



Selection of Papers

by

L.D. Porta

Volume 5

Modern Steam Concepts

Fundamental Principles of Steam Locomotive Modernization	1998
Steam Locomotive development in Argentina (Manchester paper)	1969
Progress on Steam Loco Technology carried out in Argentina since 1969	1976
Modernization of ex-Baldwin 2-6-2T locos - Emerald tourist railway Australia	1995
The Case of a Better American Steam Locomotive	c.1977

Locomotive Exhausts

The Exhaust of Locomotives (covering both Kylpor and Lempor)	1957
Addendum – Notes and Clarifications by David Fryer and Martin Johnson	2025
Lempor Theory	1974
Calculations for a Lempor Ejector for a 2-10-0 locomotive	1974

Compound Locomotives

A New Conception of the Compound Locomotive	1976
The Steam Cycle in the case of a 3-cyl compound 2-10-0	undated

Articulated Locomotives

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Miscellaneous Topics

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Cario An Advanced Axlebox Scheme for 21 st Century Steam Locomotives	2000
Steam Locomotive: Running with Closed Regulator	1977
The Fischer Knuckle Pin in Advanced Steam Locomotive Engineering	1986
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On the Performance of the British Standard Class 8 No 71000	1977

Transcribed and edited by

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Rear Cover Montage:

Top left: Porta's first locomotive design – an experimental compound 4-8-0 rebuilt 1947-48 from a Belgrano Railway Class F22 Pacific.

Top right: outline sketches of Porta's Kylpor and Lempor exhaust ejectors.

Centre: Artist's impression of Porta's 1977 proposal for a 2-12-12-0 Mallet locomotive to handle 4000 tonne trains over the 750mm gauge Rio Turbio Railway, Argentina.

Lower left: Artist's impression of Porta's proposed "Second Generation" 3-cylinder compound 2-10-0 dating from the 1970s.

Lower Right: BR Standard Class 8 Pacific No 71000 "Duke of Gloucester" (the subject of the last paper in this volume).

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Introduction to the Fifth Volume of Porta's papers

This is the fifth volume of papers by the renowned Argentinean steam locomotive engineer, Livio Dante Porta, to be published by the Advanced Steam Traction Trust (ASTT).

The first volume, published by ASTT in 2018, covered the important topics of Lubrication and Tribology, the Design of Piston Valves and the Cooling of Piston Valve Liners. The second volume, published in 2019, covered the subjects of Adhesion, Compounding, and Porta's Tornado Proposal. The third volume published in 2021 consists of 19 papers covering Boilers, Fireboxes and Combustion. The fourth volume published in 2023 covered topics relating to boiler water treatment, preheating and circulation.

The papers in this volume are less easily categorized. They have been grouped into five broad categories: (1) Modern Steam Concepts (3 papers); (2) Locomotive Exhausts (3 papers); (3) Compound Locomotives (2 papers); (4) Articulated Locomotives (5 papers); and (5) Miscellaneous Topics, the last covering a broad range of subjects, all of which should be of interest to the reader.

As was the case for the earlier volumes, most of the 21 papers in this volume have been transcribed from poor-quality photocopies, many of Porta's handwritten manuscripts. So far as is known, all but one of these papers have not been published before, the one exception being Porta's seminal "Manchester Paper" which he presented to the Institution of Locomotive Engineers at its last meeting in March 1969 before I.Loco.E. was amalgamated into the Institution of Mechanical Engineers. Fittingly perhaps, Porta's paper was the final paper to be presented at this final meeting. It was previously published by Camden Miniature Steam Services in 2006.

Whilst Porta's 1974 paper on the Lempor exhaust is believed to have been unpublished in book form before, it has been available on the Internet through Hugh Odom's Ultimate Steam Page. However, the versions of this and Porta's earlier paper on "The Exhaust of Locomotives", also published in this volume, contain numerous corrections and clarifications, together with updated knowledge that has been added by ASTT members Martin Johnson and David Fryer, both of whom the editor is indebted to. Both have worked tirelessly to bring these papers up-to-date, in addition to which Martin Johnson has also given invaluable assistance in interpreting Porta's sometimes near-illegible hand-written calculations for a Lempor exhaust, which are also included herein.

The papers on compound and articulated locomotives may by now be of only historic or academic interest, but some of the "miscellaneous" papers should be of interest to today's students of steam engineering – one in particular - the "Notes on the Optimum Value of Lead in Steam Locomotives" - was of particular interest to the Editor because it explained the mystery of how a locomotive fitted with Walschaerts valve gear can continue to run forwards with the reverser set in mid-gear, or even in reverse gear.

Whilst the Editor has a few untranscribed Porta manuscripts in his files (as listed overleaf), time and age make it unlikely that he will produce a sixth volume of papers. It is therefore probable that this volume will be the last, unless a new editor can be found to take over the task.

Readers' Queries:

Readers who would like to compare the transcriptions with the original manuscripts, should write to the editor, Chris Newman, at 2/4 Kimmerghame View, Edinburgh EH4 2GP or by email to info@advanced-steam.org. Likewise, readers should send technical queries to the editor who, when necessary, will pass them on to experts within ASTT's membership who may be able to offer clarifications, corrections or interpretations.

Papers by L.D Porta in possession of ASTT, untranscribed as at November 2024

Title	Year	Pages	Language
Modifications to the 8C locos of the FCGR	1957	14	English
The cardinal points of modern and future steam locomotive design in the context of the Energy Crisis	1975	36	English
Third Generation Steam - Facing the Energy Crisis	1978	72	English
A List of Some 500 Possible Improvements to Existing Steam Loco Power	1983	121	English
Work done by a member of the Advisory Committee of the Presidency of A.C.P.F.	1985	8	English
The Contribution of a New Steam Motive Power to an Oilless World	1987	44	English
Steam Locomotive Power Advances made during the Last 30 Years. The Future	1991	182	English
21st Century Steam - Barcelona 1998	1998	12	English
Fundamental Principles of Steam Locomotive - Barcelona 1998	1998	8	English
On the Possibility of Manufacturing the 800HP LVM 800 Steam Locomotives in Cuba	1998	39	English
Some Aspects of the LVM800 Locomotive Design	1998	33	English
A Note on Oil Burners as Applied to Steam Locomotives	2000	8	English
Steam Locomotive Power for the 21st Century	2001	9	English
Equerrage des chassis ajustement des boites a huile bielle et crosses de piston des locomotives a vapeur	1952	112	French
Quarante ans apres: une analyse des compounds de Chapelon vis-à-vis de progres recentes dans la technique des locomotives a vapeur	?	163	French
Combustión ciclónica (1963 + 1966)	1966	42	Spanish
Traccion a vapor o diesel 1946	1946?	49	Spanish
Traccion a vapor o diesel 1946	1946	25	Spanish
Detalls de la Locomotora constuida bajo las direccion del Ing. L.D. Porta	1952	18	Spanish
Construcción de un prototipo de automovil a vapor 1970 - INTI	1956	56	Spanish
La Traccion a Vapor Moderna - Un Diseno para el Futuro - Tome I - Texto	1966	63	Spanish
Informe relativo a estudios sobre tratamiento de aguas para locomotoras del FCGB	1972	89	Spanish
Part 1 - la traccion de los ferrocarriles en el contexto de la crisis energetica	1975	18	Spanish
Part 2 - la traccion de los ferrocarriles en el contexto de la crisis energetica	1975	31	Spanish
Planta Productora de Energis de 1000HP Alimentada con Residuos de Aserradero 1976	1976	23	Spanish
Tratamiento de aguas para calderas de baja presión. Parte 1 - Locomotoras	1978	60	Spanish
Tratamiento de aguas para calderas de baja presión - continued	1978	63	Spanish
El Escape de las locomotoras (by Porta and Taladriz)	?	65	Spanish
Fugas en la placa tubular Nº 1 de las calderas humotubulares - Informe Nº 1 (Preliminar)	1980	184	Spanish
Actuacion de un miembro del comite asesor de la presidencia de A.C.P.F.	1985	44	Spanish
Modernizacion de Una Locomotora de Vapor 2-8-0 del Minaz, Cuba	1992	6	Spanish
Maquina Formosa	?	6	Spanish
Una solucion para un ferrocarril ecologico y sostenible	1999	7	Spanish

Summary of Papers in order of appearance:

Part 1 - Modern Steam Concepts

1 - Fundamental Principles of Steam Locomotive Modernization (1998)

This short paper was written late in Porta's career and provides a brief summary of what "modernization" is all about. Its six sections are headed: 1 – Introduction. 2 – What is Modernization? 3 – Application of Principles. 4 – Steam Loco Modernization for Tourist Railways. 5 – Modernization of Museum Locomotives. 6 - Concluding Remarks and Recommendation. The last begins with the words "The steam locomotive is far from being a simple machine. It is very complicated, but its complication is of an intellectual nature."

2 - Steam Locomotive development in Argentina (Manchester paper) (1969)

Porta presented this paper to the Institution of Locomotive Engineers' meeting held in Manchester in March 1969. It was the last paper presented at the meeting, and the meeting was the last to be held by the I.Loco.E. which was absorbed into the I.Mech.E. that same year. The I.Loco.E. was set up as an organization within which steam locomotive engineers could meet and learn from one another. It lost its purpose with the phasing out of steam traction from Britain's railways, and the transfer of locomotive design skills and knowledge from the (then) centralized railway industry to private engineering companies specializing in diesel and electric traction. Porta's paper on his work in developing steam traction in Argentina was thus a poignant epitaph to "what had passed" and an elegy to "what might have been".

The content of the paper is as described in the title, most of which is described (often in more detail) in others of Porta's papers. However the record of the discussion following Porta's presentation is of particular interest, featuring comments and questions from past doyens of the industry that include Kenneth Cantlie and E.S. Cox, and by letter from André Chapelon.

The paper was previously published by Camden Miniature Steam Services in 2006.

3 - Progress on Steam Loco Technology carried out in Argentina since 1969 (1976)

The paper summarizes the progress that Porta made over the seven years since his 1969 presentation in Manchester. The summary is by category – viz: Water Treatment; Adhesion; Combustion; Engine Thermodynamics; Mechanical Design; Boiler Design; Blastpipe Design; concluding with a list of coming papers.

4 - Modernization of ex-Baldwin 2-6-2T locos - Emerald tourist railway, Australia (1995)

Porta never travelled to Australia to inspect at first-hand the locomotives that he had been asked to advise on. This paper therefore represents a desktop review of such information as was given to him by the then Emerald Tourist Railway (now formally constituted under the name "Puffing Billy Railway"). Notwithstanding – or perhaps it was a consequential result – the paper provides a valuable, if sometimes random overview of the astonishing range of improvements that Porta pioneered over his career.

5 – The Case for a Better American Steam Locomotive (c.1977)

This paper was previously transcribed and published by the Coalition for Sustainable Rail (CSR) in the United States. However this transcription has been made from a photocopy of the original typescript that was (and may still be) housed in the library of INTI (the National Institute of Industrial Technology) in Buenos Aires, Argentina, where Porta worked in the 1970s and 1980s. It is likely that the paper was written either in advance of or during Porta's engagement on the ACE (American Coal Enterprise) project in the late 1970s and early 1980s.

Of interest is the summary (in table form) of the conclusions of the paper written by Dr. H.F. Brown titled "Economic Results of Diesel Electric Motive Power on the Railways of the United States of

America” and presented to the Institution of Mechanical Engineers in 1961. [The full text of this paper can be found on ASTT’s website at <https://advanced-steam.org/uFAQs/downloadable-reference-material-relating-to-steam-vs-diesel-debates/>].

Part 2 - Locomotive Exhausts

6 – Exhaust of Locomotives (1957)

This paper was jointly authored by Porta and Ing. Claudio S. Taladriz, and was presented at the 9th Pan-American Railway Congress in Buenos Aires. It is an important paper in that it spells out the theories behind both the Kylpor and Lempor exhaust systems and includes the mathematics and the fluid mechanics that underlie both concepts. The paper was written and presented in Spanish, from which an English translation was produced by Porta (in typescript) from which this transcription was derived. However, this translated version is full of typist’s errors that were not picked up by Porta – particularly in the presentation of equations. Many of these errors have been corrected by referring back to the original Spanish version of the paper, but others have had to be deduced with the invaluable assistance of ASTT members Martin Johnson and David Fryer, without whose help a meaningful transcription of the paper would not have been possible.

Addendum – Notes and Clarifications on Porta’s 1957 & 1974 Exhaust System Papers

This Addendum has been written by Martin Johnson and David Fryer to update Porta’s papers in the light of more recent studies – with particular reference to Jet Pump Theory. In so doing, they demonstrate that the Kylpor is, theoretically, significantly more efficient than the Lempor.

7 – Lempor Theory (1974)

This paper was written after Porta had perfected the Lempor through its application to his “guinea-pig” locomotive – FCGB 4-8-2 No 1802. It is much shorter than his 1957 paper which covered both Lempor and Kylpor exhausts, as this paper only covers the Lempor option and does not repeat the several pages that formed an introduction to the earlier paper. Porta introduces this later paper with the words: “This is a revision of the Porta-Taladriz theory of 1957, incorporating the effect of friction in the mixing chamber and other corrections”.

A transcription of the paper has been available for free download from Hugh Odom’s “Ultimate Steam Page”, which includes corrections recommended by Jos Koopmans. However, a few transcription errors have been discovered and corrected in this version, by referring back to the handwritten manuscript.

8 - Calculations for a Lempor Ejector for a 2-10-0 locomotive (1974)

These calculations come from a poor-quality photocopy of what appear to be hastily-written calculations in Porta’s handwriting. They consist of 89 lines of calculation that have been transcribed into spreadsheet format from which they are presented in this volume. A great deal of help was provided by Martin Johnson in the interpretation of the calculations. Porta used a graphical solution from which he obtained the optimum sizes of blast nozzle and diffuser throat area – a method that has been replicated in the spreadsheet. The calculations are backed up by explanatory notes by Martin Johnson.

Part 3 - Compound Locomotives

9 - A New Conception of the Compound Locomotive (1976)

This paper describes a concept of compound expansion in which simple working automatically activates at low speeds, which differs from Porta’s normal preference for full compound working. The aim behind the idea is to produce a tractive effort curve more closely resembling that of a diesel locomotive with its high starting TE. The quality of the photocopied manuscript is not good, which renders the quality of Porta’s diagrams somewhat difficult to interpret, which is unfortunate since they would otherwise better explain the ideas presented in the text.

10 - The Steam Cycle in the case of a 3-cyl compound 2-10-0 (undated)

A three-page summary of Porta's design for a 3-cylinder compound 2-10-0. He introduces the paper with the words: "Steam pressures and temperatures have been selected according to the present status of the knowledge so as to guarantee a successful operation in daily practice." From this, it may be deduced that this is a SGS (Second Generation Steam) proposal rather than Third Generation. It's not possible to tell whether the conceptual design is the same for which he produced the 1974 calculations for a double-Lempor exhaust, but it is probably not the same because the two-page flow diagram that accompanies the text of this paper shows a schematic for only a single exhaust in the outline shape of a Lempor. It's pretty clear that the design is not related to the "New Conception" described in the previous paper because simple expansion working has not been allowed for.

Part 4 - Articulated Locomotives

11 - Some Notes on the Design of Mallet Locomotives (1977)

This 4-page summary of the weaknesses in many US Mallet locomotive designs, lists a number of improvements that could have been made to improve their performance and operation.

Both this and the following Notes on Garratt designs, were written in 1977 when Porta was working on both Mallet and Garratt conceptual designs for the Rio Turbio Railway in Patagonia.

12 - Notes on the Design of Garratt Locomotives (1977)

This is another short paper (6 pages) that outlines some of the design considerations to be taken into account when designing a Garratt locomotive to achieve its maximum potential.

13 - Some notes on Large Steam Pipe Connections in separable locomotives (1978)

In this short paper, Porta expresses a preference for flexible bolted joints on steam pipes instead of the more commonly used spherical joints in order to make them easily separable. He presents some interesting ideas for how such joints might be designed.

14 - Some Loose Notes on the Separable Locomotive (1978)

In this paper, Porta offers some extreme ideas relating to what might be possible in terms of multiple-unit operation of condensing Third Generation steam locomotives. He qualifies his ideas with a passing observation: "whether or not this is a convenient proposal from the viewpoint of railway economics is not dealt with here"!

15 - A system for coupling Mallet engine units and other Articulated Locos (1977)

This is a most interesting paper presenting a novel method of coupling Mallet engine units together using hydraulics. The Mallet in question is one of Porta's proposed locomotives for doubling the train sizes being hauled on the 750 mm gauge Rio Turbio Railway in Patagonia which was then being operated by a fleet of diminutive Japanese-built 2-10-2s capable of hauling 2000 tonne coal trains. It seems clear that Porta had opted for a Mallet design rather than a Garratt which he had considered (as described in one of the papers listed above), but sadly he offers no hint of why he opted for the Mallet option.

Notwithstanding, the paper presents an amazingly simple self-regulating concept for coupling engine units and preventing either from losing adhesion in all but the most exceptional circumstances.

Part 5 - Miscellaneous Topics

16 - A Mechanical Anti-Slipping Device for Steam, Electric or Diesel Locomotives (1977)

Another interesting paper that reveals Porta's inventiveness when it came to problem solving – in this case a simple hydraulic mechanism for automatically controlling slipping of a steam locomotive. Presumably it remained an idea that he never tried in practice.

17 - Steam Locomotive: Running with Closed Regulator (1977)

This is a short but important paper that served to convince Dave Wardale to remove the snifting valves from his modified SAR 19D Class 4-8-2 (No 2644) and to specify the practice of drifting in mid-gear with the regulator closed (or cracked open). A copy of the relevant pages from his book "The Red Devil and Other Tales from the Age of Steam" has been appended to the transcription of Porta's paper.

18 - The Fischer Knuckle Pin in Advanced Steam Locomotive Engineering (1986)

The rather specialized subject matter should still be of interest to the non-technical reader. If nothing else, it illustrates the breadth of Porta's interest and knowledge of things to do with the steam locomotive, and of his extensive reading on the subject. Of special interest is the section of the paper that describes a Swedish system for altering a coupling rod's length.

19 - Notes on the Optimum Value of Lead in Steam (1977)

The Editor first transcribed this paper in 2011, since when he has looked forward to an opportunity to publish it. It is a relatively short paper but an important one in terms of explaining the mysteries of "lead" in locomotive valve gear – in particular, how it is possible to drive a Walschaerts-fitted locomotive forwards when the valve gear is set in reverse. The Editor has supplemented the paper with an extract from David Wardale's "Red Devil and Other Tales from the Age of Steam" and illustrations generated by Dr Allan Wallace's valve gear simulation software.

20 - Cario - an Advanced Axlebox Scheme for 21st Century Steam Locomotives (2000)

One of Porta's last papers, which he himself confirms in the opening paragraph of the concluding section where he wrote: "It is the last step in the Author's effort to improve the genial STEPHENSON'S machine. The solution is a definite advance because a higher perfection is obtained with fewer demands for shop machinery, no need of fancy "yet-to-be-invented" resources, and is compatible with the services to be performed in the developing world, and cost less money and require least investments - it is ELEGANT ENGINEERING". [The Editor wonders what he would have said about Jamie Keyte's design for the elastomeric suspension system and spring beams for ASTT's *Revolution* project which, in the Editor's opinion, represents an even greater level of "elegant engineering" than the Cario system.]

21 - On the Performance of the British Standard Class 8 No 71000 (1977)

Porta's focus in writing this paper was to check the accuracy of the measurements recorded in BR's 1957 Swindon Test Plant report on the "Performance and Efficiency Tests of British Railways Standard Class 8 3-cyl 4-6-2 Express Passenger Steam Locomotive No. 71000". His aim seems to have been to assess whether the locomotive's efficiency, fitted with its British Caprotti valve gear, was sufficiently high to render compound expansion unwarranted. Porta focusses on its reported Rankin efficiency of ~82.5% at 90 mph and ~81% at 75 mph, at a steaming rate of 22,000 lb/hr. He concludes that these figures are not supported by his calculations that are based on the reported data.

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