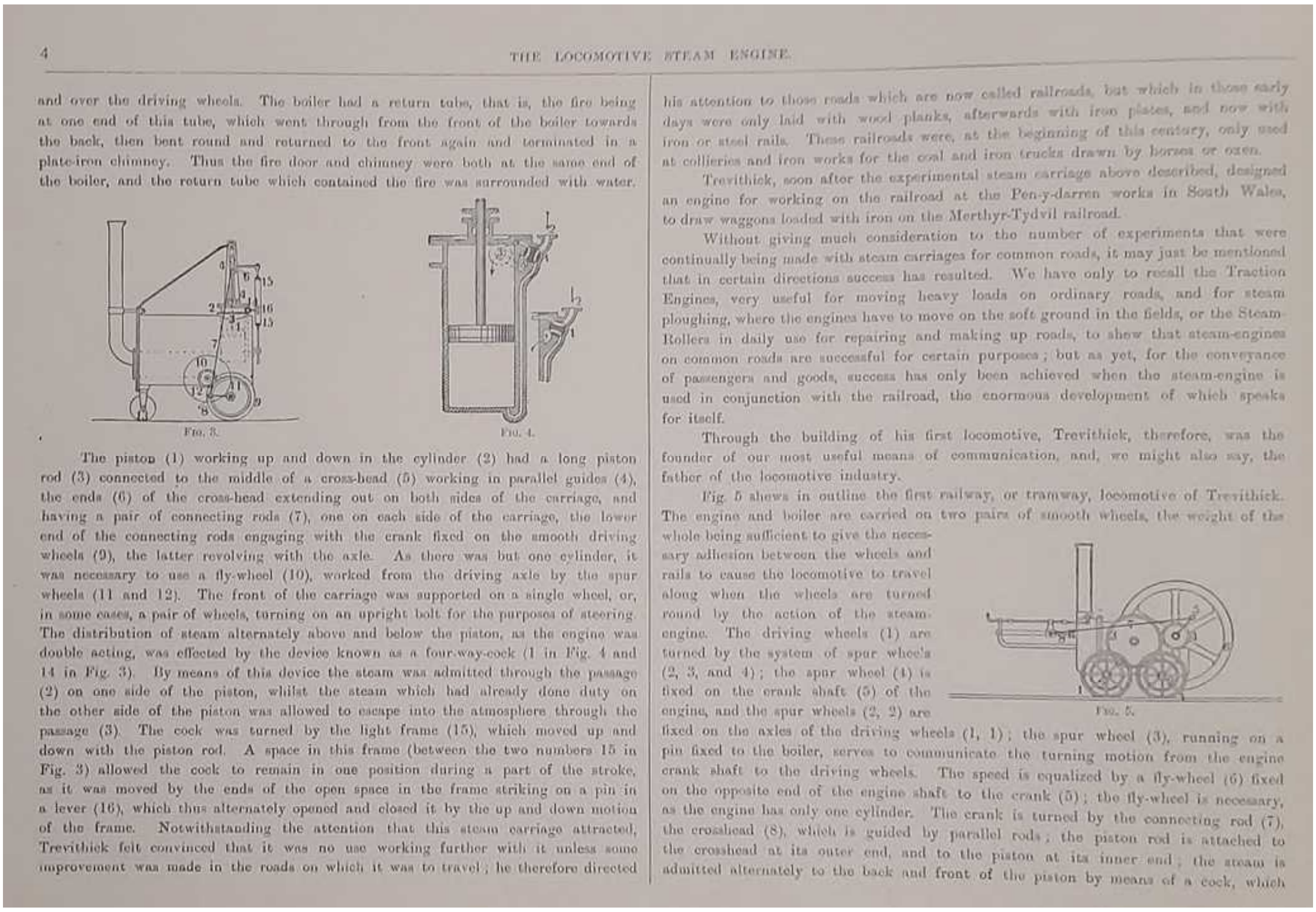
Fig. 1 shews a longitudinal section through the boiler, engine, and carriage; Fig. 2 shews a front end view. The carriage had a single driving wheel in front, and two trailing wheels. The two steam cylinders (3) stand on the front part of the carriage, one on each side of the driving wheel. The boiler (4) is carried quite in front of the cylinders and driving wheel; (5) is the steam pipe from boiler to cylinders. The steam being admitted on the top of one of the two pistons (6) presses it down, and by means of a lever connection between the two piston rods, causes the other piston to go upwards and drive out the steam, which had already been used in that cylinder, into the open air. At each down stroke of the piston, by means of the rod (7), the chain (8) and the sector (9), (which is free on the driving axle), is moved through one quarter of a revolution; a pawl (10) engages in a tooth of the wheel (11), which is fast on the axle, and, consequently, moves the driving wheel (1) through a quarter of a revolution. The pistons are connected by means of a chain (12) connected to a beam turning on a centre (13), so that when one piston is going down the other is going up. The driving wheel is thus turned by the alternate action of the two pawls and ratchet wheels by means of piston rods and chains. The distribution of steam in both cylinders is effected by a cock (14) in the steam pipe (5), this cock being moved by a pin (15) on the piston rod and a rocking beam. The engine is single acting, the cylinders being open at the bottom. The carriage was steered from the upper part of the platform, behind the engine and boiler, by a handle (16), the necessary turning movement being communicated from this handle by the spur wheels (17 and 18) and the spur segment (19) to the fore carriage, which is free to turn on the upright centre bolt (20).

Fig. 2.

After this somewhat unsuccessful experiment of Cugnot, Oliver Evans, an American engineer, was directing his thoughts to the possibility of working carriages by steam. After thirty years of opposition and misfortune, he exhibited a steam carriage in the winter of 1802—3, before a large number of spectators in the streets of Philadelphia. But this machine also proved to be no more than an interesting experiment, like many other first-fruits of inventive energy. A few years before this experiment of Evans in America, James Watt took out a patent for driving carriages by steam; his right hand man, William Murdoch, in 1784, when in Cornwall on behalf of his firm, Messrs. Boulton & Watt, made a model of a steam carriage with a small copper boiler heated by a spirit lamp. The original model is preserved in the Art Gallery at Birmingham. About the same date William Symington, of steam-boat fame, was working in the same direction; and an American in Massachusetts, Nathan Read, took out a patent in 1790 for a steam carriage, with two horizontal cylinders turning the driving wheel by means of piston rods and racks and pinions. A high pressure boiler of peculiar construction was included in his invention.

In 1802 Richard Trevithick and Andrew Vivian took out a patent for a steam carriage for ordinary road traffic. The engine on this carriage was high pressure and double acting, and the power was applied to the driving wheels by means of a piston rod, connecting rod, and crank. Figs. 3 and 4 shew one of Trevithick's early steam carriages, probably about 1800—1802. The cylinder, it will be seen, was vertical, and that the greater part of its length was in the cylindrical boiler

Abb.1/2 Dampfwagen von Nicholas Cugnot (*25. September 1725 in Void, Lothringen; †2. Oktober 1804 in Paris)



and over the driving wheels. The boiler had a return tube, that is, the fire being at one end of this tube, which went through from the front of the boiler towards the back, then bent round and returned to the front again and terminated in a plate-iron chimney. Thus the fire door and chimney were both at the same end of the boiler, and the return tube which contained the fire was surrounded with water.

Fig. 3.

Fig. 4.

The piston (1) working up and down in the cylinder (2) had a long piston rod (3) connected to the middle of a cross-head (5) working in parallel guides (4), the ends (6) of the cross-head extending out on both sides of the carriage, and having a pair of connecting rods (7), one on each side of the carriage, the lower end of the connecting rods engaging with the crank fixed on the smooth driving wheels (9), the latter revolving with the axle. As there was but one cylinder, it was necessary to use a fly-wheel (10), worked from the driving axle by the spur wheels (11 and 12). The front of the carriage was supported on a single wheel, or, in some cases, a pair of wheels, turning on an upright bolt for the purposes of steering. The distribution of steam alternately above and below the piston, as the engine was double acting, was effected by the device known as a four-way-cock (1 in Fig. 4 and 14 in Fig. 3). By means of this device the steam was admitted through the passage (2) on one side of the piston, whilst the steam which had already done duty on the other side of the piston was allowed to escape into the atmosphere through the passage (3). The cock was turned by the light frame (15), which moved up and down with the piston rod. A space in this frame (between the two numbers 15 in Fig. 3) allowed the cock to remain in one position during a part of the stroke, as it was moved by the ends of the open space in the frame striking on a pin in a lever (16), which thus alternately opened and closed it by the up and down motion of the frame. Notwithstanding the attention that this steam carriage attracted, Trevithick felt convinced that it was no use working further with it unless some improvement was made in the roads on which it was to travel; he therefore directed his attention to those roads which are now called railroads, but which in those early days were only laid with wood planks, afterwards with iron plates, and now with iron or steel rails. These railroads were, at the beginning of this century, only used at collieries and iron works for the coal and iron trucks drawn by horses or oxen.

Trevithick, soon after the experimental steam carriage above described, designed an engine for working on the railroad at the Pen-y-darren works in South Wales, to draw waggons loaded with iron on the Merthyr-Tydvil railroad.

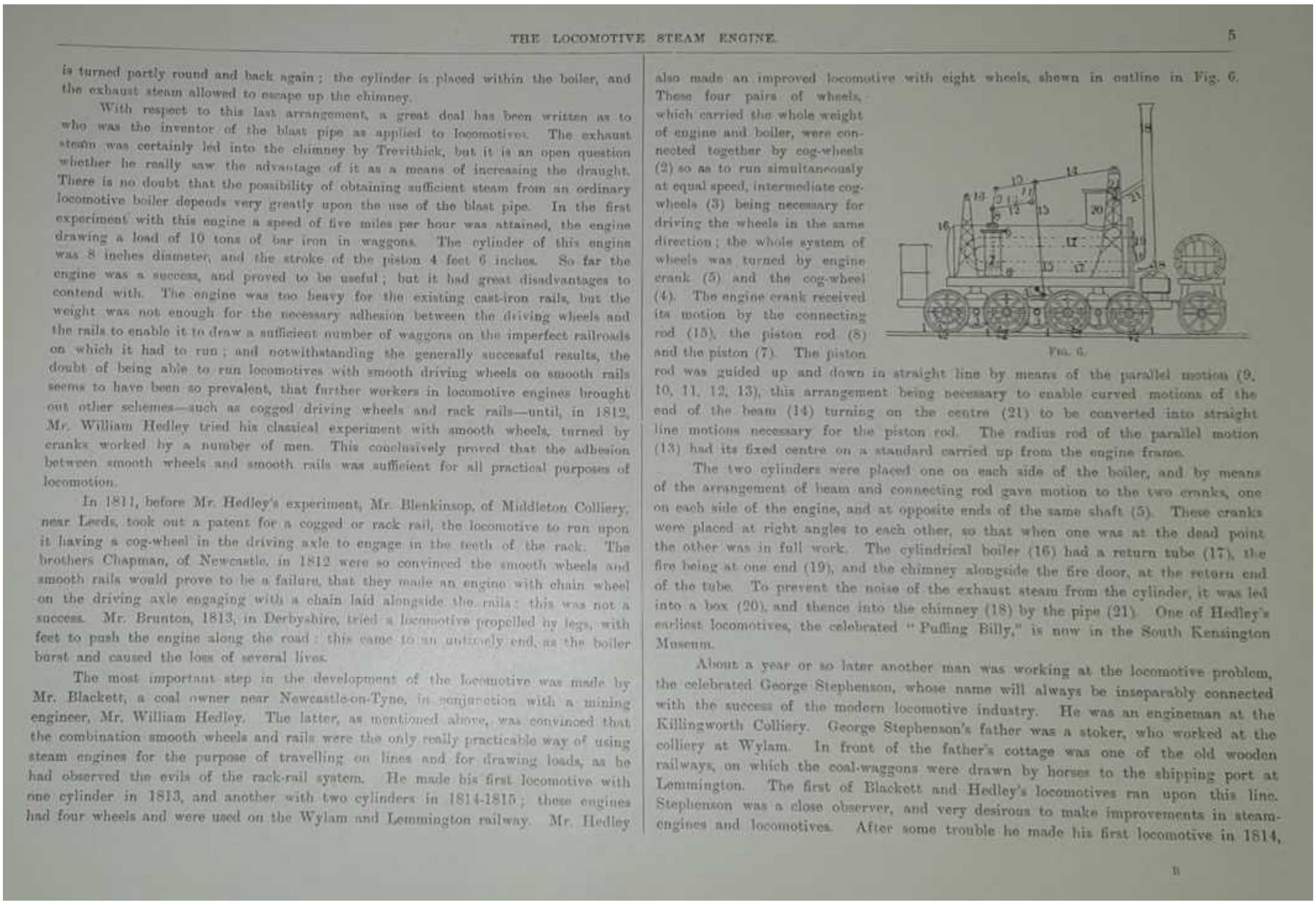
Without giving much consideration to the number of experiments that were continually being made with steam carriages for common roads, it may just be mentioned that in certain directions success has resulted. We have only to recall the Traction Engines, very useful for moving heavy loads on ordinary roads, and for steam ploughing, where the engines have to move on the soft ground in the fields, or the Steam-Rollers in daily use for repairing and making up roads, to shew that steam-engines on common roads are successful for certain purposes; but as yet, for the conveyance of passengers and goods, success has only been achieved when the steam-engine is used in conjunction with the railroad, the enormous development of which speaks for itself.

Through the building of his first locomotive, Trevithick, therefore, was the founder of our most useful means of communication, and, we might also say, the father of the locomotive industry.

Fig. 5 shews in outline the first railway, or tramway, locomotive of Trevithick. The engine and boiler are carried on two pairs of smooth wheels, the weight of the whole being sufficient to give the necessary adhesion between the wheels and rails to cause the locomotive to travel along when the wheels are turned round by the action of the steam-engine. The driving wheels (1) are turned by the system of spur wheels (2, 3, and 4); the spur wheel (4) is fixed on the crank shaft (5) of the engine, and the spur wheels (2, 2) are fixed on the axles of the driving wheels (1, 1); the spur wheel (3), running on a pin fixed to the boiler, serves to communicate the turning motion from the engine crank shaft to the driving wheels. The speed is equalized by a fly-wheel (6) fixed on the opposite end of the engine shaft to the crank (5); the fly-wheel is necessary, as the engine has only one cylinder. The crank is turned by the connecting rod (7), the crosshead (8), which is guided by parallel rods; the piston rod is attached to the crosshead at its outer end, and to the piston at its inner end; the steam is admitted alternately to the back and front of the piston by means of a cock, which

Fig. 5.

Abb.3/4 Frühe Dampfwagen (1800-1802) von Richard Trevithick (*13. April 1771 in Illogan, Cornwall; †22. April 1833 in Dartford); Abb.5 Erste Dampflok von Trevithick 1804



THE LOCOMOTIVE STEAM ENGINE. 5

is turned partly round and back again; the cylinder is placed within the boiler, and the exhaust steam allowed to escape up the chimney.

With respect to this last arrangement, a great deal has been written as to who was the inventor of the blast pipe as applied to locomotives. The exhaust steam was certainly led into the chimney by Trevithick, but it is an open question whether he really saw the advantage of it as a means of increasing the draught. There is no doubt that the possibility of obtaining sufficient steam from an ordinary locomotive boiler depends very greatly upon the use of the blast pipe. In the first experiment with this engine a speed of five miles per hour was attained, the engine drawing a load of 10 tons of bar iron in waggons. The cylinder of this engine was 8 inches diameter, and the stroke of the piston 4 feet 6 inches. So far the engine was a success, and proved to be useful; but it had great disadvantages to contend with. The engine was too heavy for the existing cast-iron rails, but the weight was not enough for the necessary adhesion between the driving wheels and the rails to enable it to draw a sufficient number of waggons on the imperfect railroads on which it had to run; and notwithstanding the generally successful results, the doubt of being able to run locomotives with smooth driving wheels on smooth rails seems to have been so prevalent, that further workers in locomotive engines brought out other schemes—such as cogged driving wheels and rack rails—until, in 1812, Mr. William Hedley tried his classical experiment with smooth wheels, turned by cranks worked by a number of men. This conclusively proved that the adhesion between smooth wheels and smooth rails was sufficient for all practical purposes of locomotion.

In 1811, before Mr. Hedley's experiment, Mr. Blenkinsop, of Middleton Colliery, near Leeds, took out a patent for a cogged or rack rail, the locomotive to run upon it having a cog-wheel in the driving axle to engage in the teeth of the rack. The brothers Chapman, of Newcastle, in 1812 were so convinced the smooth wheels and smooth rails would prove to be a failure, that they made an engine with chain wheel on the driving axle engaging with a chain laid alongside the rails; this was not a success. Mr. Brunton, 1813, in Derbyshire, tried a locomotive propelled by legs, with feet to push the engine along the road; this came to an untimely end, as the boiler burst and caused the loss of several lives.

The most important step in the development of the locomotive was made by Mr. Blackett, a coal owner near Newcastle-on-Tyne, in conjunction with a mining engineer, Mr. William Hedley. The latter, as mentioned above, was convinced that the combination smooth wheels and rails were the only really practicable way of using steam engines for the purpose of travelling on lines and for drawing loads, as he had observed the evils of the rack-rail system. He made his first locomotive with one cylinder in 1813, and another with two cylinders in 1814-1815; these engines had four wheels and were used on the Wylam and Lemmington railway. Mr. Hedley also made an improved locomotive with eight wheels, shewn in outline in Fig. 6. These four pairs of wheels, which carried the whole weight of engine and boiler, were connected together by cog-wheels (2) so as to run simultaneously at equal speed, intermediate cog-wheels (3) being necessary for driving the wheels in the same direction; the whole system of wheels was turned by engine crank (5) and the cog-wheel (4). The engine crank received its motion by the connecting rod (15), the piston rod (8) and the piston (7). The piston rod was guided up and down in straight line by means of the parallel motion (9, 10, 11, 12, 13), this arrangement being necessary to enable curved motions of the end of the beam (14) turning on the centre (21) to be converted into straight line motions necessary for the piston rod. The radius rod of the parallel motion (13) had its fixed centre on a standard carried up from the engine frame.

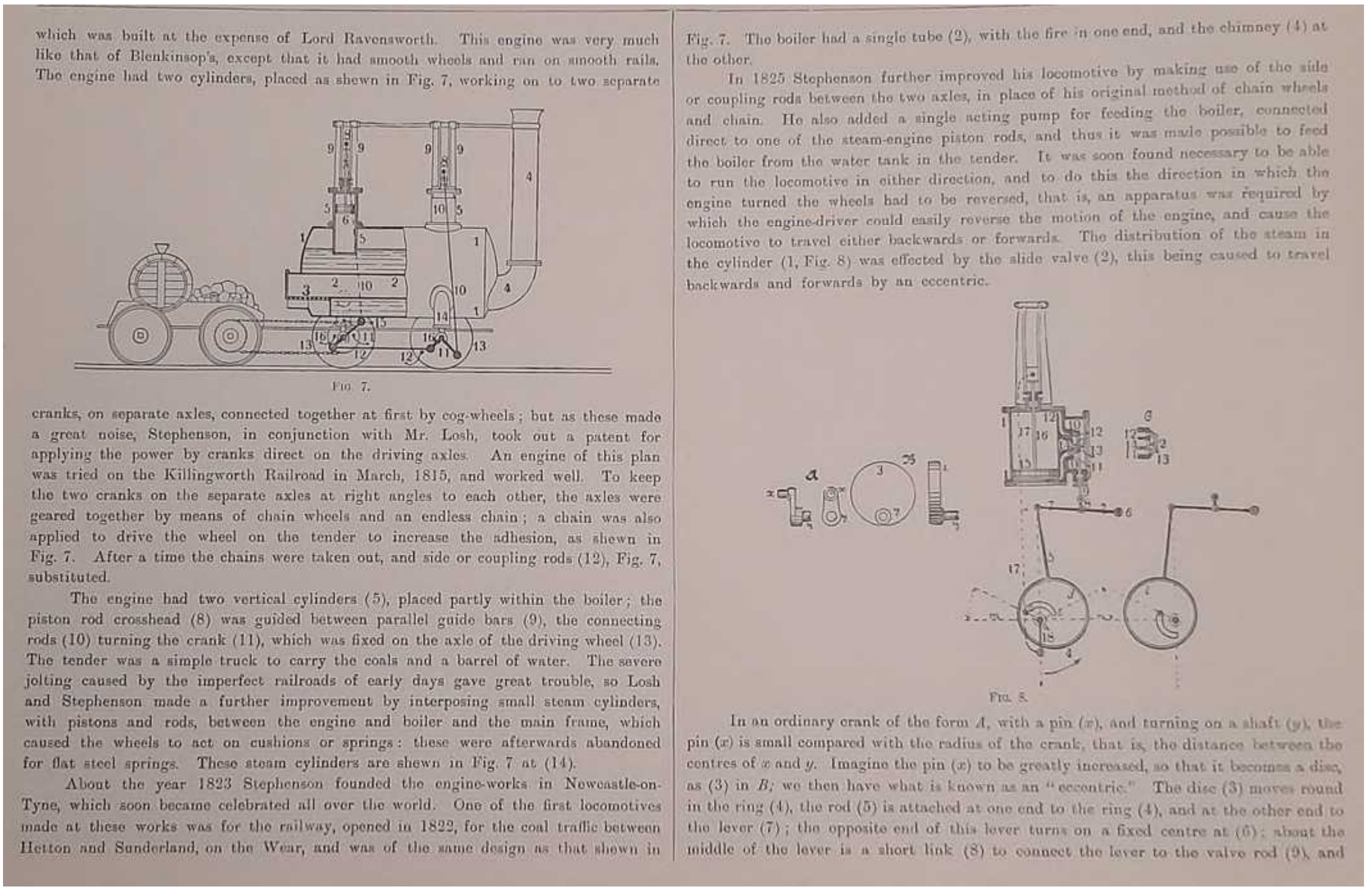
FIG. 6.

The two cylinders were placed one on each side of the boiler, and by means of the arrangement of beam and connecting rod gave motion to the two cranks, one on each side of the engine, and at opposite ends of the same shaft (5). These cranks were placed at right angles to each other, so that when one was at the dead point the other was in full work. The cylindrical boiler (16) had a return tube (17), the fire being at one end (19), and the chimney alongside the fire door, at the return end of the tube. To prevent the noise of the exhaust steam from the cylinder, it was led into a box (20), and thence into the chimney (18) by the pipe (21). One of Hedley's earliest locomotives, the celebrated "Puffing Billy," is now in the South Kensington Museum.

About a year or so later another man was working at the locomotive problem, the celebrated George Stephenson, whose name will always be inseparably connected with the success of the modern locomotive industry. He was an engineman at the Killingworth Colliery. George Stephenson's father was a stoker, who worked at the colliery at Wylam. In front of the father's cottage was one of the old wooden railways, on which the coal-waggons were drawn by horses to the shipping port at Lemmington. The first of Blackett and Hedley's locomotives ran upon this line. Stephenson was a close observer, and very desirous to make improvements in steam-engines and locomotives. After some trouble he made his first locomotive in 1814,

B

Abb.6 Dampfwagen von William Hedley (*13. Juli 1779 in Newburn; †9. Januar 1843 bei Durham)



which was built at the expense of Lord Ravensworth. This engine was very much like that of Blenkinsop's, except that it had smooth wheels and ran on smooth rails. The engine had two cylinders, placed as shewn in Fig. 7, working on to two separate cranks, on separate axles, connected together at first by cog-wheels; but as these made a great noise, Stephenson, in conjunction with Mr. Losh, took out a patent for applying the power by cranks direct on the driving axles. An engine of this plan was tried on the Killingworth Railroad in March, 1815, and worked well. To keep the two cranks on the separate axles at right angles to each other, the axles were geared together by means of chain wheels and an endless chain; a chain was also applied to drive the wheel on the tender to increase the adhesion, as shewn in Fig. 7. After a time the chains were taken out, and side or coupling rods (12), Fig. 7, substituted.

FIG. 7.

The engine had two vertical cylinders (5), placed partly within the boiler; the piston rod crosshead (8) was guided between parallel guide bars (9), the connecting rods (10) turning the crank (11), which was fixed on the axle of the driving wheel (13). The tender was a simple truck to carry the coals and a barrel of water. The severe jolting caused by the imperfect railroads of early days gave great trouble, so Losh and Stephenson made a further improvement by interposing small steam cylinders, with pistons and rods, between the engine and boiler and the main frame, which caused the wheels to act on cushions or springs: these were afterwards abandoned for flat steel springs. These steam cylinders are shewn in Fig. 7 at (14).

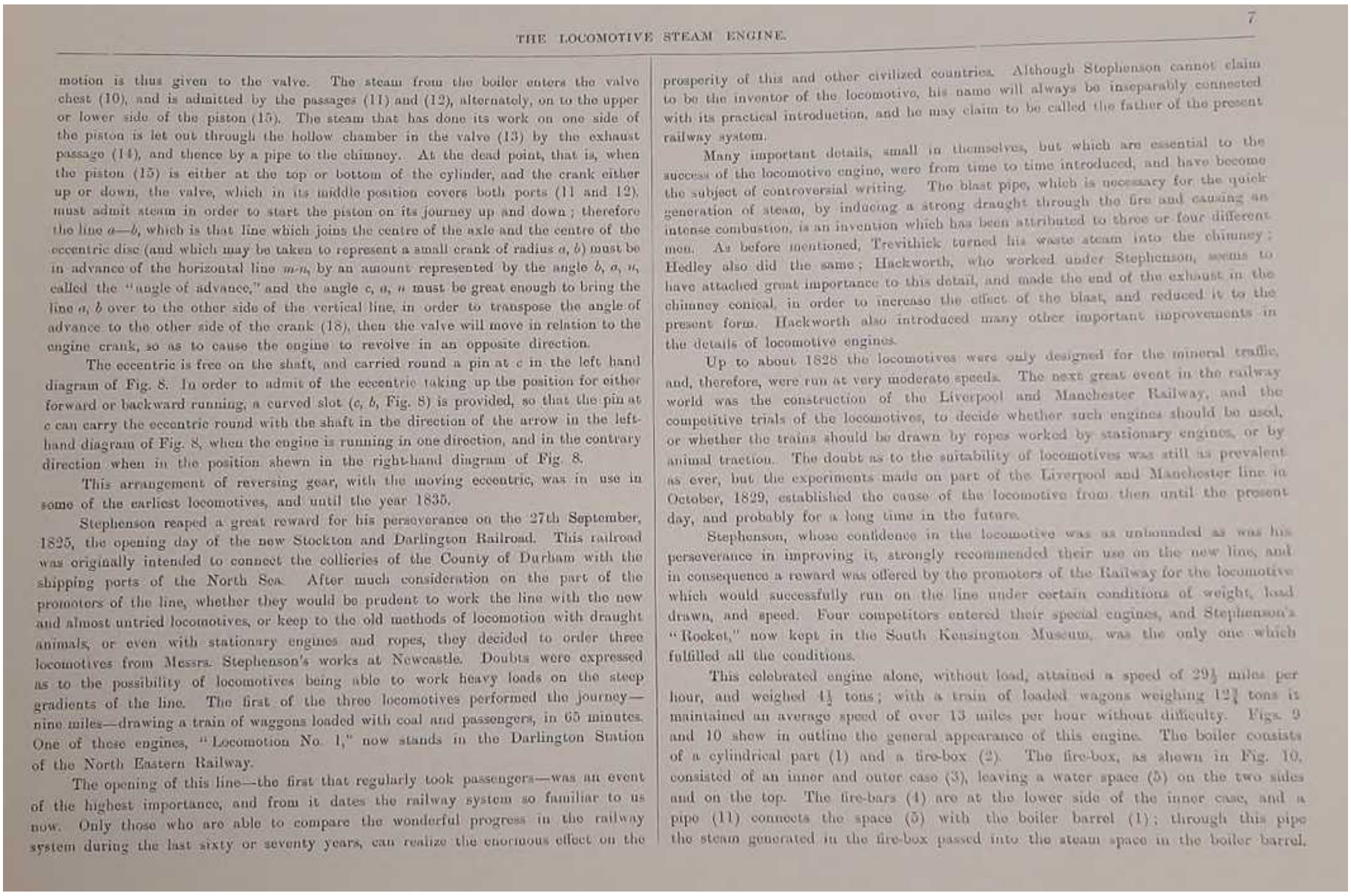
About the year 1823 Stephenson founded the engine-works in Newcastle-on-Tyne, which soon became celebrated all over the world. One of the first locomotives made at these works was for the railway, opened in 1822, for the coal traffic between Hetton and Sunderland, on the Wear, and was of the same design as that shewn in Fig. 7. The boiler had a single tube (2), with the fire in one end, and the chimney (4) at the other.

In 1825 Stephenson further improved his locomotive by making use of the side or coupling rods between the two axles, in place of his original method of chain wheels and chain. He also added a single acting pump for feeding the boiler, connected direct to one of the steam-engine piston rods, and thus it was made possible to feed the boiler from the water tank in the tender. It was soon found necessary to be able to run the locomotive in either direction, and to do this the direction in which the engine turned the wheels had to be reversed, that is, an apparatus was required by which the engine-driver could easily reverse the motion of the engine, and cause the locomotive to travel either backwards or forwards. The distribution of the steam in the cylinder (1, Fig. 8) was effected by the slide valve (2), this being caused to travel backwards and forwards by an eccentric.

FIG. 8.

In an ordinary crank of the form *A*, with a pin (*x*), and turning on a shaft (*y*), the pin (*x*) is small compared with the radius of the crank, that is, the distance between the centres of *x* and *y*. Imagine the pin (*x*) to be greatly increased, so that it becomes a disc, as (3) in *B*; we then have what is known as an "eccentric." The disc (3) moves round in the ring (4), the rod (5) is attached at one end to the ring (4), and at the other end to the lever (7); the opposite end of this lever turns on a fixed centre at (6); about the middle of the lever is a short link (8) to connect the lever to the valve rod (9), and

Abb.7/8 Lokomotive von George Stephenson (*9.Juni 1781 in Wylam bei Newcastle upon Tyne, Northumberland; †12. August 1848 in Tapton House bei Chesterfield)



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motion is thus given to the valve. The steam from the boiler enters the valve chest (10), and is admitted by the passages (11) and (12), alternately, on to the upper or lower side of the piston (15). The steam that has done its work on one side of the piston is let out through the hollow chamber in the valve (13) by the exhaust passage (14), and thence by a pipe to the chimney. At the dead point, that is, when the piston (15) is either at the top or bottom of the cylinder, and the crank either up or down, the valve, which in its middle position covers both ports (11 and 12), must admit steam in order to start the piston on its journey up and down; therefore the line *a—b*, which is that line which joins the centre of the axle and the centre of the eccentric disc (and which may be taken to represent a small crank of radius *a*, *b*) must be in advance of the horizontal line *m-n*, by an amount represented by the angle *b*, *a*, *n*, called the "angle of advance," and the angle c, *a*, *n* must be great enough to bring the line *a*, *b* over to the other side of the vertical line, in order to transpose the angle of advance to the other side of the crank (18), then the valve will move in relation to the engine crank, so as to cause the engine to revolve in an opposite direction.

The eccentric is free on the shaft, and carried round a pin at c in the left hand diagram of Fig. 8. In order to admit of the eccentric taking up the position for either forward or backward running, a curved slot (*c*, *b*, Fig. 8) is provided, so that the pin at *c* can carry the eccentric round with the shaft in the direction of the arrow in the left-hand diagram of Fig. 8, when the engine is running in one direction, and in the contrary direction when in the position shewn in the right-hand diagram of Fig. 8.

This arrangement of reversing gear, with the moving eccentric, was in use in some of the earliest locomotives, and until the year 1835.

Stephenson reaped a great reward for his perseverance on the 27th September, 1825, the opening day of the new Stockton and Darlington Railroad. This railroad was originally intended to connect the collieries of the County of Durham with the shipping ports of the North Sea. After much consideration on the part of the promoters of the line, whether they would be prudent to work the line with the new and almost untried locomotives, or keep to the old methods of locomotion with draught animals, or even with stationary engines and ropes, they decided to order three locomotives from Messrs. Stephenson's works at Newcastle. Doubts were expressed as to the possibility of locomotives being able to work heavy loads on the steep gradients of the line. The first of the three locomotives performed the journey—nine miles—drawing a train of waggons loaded with coal and passengers, in 65 minutes. One of these engines, "Locomotion No. 1," now stands in the Darlington Station of the North Eastern Railway.

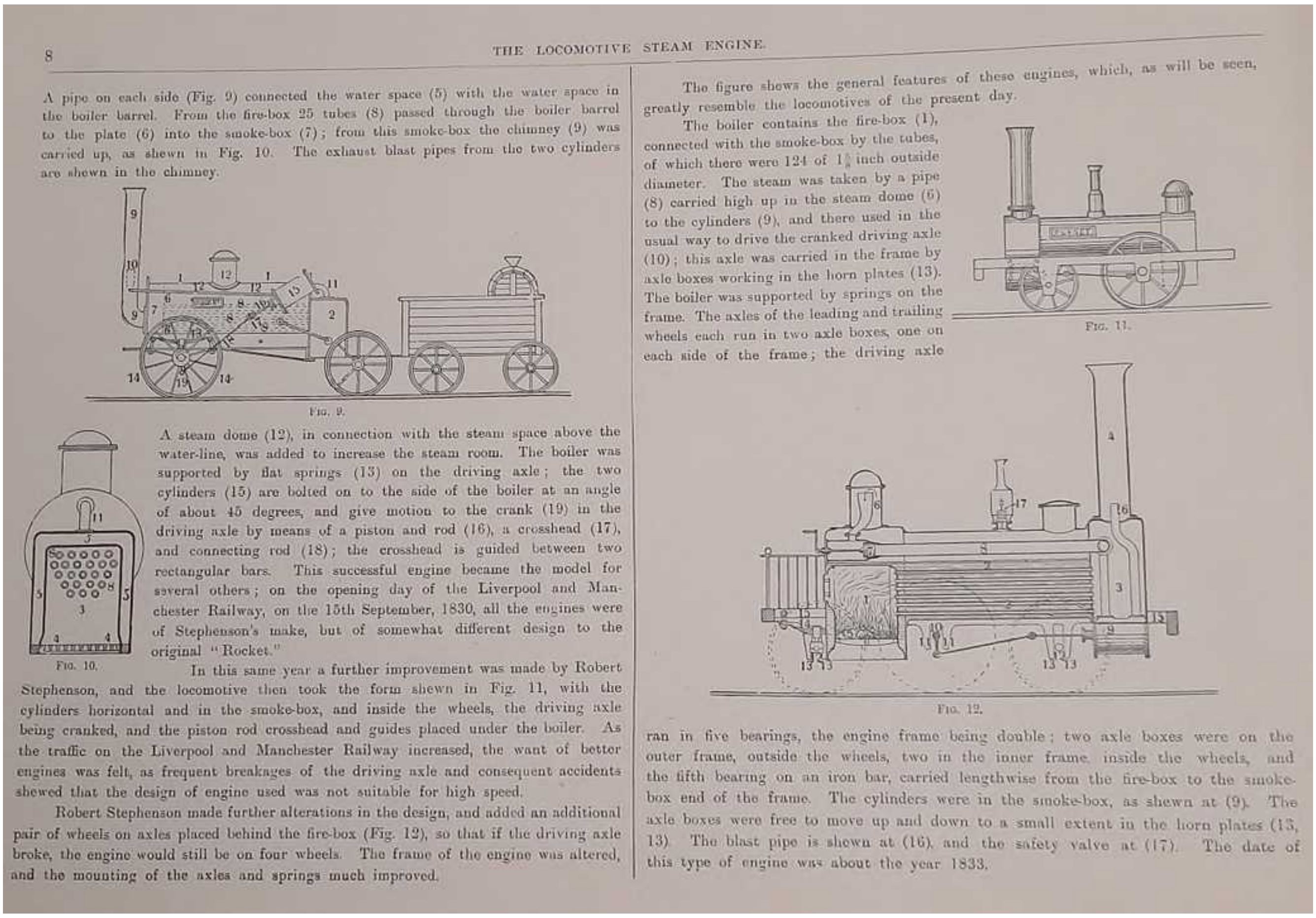
The opening of this line—the first that regularly took passengers—was an event of the highest importance, and from it dates the railway system so familiar to us now. Only those who are able to compare the wonderful progress in the railway system during the last sixty or seventy years, can realize the enormous effect on the prosperity of this and other civilized countries. Although Stephenson cannot claim to be the inventor of the locomotive, his name will always be inseparably connected with its practical introduction, and he may claim to be called the father of the present railway system.

Many important details, small in themselves, but which are essential to the success of the locomotive engine, were from time to time introduced, and have become the subject of controversial writing. The blast pipe, which is necessary for the quick generation of steam, by inducing a strong draught through the fire and causing an intense combustion, is an invention which has been attributed to three or four different men. As before mentioned, Trevithick turned his waste steam into the chimney; Hedley also did the same; Hackworth, who worked under Stephenson, seems to have attached great importance to this detail, and made the end of the exhaust in the chimney conical, in order to increase the effect of the blast, and reduced it to the present form. Hackworth also introduced many other important improvements in the details of locomotive engines.

Up to about 1828 the locomotives were only designed for the mineral traffic, and, therefore, were run at very moderate speeds. The next great event in the railway world was the construction of the Liverpool and Manchester Railway, and the competitive trials of the locomotives, to decide whether such engines should be used, or whether the trains should be drawn by ropes worked by stationary engines, or by animal traction. The doubt as to the suitability of locomotives was still as prevalent as ever, but the experiments made on part of the Liverpool and Manchester line in October, 1829, established the cause of the locomotive from then until the present day, and probably for a long time in the future.

Stephenson, whose confidence in the locomotive was as unbounded as was his perseverance in improving it, strongly recommended their use on the new line, and in consequence a reward was offered by the promoters of the Railway for the locomotive which would successfully run on the line under certain conditions of weight, load drawn, and speed. Four competitors entered their special engines, and Stephenson's "Rocket," now kept in the South Kensington Museum, was the only one which fulfilled all the conditions.

This celebrated engine alone, without load, attained a speed of 29½ miles per hour, and weighed 4½ tons; with a train of loaded wagons weighing 12¾ tons it maintained an average speed of over 13 miles per hour without difficulty. Figs. 9 and 10 shew in outline the general appearance of this engine. The boiler consists of a cylindrical part (1) and a fire-box (2). The fire-box, as shewn in Fig. 10, consisted of an inner and outer case (3), leaving a water space (5) on the two sides and on the top. The fire-bars (4) are at the lower side of the inner case, and a pipe (11) connects the space (5) with the boiler barrel (1); through this pipe the steam generated in the fire-box passed into the steam space in the boiler barrel.



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A pipe on each side (Fig. 9) connected the water space (5) with the water space in the boiler barrel. From the fire-box 25 tubes (8) passed through the boiler barrel to the plate (6) into the smoke-box (7); from this smoke-box the chimney (9) was carried up, as shewn in Fig. 10. The exhaust blast pipes from the two cylinders are shewn in the chimney.

Fig. 9.

A steam dome (12), in connection with the steam space above the water-line, was added to increase the steam room. The boiler was supported by flat springs (13) on the driving axle; the two cylinders (15) are bolted on to the side of the boiler at an angle of about 45 degrees, and give motion to the crank (19) in the driving axle by means of a piston and rod (16), a crosshead (17), and connecting rod (18); the crosshead is guided between two rectangular bars. This successful engine became the model for several others; on the opening day of the Liverpool and Manchester Railway, on the 15th September, 1830, all the engines were of Stephenson's make, but of somewhat different design to the original "Rocket."

Fig. 10.

In this same year a further improvement was made by Robert Stephenson, and the locomotive then took the form shewn in Fig. 11, with the cylinders horizontal and in the smoke-box, and inside the wheels, the driving axle being cranked, and the piston rod crosshead and guides placed under the boiler. As the traffic on the Liverpool and Manchester Railway increased, the want of better engines was felt, as frequent breakages of the driving axle and consequent accidents shewed that the design of engine used was not suitable for high speed.

Robert Stephenson made further alterations in the design, and added an additional pair of wheels on axles placed behind the fire-box (Fig. 12), so that if the driving axle broke, the engine would still be on four wheels. The frame of the engine was altered, and the mounting of the axles and springs much improved.

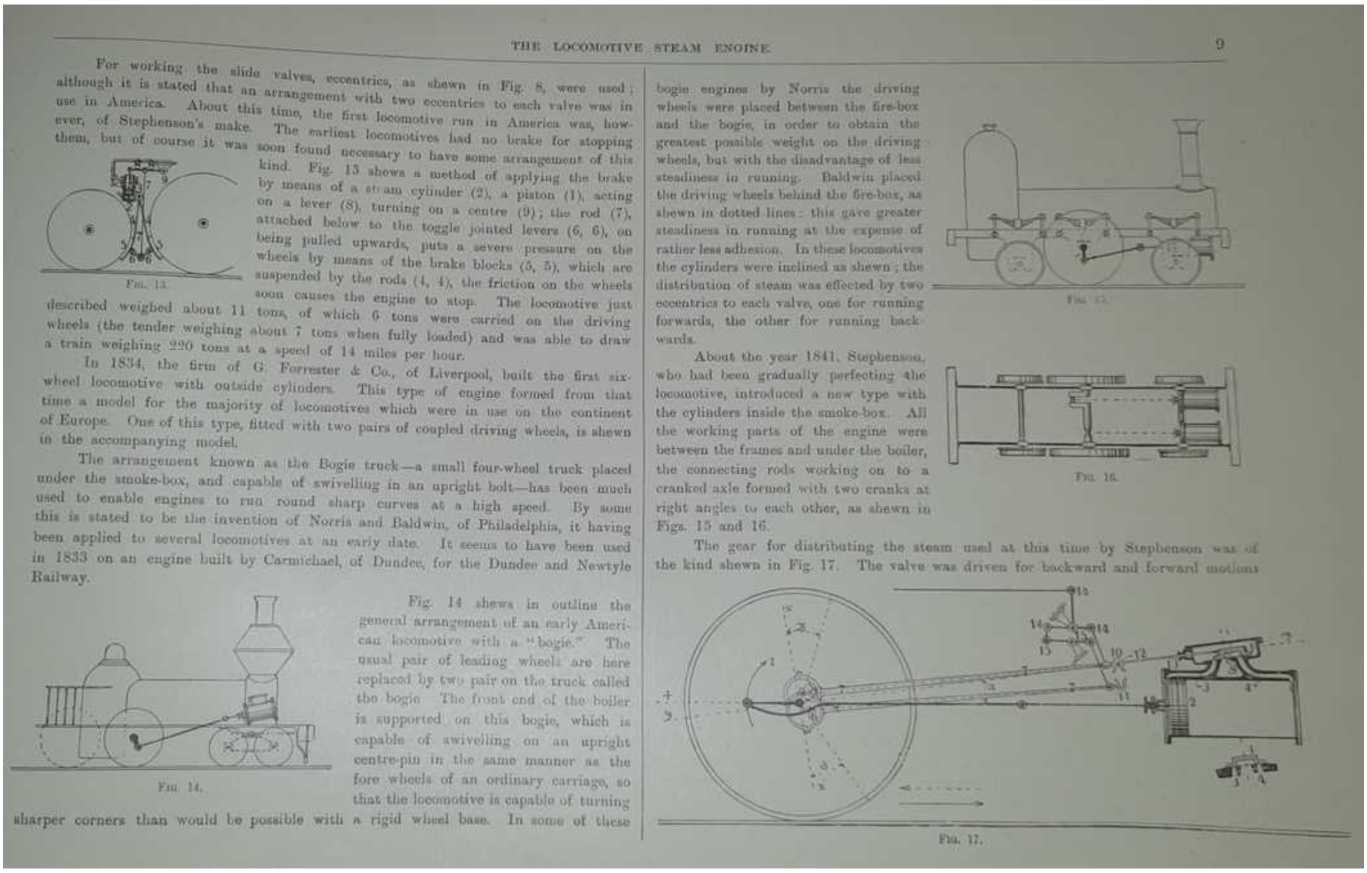
The figure shews the general features of these engines, which, as will be seen, greatly resemble the locomotives of the present day.

The boiler contains the fire-box (1), connected with the smoke-box by the tubes, of which there were 124 of 1⅝ inch outside diameter. The steam was taken by a pipe (8) carried high up in the steam dome (6) to the cylinders (9), and there used in the usual way to drive the cranked driving axle (10); this axle was carried in the frame by axle boxes working in the horn plates (13). The boiler was supported by springs on the frame. The axles of the leading and trailing wheels each run in two axle boxes, one on each side of the frame; the driving axle ran in five bearings, the engine frame being double; two axle boxes were on the outer frame, outside the wheels, two in the inner frame, inside the wheels, and the fifth bearing on an iron bar, carried lengthwise from the fire-box to the smoke-box end of the frame. The cylinders were in the smoke-box, as shewn at (9). The axle boxes were free to move up and down to a small extent in the horn plates (13, 13). The blast pipe is shewn at (16), and the safety valve at (17). The date of this type of engine was about the year 1833.

Fig. 11.

Fig. 12.

Abb.9/10 Lokomotive „Rocket“ (1829) von George Stephenson; Abb.11/12 Lokomotiven verbessert von Robert Stephenson (*16. Oktober 1803 in Willington Quay; †12. Oktober 1859 in London)



THE LOCOMOTIVE STEAM ENGINE. 9

For working the slide valves, eccentrics, as shewn in Fig. 8, were used; although it is stated that an arrangement with two eccentrics to each valve was in use in America. About this time, the first locomotive run in America was, however, of Stephenson's make. The earliest locomotives had no brake for stopping them, but of course it was soon found necessary to have some arrangement of this kind. Fig. 13 shows a method of applying the brake by means of a steam cylinder (2), a piston (1), acting on a lever (8), turning on a centre (9); the rod (7), attached below to the toggle jointed levers (6, 6), on being pulled upwards, puts a severe pressure on the wheels by means of the brake blocks (5, 5), which are suspended by the rods (4, 4), the friction on the wheels soon causes the engine to stop. The locomotive just described weighed about 11 tons, of which 6 tons were carried on the driving wheels (the tender weighing about 7 tons when fully loaded) and was able to draw a train weighing 220 tons at a speed of 14 miles per hour.

Fig. 13.

In 1834, the firm of G. Forrester & Co., of Liverpool, built the first six-wheel locomotive with outside cylinders. This type of engine formed from that time a model for the majority of locomotives which were in use on the continent of Europe. One of this type, fitted with two pairs of coupled driving wheels, is shewn in the accompanying model.

The arrangement known as the Bogie truck—a small four-wheel truck placed under the smoke-box, and capable of swivelling in an upright bolt—has been much used to enable engines to run round sharp curves at a high speed. By some this is stated to be the invention of Norris and Baldwin, of Philadelphia, it having been applied to several locomotives at an early date. It seems to have been used in 1833 on an engine built by Carmichael, of Dundee, for the Dundee and Newtyle Railway.

Fig. 14 shews in outline the general arrangement of an early American locomotive with a "bogie." The usual pair of leading wheels are here replaced by two pair on the truck called the bogie. The front end of the boiler is supported on this bogie, which is capable of swivelling on an upright centre-pin in the same manner as the fore wheels of an ordinary carriage, so that the locomotive is capable of turning sharper corners than would be possible with a rigid wheel base. In some of these bogie engines by Norris the driving wheels were placed between the fire-box and the bogie, in order to obtain the greatest possible weight on the driving wheels, but with the disadvantage of less steadiness in running. Baldwin placed the driving wheels behind the fire-box, as shewn in dotted lines: this gave greater steadiness in running at the expense of rather less adhesion. In these locomotives the cylinders were inclined as shewn; the distribution of steam was effected by two eccentrics to each valve, one for running forwards, the other for running backwards.

Fig. 14.

Fig. 15.

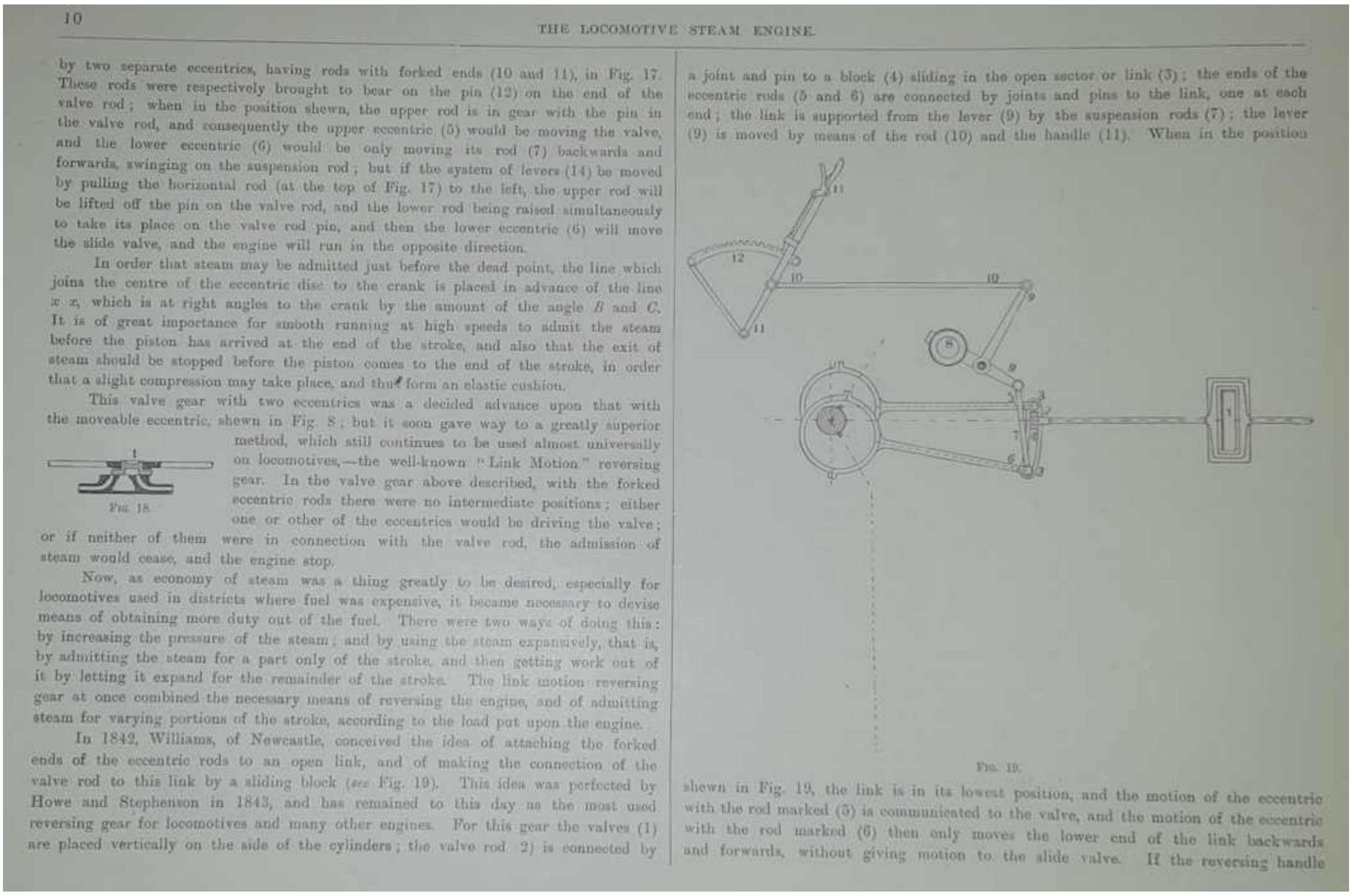
About the year 1841, Stephenson, who had been gradually perfecting the locomotive, introduced a new type with the cylinders inside the smoke-box. All the working parts of the engine were between the frames and under the boiler, the connecting rods working on to a cranked axle formed with two cranks at right angles to each other, as shewn in Figs. 15 and 16.

Fig. 16.

The gear for distributing the steam used at this time by Stephenson was of the kind shewn in Fig. 17. The valve was driven for backward and forward motions

Fig. 17.

Abb.13 Frühes amerikanisches Bremssystem; Abb.14 Frühe amerikanische Lok mit Bogie-Drehgestell; Abb.15/16 Stephenson-Lok mit Innentriebwerk; Abb.17 Dampfverteilung nach Stephenson



10 THE LOCOMOTIVE STEAM ENGINE.

by two separate eccentrics, having rods with forked ends (10 and 11), in Fig. 17. These rods were respectively brought to bear on the pin (12) on the end of the valve rod; when in the position shewn, the upper rod is in gear with the pin in the valve rod, and consequently the upper eccentric (5) would be moving the valve, and the lower eccentric (6) would be only moving its rod (7) backwards and forwards, swinging on the suspension rod; but if the system of levers (14) be moved by pulling the horizontal rod (at the top of Fig. 17) to the left, the upper rod will be lifted off the pin on the valve rod, and the lower rod being raised simultaneously to take its place on the valve rod pin, and then the lower eccentric (6) will move the slide valve, and the engine will run in the opposite direction.

In order that steam may be admitted just before the dead point, the line which joins the centre of the eccentric disc to the crank is placed in advance of the line *x x*, which is at right angles to the crank by the amount of the angle *B* and *C*. It is of great importance for smooth running at high speeds to admit the steam before the piston has arrived at the end of the stroke, and also that the exit of steam should be stopped before the piston comes to the end of the stroke, in order that a slight compression may take place, and thus form an elastic cushion.

This valve gear with two eccentrics was a decided advance upon that with the moveable eccentric, shewn in Fig. 8; but it soon gave way to a greatly superior method, which still continues to be used almost universally on locomotives,—the well-known "Link Motion" reversing gear. In the valve gear above described, with the forked eccentric rods there were no intermediate positions; either one or other of the eccentrics would be driving the valve; or if neither of them were in connection with the valve rod, the admission of steam would cease, and the engine stop.

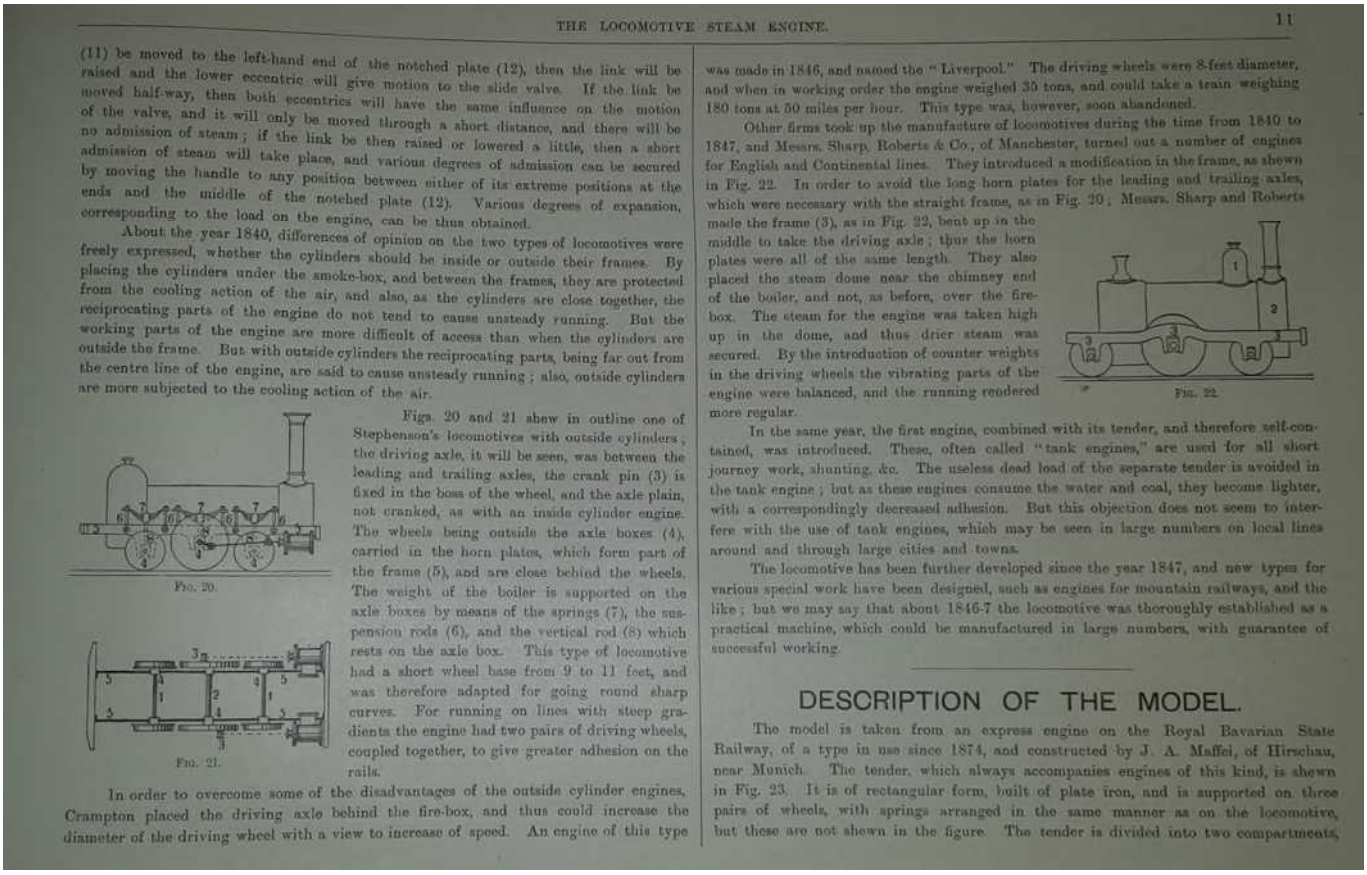
Fig. 18.

Now, as economy of steam was a thing greatly to be desired, especially for locomotives used in districts where fuel was expensive, it became necessary to devise means of obtaining more duty out of the fuel. There were two ways of doing this: by increasing the pressure of the steam; and by using the steam expansively, that is, by admitting the steam for a part only of the stroke, and then getting work out of it by letting it expand for the remainder of the stroke. The link motion reversing gear at once combined the necessary means of reversing the engine, and of admitting steam for varying portions of the stroke, according to the load put upon the engine.

In 1842, Williams, of Newcastle, conceived the idea of attaching the forked ends of the eccentric rods to an open link, and of making the connection of the valve rod to this link by a sliding block (*see* Fig. 19). This idea was perfected by Howe and Stephenson in 1843, and has remained to this day as the most used reversing gear for locomotives and many other engines. For this gear the valves (1) are placed vertically on the side of the cylinders; the valve rod (2) is connected by a joint and pin to a block (4) sliding in the open sector or link (3); the ends of the eccentric rods (5 and 6) are connected by joints and pins to the link, one at each end; the link is supported from the lever (9) by the suspension rods (7); the lever (9) is moved by means of the rod (10) and the handle (11). When in the position shewn in Fig. 19, the link is in its lowest position, and the motion of the eccentric with the rod marked (5) is communicated to the valve, and the motion of the eccentric with the rod marked (6) then only moves the lower end of the link backwards and forwards, without giving motion to the slide valve. If the reversing handle

Fig. 19.

Abb.18/19 Steuerung von Williams aus Newcastle, verbessert von Howe und Stephenson



(11) be moved to the left-hand end of the notched plate (12), then the link will be raised and the lower eccentric will give motion to the slide valve. If the link be moved half-way, then both eccentrics will have the same influence on the motion of the valve, and it will only be moved through a short distance, and there will be no admission of steam; if the link be then raised or lowered a little, then a short admission of steam will take place, and various degrees of admission can be secured by moving the handle to any position between either of its extreme positions at the ends and the middle of the notched plate (12). Various degrees of expansion, corresponding to the load on the engine, can be thus obtained.

About the year 1840, differences of opinion on the two types of locomotives were freely expressed, whether the cylinders should be inside or outside their frames. By placing the cylinders under the smoke-box, and between the frames, they are protected from the cooling action of the air, and also, as the cylinders are close together, the reciprocating parts of the engine do not tend to cause unsteady running. But the working parts of the engine are more difficult of access than when the cylinders are outside the frame. But with outside cylinders the reciprocating parts, being far out from the centre line of the engine, are said to cause unsteady running; also, outside cylinders are more subjected to the cooling action of the air.

Fig. 20.

Fig. 21.

Figs. 20 and 21 shew in outline one of Stephenson's locomotives with outside cylinders; the driving axle, it will be seen, was between the leading and trailing axles, the crank pin (3) is fixed in the boss of the wheel, and the axle plain, not cranked, as with an inside cylinder engine. The wheels being outside the axle boxes (4), carried in the horn plates, which form part of the frame (5), and are close behind the wheels. The weight of the boiler is supported on the axle boxes by means of the springs (7), the suspension rods (6), and the vertical rod (8) which rests on the axle box. This type of locomotive had a short wheel base from 9 to 11 feet, and was therefore adapted for going round sharp curves. For running on lines with steep gradients the engine had two pairs of driving wheels, coupled together, to give greater adhesion on the rails.

In order to overcome some of the disadvantages of the outside cylinder engines, Crampton placed the driving axle behind the fire-box, and thus could increase the diameter of the driving wheel with a view to increase of speed. An engine of this type was made in 1846, and named the "Liverpool." The driving wheels were 8-feet diameter, and when in working order the engine weighed 35 tons, and could take a train weighing 180 tons at 50 miles per hour. This type was, however, soon abandoned.

Other firms took up the manufacture of locomotives during the time from 1840 to 1847, and Messrs. Sharp, Roberts & Co., of Manchester, turned out a number of engines for English and Continental lines. They introduced a modification in the frame, as shewn in Fig. 22. In order to avoid the long horn plates for the leading and trailing axles, which were necessary with the straight frame, as in Fig. 20; Messrs. Sharp and Roberts made the frame (3), as in Fig. 22, bent up in the middle to take the driving axle; thus the horn plates were all of the same length. They also placed the steam dome near the chimney end of the boiler, and not, as before, over the fire-box. The steam for the engine was taken high up in the dome, and thus drier steam was secured. By the introduction of counter weights in the driving wheels the vibrating parts of the engine were balanced, and the running rendered more regular.

Fig. 22.

In the same year, the first engine, combined with its tender, and therefore self-contained, was introduced. These, often called "tank engines," are used for all short journey work, shunting, &c. The useless dead load of the separate tender is avoided in the tank engine; but as these engines consume the water and coal, they become lighter, with a correspondingly decreased adhesion. But this objection does not seem to interfere with the use of tank engines, which may be seen in large numbers on local lines around and through large cities and towns.

The locomotive has been further developed since the year 1847, and new types for various special work have been designed, such as engines for mountain railways, and the like; but we may say that about 1846-7 the locomotive was thoroughly established as a practical machine, which could be manufactured in large numbers, with guarantee of successful working.

DESCRIPTION OF THE MODEL.

The model is taken from an express engine on the Royal Bavarian State Railway, of a type in use since 1874, and constructed by J. A. Maffei, of Hirschau, near Munich. The tender, which always accompanies engines of this kind, is shewn in Fig. 23. It is of rectangular form, built of plate iron, and is supported on three pairs of wheels, with springs arranged in the same manner as on the locomotive, but these are not shewn in the figure. The tender is divided into two compartments,

Abb.20/21 Stephenson-Lokomotive mit Außenzylindern; Abb.22 Lok von Sharp und Roberts

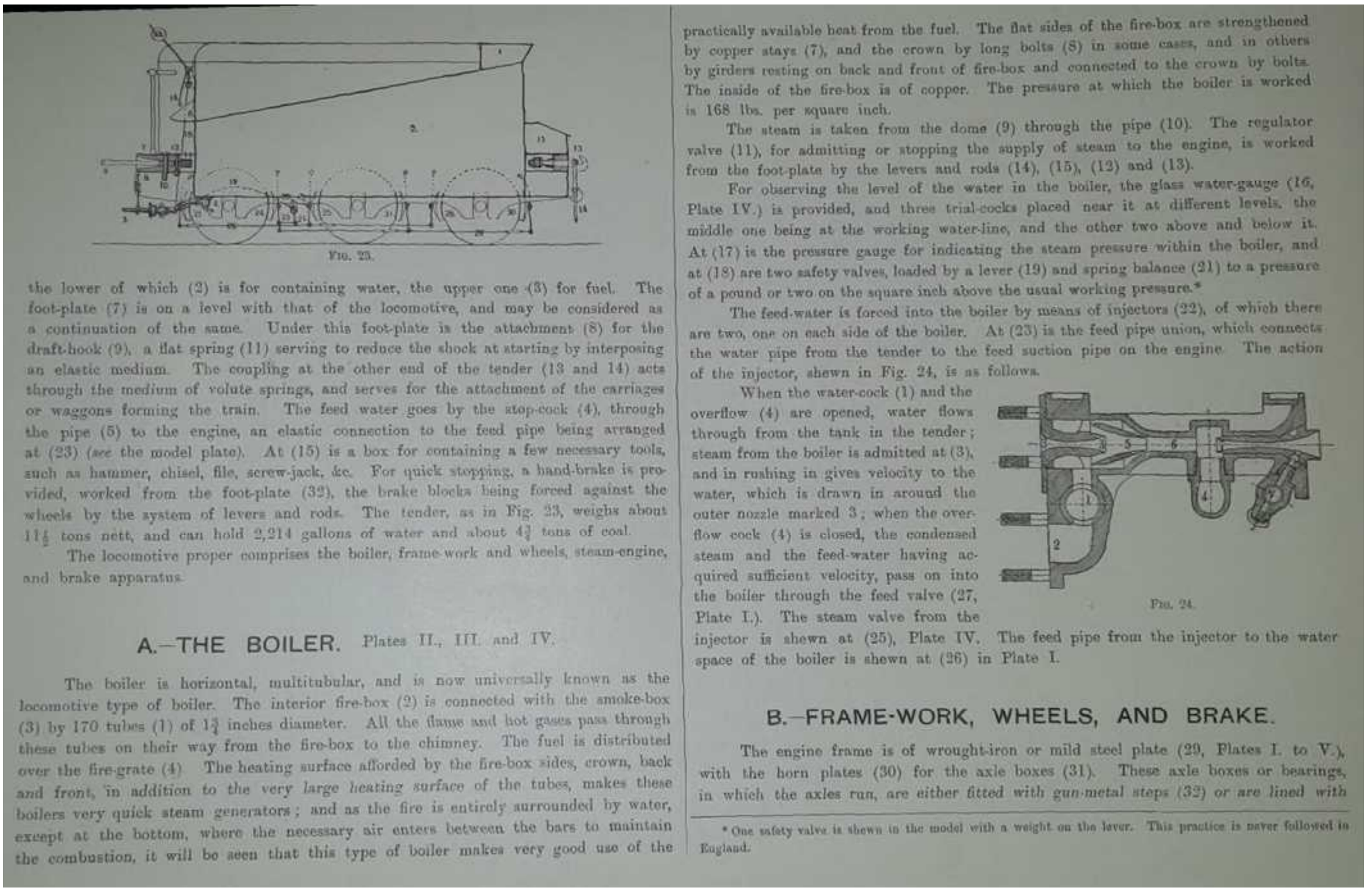


Fig. 23.

the lower of which (2) is for containing water, the upper one (3) for fuel. The foot-plate (7) is on a level with that of the locomotive, and may be considered as a continuation of the same. Under this foot-plate is the attachment (8) for the draft-hook (9), a flat spring (11) serving to reduce the shock at starting by interposing an elastic medium. The coupling at the other end of the tender (13 and 14) acts through the medium of volute springs, and serves for the attachment of the carriages or waggons forming the train. The feed water goes by the stop-cock (4), through the pipe (5) to the engine, an elastic connection to the feed pipe being arranged at (23) (*see* the model plate). At (15) is a box for containing a few necessary tools, such as hammer, chisel, file, screw-jack, &c. For quick stopping, a hand-brake is provided, worked from the foot-plate (32), the brake blocks being forced against the wheels by the system of levers and rods. The tender, as in Fig. 23, weighs about 11½ tons nett, and can hold 2,214 gallons of water and about 4¾ tons of coal.

The locomotive proper comprises the boiler, frame-work and wheels, steam-engine, and brake apparatus.

A.—THE BOILER. Plates II., III. and IV.

The boiler is horizontal, multitubular, and is now universally known as the locomotive type of boiler. The interior fire-box (2) is connected with the smoke-box (3) by 170 tubes (1) of 1¾ inches diameter. All the flame and hot gases pass through these tubes on their way from the fire-box to the chimney. The fuel is distributed over the fire-grate (4). The heating surface afforded by the fire-box sides, crown, back and front, in addition to the very large heating surface of the tubes, makes these boilers very quick steam generators; and as the fire is entirely surrounded by water, except at the bottom, where the necessary air enters between the bars to maintain the combustion, it will be seen that this type of boiler makes very good use of the practically available heat from the fuel. The flat sides of the fire-box are strengthened by copper stays (7), and the crown by long bolts (8) in some cases, and in others by girders resting on back and front of fire-box and connected to the crown by bolts. The inside of the fire-box is of copper. The pressure at which the boiler is worked is 168 lbs. per square inch.

The steam is taken from the dome (9) through the pipe (10). The regulator valve (11), for admitting or stopping the supply of steam to the engine, is worked from the foot-plate by the levers and rods (14), (15), (12) and (13).

For observing the level of the water in the boiler, the glass water-gauge (16, Plate IV.) is provided, and three trial-cocks placed near it at different levels, the middle one being at the working water-line, and the other two above and below it. At (17) is the pressure gauge for indicating the steam pressure within the boiler, and at (18) are two safety valves, loaded by a lever (19) and spring balance (21) to a pressure of a pound or two on the square inch above the usual working pressure.*

The feed-water is forced into the boiler by means of injectors (22), of which there are two, one on each side of the boiler. At (23) is the feed pipe union, which connects the water pipe from the tender to the feed suction pipe on the engine. The action of the injector, shewn in Fig. 24, is as follows.

When the water-cock (1) and the overflow (4) are opened, water flows through from the tank in the tender; steam from the boiler is admitted at (3), and in rushing in gives velocity to the water, which is drawn in around the outer nozzle marked 3; when the overflow cock (4) is closed, the condensed steam and the feed-water having acquired sufficient velocity, pass on into the boiler through the feed valve (27, Plate I.). The steam valve from the injector is shewn at (25), Plate IV. The feed pipe from the injector to the water space of the boiler is shewn at (26) in Plate I.

Fig. 24.

B.—FRAME-WORK, WHEELS, AND BRAKE.

The engine frame is of wrought-iron or mild steel plate (29, Plates I. to V.), with the horn plates (30) for the axle boxes (31). These axle boxes or bearings, in which the axles run, are either fitted with *gun-metal steps* (32) *or are lined with*

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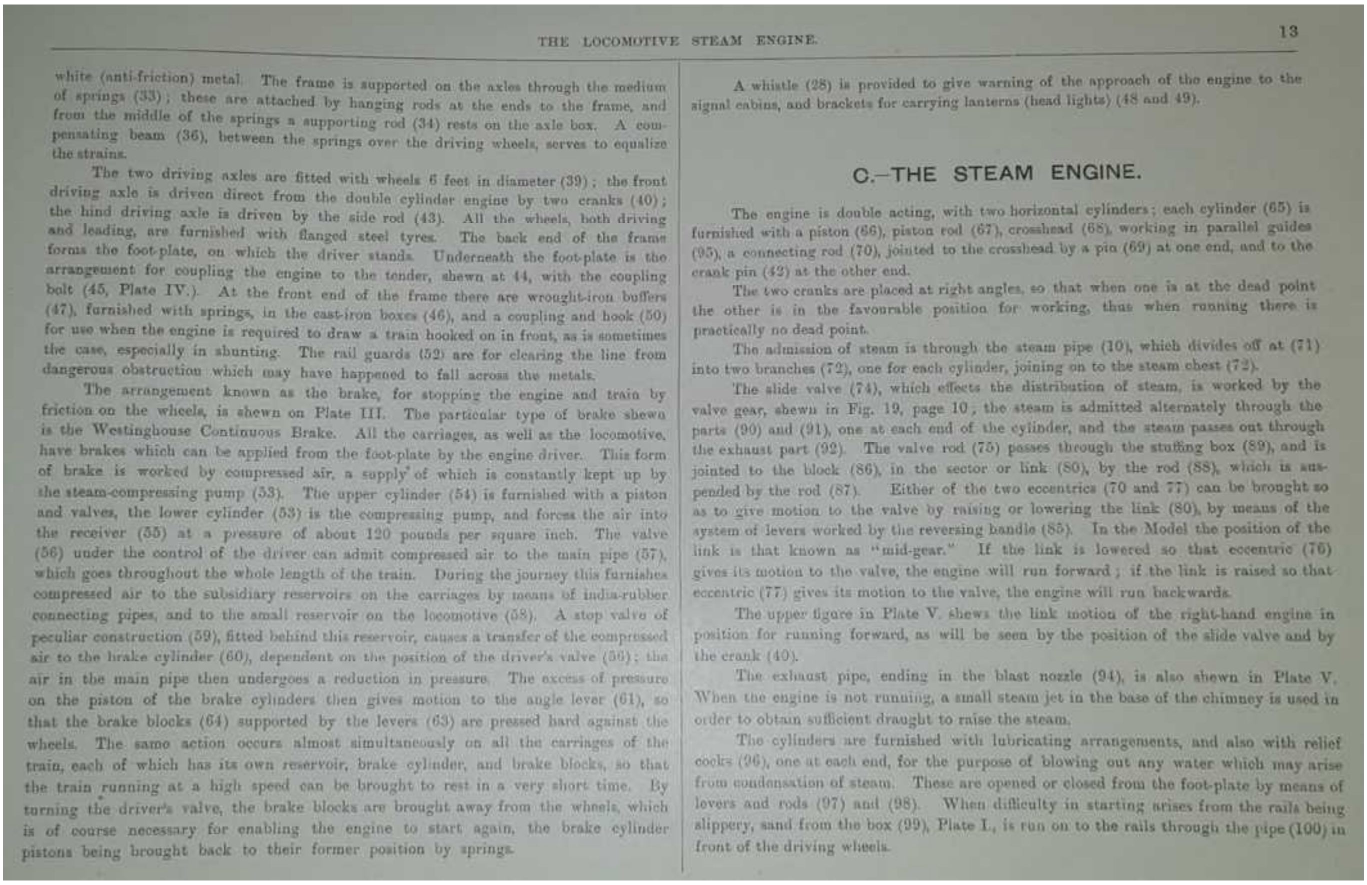
* One safety valve is shewn in the model with a weight on the lever. This practice is never followed in England.

Abb.23 Tender der Maffei-Lok; Abb.24 Injektor



white (anti-friction) metal. The frame is supported on the axles through the medium of springs (33); these are attached by hanging rods at the ends to the frame, and from the middle of the springs a supporting rod (34) rests on the axle box. A compensating beam (36), between the springs over the driving wheels, serves to equalize the strains.

The two driving axles are fitted with wheels 6 feet in diameter (39); the front driving axle is driven direct from the double cylinder engine by two cranks (40); the hind driving axle is driven by the side rod (43). All the wheels, both driving and leading, are furnished with flanged steel tyres. The back end of the frame forms the foot-plate, on which the driver stands. Underneath the foot-plate is the arrangement for coupling the engine to the tender, shewn at 44, with the coupling bolt (45, Plate IV.). At the front end of the frame there are wrought-iron buffers (47), furnished with springs, in the cast-iron boxes (46), and a coupling and hook (50) for use when the engine is required to draw a train hooked on in front, as is sometimes the case, especially in shunting. The rail guards (52) are for clearing the line from dangerous obstruction which may have happened to fall across the metals.

The arrangement known as the brake, for stopping the engine and train by friction on the wheels, is shewn on Plate III. The particular type of brake shewn is the Westinghouse Continuous Brake. All the carriages, as well as the locomotive, have brakes which can be applied from the foot-plate by the engine driver. This form of brake is worked by compressed air, a supply of which is constantly kept up by the steam-compressing pump (53). The upper cylinder (54) is furnished with a piston and valves, the lower cylinder (53) is the compressing pump, and forces the air into the receiver (55) at a pressure of about 120 pounds per square inch. The valve (56) under the control of the driver can admit compressed air to the main pipe (57), which goes throughout the whole length of the train. During the journey this furnishes compressed air to the subsidiary reservoirs on the carriages by means of india-rubber connecting pipes, and to the small reservoir on the locomotive (58). A stop valve of peculiar construction (59), fitted behind this reservoir, causes a transfer of the compressed air to the brake cylinder (60), dependent on the position of the driver's valve (56); the air in the main pipe then undergoes a reduction in pressure. The excess of pressure on the piston of the brake cylinders then gives motion to the angle lever (61), so that the brake blocks (64) supported by the levers (63) are pressed hard against the wheels. The same action occurs almost simultaneously on all the carriages of the train, each of which has its own reservoir, brake cylinder, and brake blocks, so that the train running at a high speed can be brought to rest in a very short time. By turning the driver's valve, the brake blocks are brought away from the wheels, which is of course necessary for enabling the engine to start again, the brake cylinder pistons being brought back to their former position by springs.

A whistle (28) is provided to give warning of the approach of the engine to the signal cabins, and brackets for carrying lanterns (head lights) (48 and 49).

C.—THE STEAM ENGINE.

The engine is double acting, with two horizontal cylinders; each cylinder (65) is furnished with a piston (66), piston rod (67), crosshead (68), working in parallel guides (95), a connecting rod (70), jointed to the crosshead by a pin (69) at one end, and to the crank pin (42) at the other end.

The two cranks are placed at right angles, so that when one is at the dead point the other is in the favourable position for working, thus when running there is practically no dead point.

The admission of steam is through the steam pipe (10), which divides off at (71) into two branches (72), one for each cylinder, joining on to the steam chest (72).

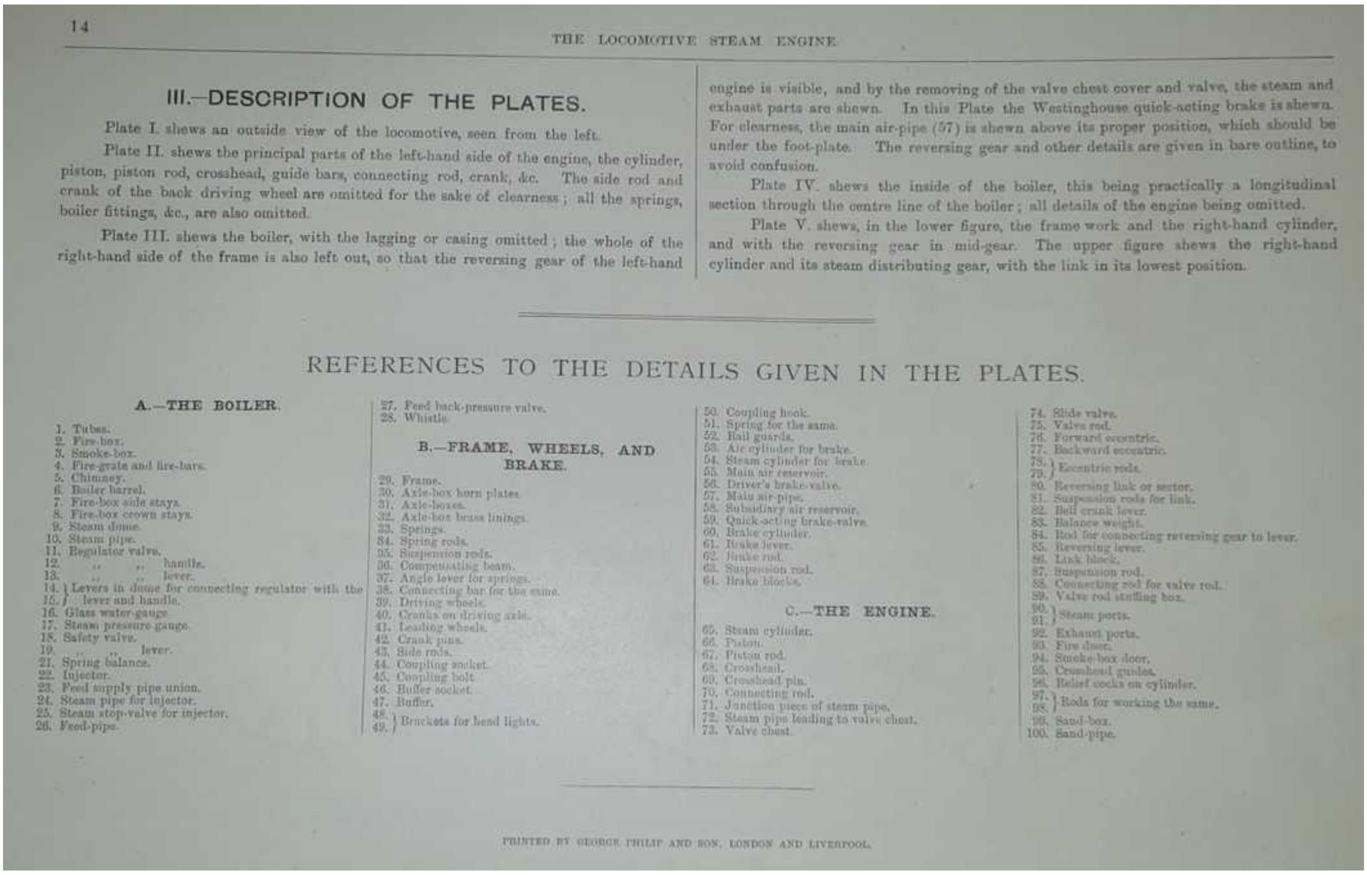
The slide valve (74), which effects the distribution of steam, is worked by the valve gear, shewn in Fig. 19, page 10; the steam is admitted alternately through the parts (90) and (91), one at each end of the cylinder, and the steam passes out through the exhaust part (92). The valve rod (75) passes through the stuffing box (89), and is jointed to the block (86), in the sector or link (80), by the rod (88), which is suspended by the rod (87). Either of the two eccentrics (70 and 77) can be brought so as to give motion to the valve by raising or lowering the link (80), by means of the system of levers worked by the reversing handle (85). In the Model the position of the link is that known as "mid-gear." If the link is lowered so that eccentric (76) gives its motion to the valve, the engine will run forward; if the link is raised so that eccentric (77) gives its motion to the valve, the engine will run backwards.

The upper figure in Plate V. shews the link motion of the right-hand engine in position for running forward, as will be seen by the position of the slide valve and by the crank (40).

The exhaust pipe, ending in the blast nozzle (94), is also shewn in Plate V. When the engine is not running, a small steam jet in the base of the chimney is used in order to obtain sufficient draught to raise the steam.

The cylinders are furnished with lubricating arrangements, and also with relief cocks (96), one at each end, for the purpose of blowing out any water which may arise from condensation of steam. These are opened or closed from the foot-plate by means of levers and rods (97) and (98). When difficulty in starting arises from the rails being slippery, sand from the box (99), Plate I., is run on to the rails through the pipe (100) in front of the driving wheels.

Beschreibung der Tafeln



14 THE LOCOMOTIVE STEAM ENGINE.

III.—DESCRIPTION OF THE PLATES.

Plate I. shews an outside view of the locomotive, seen from the left.

Plate II. shews the principal parts of the left-hand side of the engine, the cylinder, piston, piston rod, crosshead, guide bars, connecting rod, crank, &c. The side rod and crank of the back driving wheel are omitted for the sake of clearness; all the springs, boiler fittings, &c., are also omitted.

Plate III. shews the boiler, with the lagging or casing omitted; the whole of the right-hand side of the frame is also left out, so that the reversing gear of the left-hand engine is visible, and by the removing of the valve chest cover and valve, the steam and exhaust parts are shewn. In this Plate the Westinghouse quick-acting brake is shewn. For clearness, the main air-pipe (57) is shewn above its proper position, which should be under the foot-plate. The reversing gear and other details are given in bare outline, to avoid confusion.

Plate IV. shews the inside of the boiler, this being practically a longitudinal section through the centre line of the boiler; all details of the engine being omitted.

Plate V. shews, in the lower figure, the frame work and the right-hand cylinder, and with the reversing gear in mid-gear. The upper figure shews the right-hand cylinder and its steam distributing gear, with the link in its lowest position.

REFERENCES TO THE DETAILS GIVEN IN THE PLATES.

A.—THE BOILER.

1. Tubes.
2. Fire-box.
3. Smoke-box.
4. Fire-grate and fire-bars.
5. Chimney.
6. Boiler barrel.
7. Fire-box side stays.
8. Fire-box crown stays.
9. Steam dome.
10. Steam pipe.
11. Regulator valve.
12. „ „ handle.
13. „ „ lever.
14. } Levers in dome for connecting regulator with the
15. } lever and handle.
16. Glass water-gauge.
17. Steam pressure gauge.
18. Safety valve.
19. „ „ lever.
21. Spring balance.
22. Injector.
23. Feed supply pipe union.
24. Steam pipe for injector.
25. Steam stop-valve for injector.
26. Feed-pipe.
27. Feed back-pressure valve.
28. Whistle.

B.—FRAME, WHEELS, AND BRAKE.

29. Frame.
30. Axle-box horn plates.
31. Axle-boxes.
32. Axle-box brass linings.
33. Springs.
34. Spring rods.
35. Suspension rods.
36. Compensating beam.
37. Angle lever for springs.
38. Connecting bar for the same.
39. Driving wheels.
40. Cranks on driving axle.
41. Leading wheels.
42. Crank pins.
43. Side rods.
44. Coupling socket.
45. Coupling bolt.
46. Buffer socket.
47. Buffer.
48. } Brackets for head lights.
49. }
50. Coupling hook.
51. Spring for the same.
52. Rail guards.
53. Air cylinder for brake.
54. Steam cylinder for brake.
55. Main air reservoir.
56. Driver's brake-valve.
57. Main air-pipe.
58. Subsidiary air reservoir.
59. Quick-acting brake-valve.
60. Brake cylinder.
61. Brake lever.
62. Brake rod.
63. Suspension rod.
64. Brake blocks.

C.—THE ENGINE.

65. Steam cylinder.
66. Piston.
67. Piston rod.
68. Crosshead.
69. Crosshead pin.
70. Connecting rod.
71. Junction piece of steam pipe.
72. Steam pipe leading to valve chest.
73. Valve chest.
74. Slide valve.
75. Valve rod.
76. Forward eccentric.
77. Backward eccentric.
78. } Eccentric rods.
79. }
80. Reversing link or sector.
81. Suspension rods for link.
82. Bell crank lever.
83. Balance weight.
84. Rod for connecting reversing gear to lever.
85. Reversing lever.
86. Link block.
87. Suspension rod.
88. Connecting rod for valve rod.
89. Valve rod stuffing box.
90. } Steam ports.
91. }
92. Exhaust ports.
93. Fire door.
94. Smoke-box door.
95. Crosshead guides.
96. Relief cocks on cylinder.
97. } Rods for working the same.
98. }
99. Sand-box.
100. Sand-pipe.

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III. Gebrauch der Tafeln

Um schnell einen Einblick in die gesamte Einrichtung der durch vorliegende Modellzeichnung dargestellten Lokomotive zu erhalten, empfiehlt sich die Durchsicht der Reihenfolge der Tafelnummer I bis V.

Tafel I zeigt den eigentlichen Dampfwagen ohne Tender von der linken Seite der gewöhnlichen Fahrrichtung mit den wesentlichsten Bestandteilen ausgerüstet in voll Ansicht.

Tafel II bringt die wichtigsten Teile der linksseitigen Dampfmaschine; Cylinder mit Stopfbüchse, Kolben, Kolbenstange, Kreuzkopf samt Gleitschienen, Schubstange und Kurbel, wenn nötig zu Erkennung der inneren Einrichtung in den entsprechenden Schnitten zur Anschauung. Die Kuppelstange als Verbindungsglied zwischen den beiden Triebkurbelzapfen ist weggelassen, ebenso die Kurbel der hinteren Triebradachse, um die Achskiste ähnlich wie die der Laufradachse durch Schnitt hinsichtlich ihrer inneren Einrichtung kenntlich zu machen. Tragfedern und Federstützen, sowie andere, die Übersichtlichkeit störende Einzelteile, insbesondere die Kesselverkleidung nebst Führerstand, sowie alle Armaturteile des Kessels sind gleichfalls entfernt gedacht.

Tafel III zeigt wiederum den nackten Dampfkessel, indem die rechtsseitige Rahmenhälfte der Lokomotive und alle damit verbundenen Teile entfernt sind, wodurch die Umsteuer-Vorrichtung der linksseitigen Dampfmaschine, und durch Weglassung des Schieberkastendeckels auch die Lage der Dampfkanäle für Ein- und Austritt erkennbar. Im wesentlichen soll durch diese Tafel die Einrichtung der Westinghouse-Schnell-Bremse veranschaulicht werden. Der Übersichtlichkeit halber sind deren Einzelteile auf die geringste Zahl beschränkt, die Haupt-Luftleitung entgegen der wirklichen Ausführung oberhalb statt unterhalb der Führerstandfläche fortgeführt. Steuerbogen, Reversierhebel, Zugstange, Winkelhebel und Hängeschienen für die Bewegung der Umsteuer-Coulisse sind nur andeutungsweise dargestellt.

Tafel IV bringt mit besonderer Ausführlichkeit die innere Einrichtung des Kessels zur Anschauung, indem die ganze Lokomotive in der Längsrichtung nach einer senkrechten Ebene durchschnitten gedacht ist. Alle die Übersichtlichkeit störenden Teile, die der Bremse oder der Maschinensteuerung angehören, sind weggelassen.

Tafel V zeigt in der unteren Haupt-Figur den Gestellrahmen samt rechtsseitigem Cylinder mit Dampfzuleitung und Auspuff, sowie besonders ausführlich die Steuerung jedes der beiden Dampfcylinder in der Coulissen-Mittelstellung. Die darüber liegende zweite Figur stellt den rechtsseitigen Dampfcylinder nebst zugehöriger Steuerung vor, letztere in jener tiefsten Lage der Coulisse, welche bei größtem Dampfverbrauch die Maschine zum Vorwärtslauf befähigt. Die Maschinenkurbel ist dabei um etwa 45° aus ihrer Todlage ausgelenkt gedacht.

Das Vorbild - eine königlich-bayerische Schnellzuglok Baureihe BIX

Das Modell von Christoph Volkert hat zum Vorbild eine **1’B-Schnellzuglok der Königlichen Bayerischen Staatseisenbahn Baureihe BIX, seit 1874 in Dienst, konstruiert von J.A. Maffei in Hirschau bei München.**

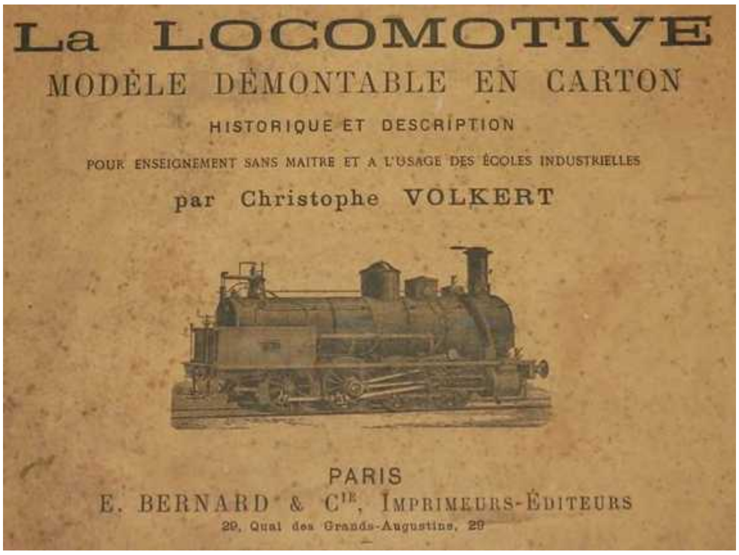
Die Dampflokomotiven der Bauart B IX der Königlich Bayerischen Staatsbahn waren die ersten zweifach gekuppelten Schnellzuglokomotiven in Bayern. Die hintere Kuppelachse befand sich unter dem Stehkessel, sodass die überhängenden Massen klein gehalten werden konnten. Daher konnte eine Höchstgeschwindigkeit der Lok von 90 km/h zugelassen werden. Die Lok erreichte in der Ebene mit einem 150 Tonnen schweren Zug eine Geschwindigkeit von 70 km/h. Die ansonsten im Stil ihrer Vorgänger gehaltenen Lokomotiven besaßen einen tiefliegenden Kessel, Außenrahmen und Stephensonsteuerung. Die Reichsbahn stufte die 1923 noch vorhandenen Maschinen — trotz ihres Treib- und Kuppelraddurchmessers von 1870 mm — nur als Personenzuglokomotive in die Gattung P23.12 ein und sah für sie noch die Betriebsnummern 34 7421–7440 vor. Die Fahrzeuge, welche zwischen 1874 und 1887 gebaut worden waren, wurden aber noch vor der Umzeichnung bis 1925 ausgemustert.

Gekuppelt waren die Lokomotiven mit Schlepptendern der Bauart bay 3 T 10,5.

Numerierung:	602 STEINBERG bis 139 SALZBURG
Anzahl:	104
Hersteller:	Maffei
Baujahre:	1874–1887
Ausmusterung:	bis 1925
Bauart:	1B n2
Spurweite:	1435 mm (Normalspur)
Länge über Puffer:	13.960–14.050
Dienstmasse:	33,6 t
Reibungsmasse:	22,0 t
Radsatzfahrmasse:	11,0 t
Höchstgeschwindigkeit:	90 km/h
Treibraddurchmesser:	1.870 mm
Laufraddurchmesser vorn:	1.170 mm
Zylinderanzahl:	2

Zylinderdurchmesser:	406 mm
Kolbenhub:	610 mm
Kesselüberdruck:	10 bar
Rostfläche:	1,50/1,70 m²
Verdampfungsheizfläche:	88,50/91,00 m²
Tender:	bay 3 T 10,5
Wasservorrat:	10,5 m³
Lokbremse:	Heberlein-Schnellbremse

Das Lok-Modell von Christoph Volkert erschien auch auf Französisch: **„La Locomotive. Modèle démontable en carton. Historique et description pour enseignement sans maître et à l'usage des écoles industrielles“**, 24 Seiten im Querformat mit 1 Zeichnung, zahlreichen Abbildungen im Text und einer Tafel mit zerlegbarem Modell in Paris bei E. Bernard & Cie. Enthalten ist eine Geschichte der aufeinanderfolgenden Verbesserungen und eine sehr genaue Beschreibung der Lokomotive.



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par Christophe VOLKERT

PARIS
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29, Quai des Grands-Augustins, 29

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