

Along the Railway. Italian Industrial Design in Portugal

Railways, Design, Fast trains, FIAT, “Foguete”

/Abstract

On the margins and, therefore, little known, is the relationship between Italy and the most performant trains on the Portuguese railway network. One of the most important cases was the advent of Lisbon-Porto-Lisbon line of Fiat Ferroviaria’s self-propelled diesel-hydraulics trains, named in Portugal, “Foguete”, known internally as “CP class 0500”. The travel time between the two cities was 4.30 hours, only surpassed since 1993, - and with the protagonism of another product designed by Fiat Ferroviaria (today Alstom-Italia).

/Author

Paulo Pereira
CIAUD, Research Centre for Architecture, Urbanism and Design
Lisbon School of Architecture, Universidade de Lisboa
pjgp@netcabo.pt

Associate professor with aggregation at Lisbon School of Architecture, Universidade de Lisboa, art and architecture historian, Head of History, Theory and Design Department of Lisbon School of Architecture, Universidade de Lisboa. Member of CIAUD. Completed his PhD in Architecture with a specialization in History on June 25, 2012, at Lisbon School of Architecture, Universidade de Lisboa.

It is not about architecture, perhaps more about design and, specifically, industrial design.

But it is still worthy of note as a relationship, at the very least curious, or even more than that: important! – between Portugal and Italy. It could be said to be a case of trust and mutual satisfaction that is easily verifiable, even on the margins. And for what matters, I believe this a little known relationship. In fact, the Fiat brand is famous and has a multitude of customers all over the world. We know very well that it was the automobile industry that would make it a reference in modern industry. The Fiat Balila (associated, it is true, with Italian fascism) and, very especially, the first series of the famous Fiat 500 remain in our memory for their sales success.

Fiat, becoming a powerhouse in the motorization and driving machinery sector, manufactured tanks, transport aircraft, fighter aircraft, fighter bombers before and during World War II, and supplied internal combustion engines to other manufacturers as well as jet engines in the post-war period, even producing a well-known light fighter-bomber used officially by several NATO countries and not only in the post-war period (in fact, the most conspicuous jet fighter-bomber of the Portuguese Air Force in the 70s and 80s, the agile and efficient single-engine Fiat G 91, was also manufactured by FIAT).

However, I am not going to talk about cars, tanks or planes, but rather about a sector that almost only specialists know about and that played an interesting role in the history of Portugal (and Spain, too). In fact, the railway sector was and still is, albeit with a different corporate name, one of the departments that has seen the greatest development by Fiat since the end of the 19th century. It was founded under the name Società Nazionale Officine di Savigliano (SNOS) in 1880. Initially dedicated to the maintenance and manufacture of railway equipment including carriages, wagons and various components, it later merged with another company, Società Anonima Italiana Ausiliare (1889), expanding its industrial reach with the manufacture of industrial machinery and heavy metal-working, including bridges, but participating in the war efforts, in the Great War (1914-1918), in the interwar period and, later, in World War II. This period saw the production of various types of armored vehicles, as well as commercial and military aviation, which were widely used by the belligerents of the Axis powers and, of course, in particular, by Italy.

The company’s shareholder was Fiat, and this company assumed full control of railway production in 1970, and has since been known as Fiat Ferrotranviaria. After World War II, Fiat began producing components from various players in the sector, in the production of diesel locomotives and electric locomotives widely used on the Italian railway network of FS (Ferrovia dell Stato). Fiat machines established new standards in the railway sector, despite the competition that was emerging in Italy itself, but always managed to play a predominant role. The official catalogue of Fiat Feerrotranviaria¹ lists the various products, includ-

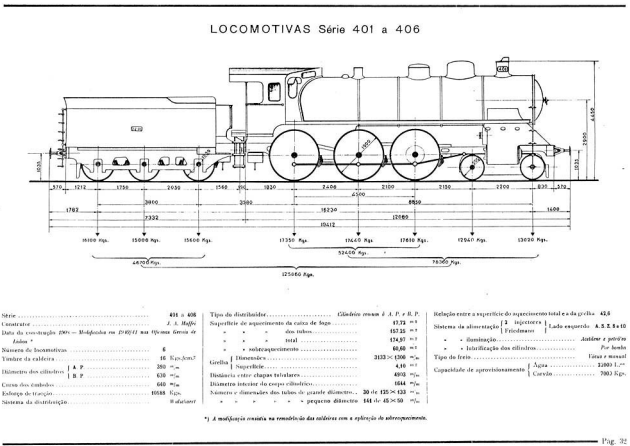
¹ FIAT, *Materiale ferrotranviario* (Turin: Fiat Ferroviaria, 1970).

ing passenger carriages, freight wagons, auxiliary wagons, engines, bogies, mechanical and hydraulic transmission systems, diesel railcars (DMUs), electric railcars (EMUs) / diesel-hydraulic locomotives, diesel-electric locomotives and three-phase electric locomotives with various voltages of direct current (DC) and alternating current (AC), among which the powerful and monstrous (in the literal and figurative sense) E.626, as well as one of the first high-speed powerful traction locomotives, the famous E444, alongside (and in competition with) the other brands of two nations involved in the manufacture of cutting-edge railway equipment: France and Germany. Since the 1980s, it will have participation from General Electric, Ercole Marelli (Marelli) and Ansaldo. Today, trains are the result of several mergers of colleges of diverse origins, from the USA and the rest of Europe, of companies specialized in railway systems (brakes, on-board electronics, preventive signaling, safety systems, interior design, etc.). Italy, on the other hand, had and still has one of the densest and most efficient railway networks in Europe and even in the world. [Figg.1a-1b]

Portugal would have a considerably dense network on the mainland, which had grown since its first installation in 1856, until the connection to Spain in 1863, in an incredibly fast process driven by the then Minister of Public Works, Eng^o Fontes Pereira de Melo (1819-1887) ², through large international bank loans and with the help of a Spanish capitalist, José de Salamanca y Mayol, founder of Companhia Real de Caminhos de Ferro. This peculiar connection with Spain explains why Portugal would adopt the same gauge as the Spanish line, 1668 mm. In 1920, the network already had an extension of more than 2,803.755 km of broad track with a gauge of 1.668 mm and 758.075 km of narrow track with a gauge of 1.00 mm, in addition to the Cascais Line, which was 25.451 km long at the time.

Since then, and from 1930 onwards, several attempts at modernization were made, with steam traction predominating. The first signs were given with the adoption of fast trains, some very early, such as those pulled by locomotives of the 401-406 class (Krauss-Maffei) with aerodynamic lower fairing, in service since 1904. The main offer would be the Lisbon-Porto line, connecting the main cities of the country, many times with trains pulled by locomotives of the Pacific type of the 500 series. In 1940, the most serious progress, but with continuity compromised in effectiveness with the advent of the Second World War, was the adoption of stainless steel carriages of the North American patent Budd, manufactured in Portugal in the workshops of the company SOREFAME under license, even presenting an aerodynamic locomotive of the 500 class (locomotive 503) with aerodynamic fairing that followed the trends of the time, designed by Eng. Manuel Bruschy and exhibited at the Portuguese World Exhibition of 1940, in what would constitute the more prestigious national train, the “Flecha de Prata” (Silver Arrow). [Figg. 2-3]

2 On Fontes Pereira de Melo see Maria Filomena Mónica, *Fontes Pereira de Melo: uma biografia* (Lisbon: Alétheia, 2009).



1a



1b



2



3

Fig. 1a-1b
CP locomotive class 401-406 (Krauss-Maffei, 2-3-0, from 1904), with streamlined lower front fairing
Fig 2.
Steam locomotive, Henschel & Sohn (1925) Pacific, class 500 - CP 553 -, preserved in Museu Nacional Ferroviário (Entroncamento) (photo, adapted MNF)

Fig. 3
Design experience: CP's aerodynamic fairing of the Pacific (Henschel) steam locomotive 503 (CP's 500 class) for the Silver Arrow precursor to the Foguete (1940) (Archive Comboios de Portugal/ CP)

It should be noted that the railway relationship between Portugal and Italy began in 1931 when CN, Companhia do Norte, acquired 17 freight carriages and 3 vans for traffic on its narrow gauge (metric) track, from OFM - Officine Ferroviarie Meridionali, S.A., based in Naples, and they were successively reconditioned until their withdrawal in 1995! They became known as “Neapolitans” and were well-loved by users. Some of them were recently (2020/21) recovered and returned to circulation on tourist trains, but occasionally ensuring current use. [Fig.4]



4

One sector that received greater attention in the context of the Portuguese railway in the 1940s was the architecture of stations, support equipment and housing for employees and technicians. The work of architects Cotinelli Telmo and Luis da Cunha was remarkable during this period, which began in the 1920s and progressed towards more cosmopolitan solutions in the following decades, after the nationalization and unification of the various Portuguese railway lines under the same company – CP. In particular, Continelli Telmo (1897-1948), who would become one of the pioneers of modernist architecture in Portugal, authored several projects that transformed the image of railway architecture with projects that were openly avant-garde for the time, despite a career that was prematurely interrupted but still filled with large-scale works that would be tedious to list here³. Let us focus on railway architecture, through the studies of João Paulo Martins⁴, since Telmo’s decisive contribution in this field is now known with a set of works that are mostly still in existence. The first projects from the end of the 1920s were still guided by classicist historicism and eclecticism, and this impulse, even due to the regime’s taste determinants, would continue until the end of the 1930s.

Still following eclectic standards, he, in collaboration with Luis da Cunha, designed the remodelling projects for the initial project for Coimbra “A” station (1923-1931), Tomar railway station (1928-1929), Azambuja station (1934), which was more restrained but had classicist references, and the Camões

3 Among his most notable works is the remarkable plan and general coordination of the Portuguese World Exhibition (1939–1940) with authorship of the Praça do Império, World Exhibition, Pavilion of the Portuguese in the World, and the Padrão dos Descobrimentos, in Belém; the plan and construction of the University City of Coimbra with the Monumental Staircase (1943–1950) according to a language derived from the “modernist neo-classicism” of Germanic origin, and the Standard Elétrica Installations on Avenida da Índia in Lisbon (1945–1948).

4 João Paulo Martins, “Cotinelli Telmo, arquitecto,” in *O caminho de ferro revisitado: o caminho de ferro em Portugal de 1856 a 1996*, edited by João Paulo Martins (Lisbon: Caminhos de Ferro Portugueses, 1996), 126–34.

Fig. 4
Vouga Valley metric gauge
touristic train consist with
three “Neapolitanas” passenger
cars, lead by a Henschel &
Sohn Mallet compound steam
engine CP E 200 class (photo
by Pedro Mêda)

neighbourhood for the large railway centre of Entroncamento, intended for housing and daily life according to the garden city model and with a traditionalist character for the company’s workers, with its respective school, Escola Camões (1923-1928). The shift towards a contemporary language is evident in the emblematic and recently restored work of the Estação de Sul e Sueste (1928-1932), on the banks of the Tagus, and in the alignment of one of the wings of the the 18th-century Pombaline monumental Praça do Comércio, with which it establishes a marked contrast, even against the will of the promoters at the time, in a frank adherence to innovative principles of Art-Deco tone, but already marked by international modernism. [Figg. 5-6]

The façade offered itself to the city with robustness, signaling the play of clear volumes and flat roof of the station block. João Paulo Martins says:



5

On the two main elevations the portico with three circular arches revisited a theme dear to railway buildings around the world, ensuring immediate identification of its function. On the other hand, in the scenographic monumentality of the scale of these elements, the building acquired an undeniable urban character, of a public facility. And even if this image established an epidermal compromise, even if it did not do full justice to the more innovative statement of the interior space, it also revealed its modernity in the generous glazing of metal frames intercepted by the concrete roofs that projected in a cantilever.⁵



6

5 Martins, “Cotinelli Telmo, arquitecto,” 130.

The interior, in turn, gained, in the boarding room for the river crossing that led to the Barreiro train station on the south bank of the river, a transparency that revealed an innovative spatial reading, enriched by the materials of the marble cladding columns and modern design. [Figg. 7a-7b-7c] It will continue with a new aesthetic attitude in several support buildings and equipment less restricted to railway activity at the service of CP, but its most conspicuous contribution would be the series of automatic control posts that corresponded to the modernization of the network's switch system. The installations of the towers of Pinhal Novo (1935-1937), Ermesinde (1937; demolished), Rossio (1939) and Campolide (1940)⁶ are notable for their elegance, functionality and almost experimental plastic value in their modern vigor. In a way, it was a harbinger of changes in the railway network, of which the case reported here is yet another episode (after the inclement vortex of the outbreak of war in 1939-45) and an updating process began, which, even so, remained incomplete.

It was only in 1948 that the railway would be modernised, first with dieselisation due to the already high price of coal, but alongside the maintenance of steam traction, which declined until around 1974. Electric traction would be adopted from 1956 onwards, with the use of French technology from the "50 Hz Group", as it was known, and the country came to generalise power supply by catenary on the Porto-Lisbon line (and later, the others) with a voltage of 25,000 V alternating current at 50 Hz, single-phase (with the exception of the Cascais Line, of DC 1500 V). But diesel traction proved effective, and the date 1953 marks significant progress in the service of the backbone of the network.

In fact, one of the most important cases was the advent of Lisbon-Porto-Lisbon line of Fiat Ferroviaria's self-propelled diesel-hydraulics trains, named in Portugal, "Foguete" (Rocket), known internally as "CP class 0500". The travel time between the two cities was 4.30 hours, only surpassed in 1998, - and with the protagonism of another product designed by Fiat Ferroviaria (today Alstom-Italia). [Fig.8]

Three triple train units - with two motor carriages and one intermediate carriage each -, they arrived in Portugal between 1953 and 1954, coming from Savignano (Turin), similar to the TAF trains of the 595 class - formerly 9500 - from RENFE. They were immediately used on the "Linha do Norte" (Northern Line) in regular 1st class trains, with great acceptance from passengers and users. From a design point of view, it focused on clear lines with an aerodynamic contribution, which provided stable top speeds in a straight line on a horizontal platform at around 120 km/h. They were powered by two twelve-cylinder engines, one for each motorized carriage, delivering 505 hp each, 1010 hp in total ⁷.

The average operating speed was high, measuring around 100 km/h. The 174-seat coaches were equipped with comfortable, high-quality seats, with padding, fabric and cooked felt, and had a small bar-cafeteria service and, a



7a



7b



7c

curious refinement for the time, meals served on board in the passenger seat by stewardesses. It was, therefore, a diesel-electric railcar or "idromeccanica" as referred to in the Fiat Ferrotranviaria catalogue, number 083/087. It resulted from the development of lighter railcar variants that Fiat manufactured for FS, including the one catalogued under number 073⁸.

The first class of railcars that corresponded to what would become the Foguete acquired and operated by CP were used by Renfe, from 1952, and numbered according to the class 9501 to 9510 (Fiat catalogue, 080), silver in colour, but without air conditioning equipment. A year later, a new order would include the supply of air-conditioned railcars, identical to those of CP. The characteristic hump on the vehicles was intended to receive the "conditioning" equipment and it was in this form (Fiat 086/087 catalogue) that they entered service in Spain (RENFE) and Portugal, here also initially in silver with a red stripe and dynamic lettering with the name "Foguete" on the front. [Fig. 9] The "Foguete's" compositions were organized, according to railway slang, in the manner explained in the table comprised in the Fiat catalogue [Fig.10]

This means that it was made up of two passenger vehicles with a traction motor at the ends, with an intermediate carriage, i.e. M+Rp+M, where M=motorized. The drive was provided by horizontally arranged engines, gaining ample cabin space throughout the entire composition, with traction being transmitted by means of a cardan shaft to one of the motor bogies located at the end of the vehicle. The twin-cylinder engines, as mentioned, had 505 hp, which together provided correct operating stability and high speed, making it possible to still progress with the train if one of the motor units broke down, albeit at controlled speed⁹. [Figg. 11a-11b, 12]

The transmission system was complex, with a mechanical gearbox and not a hydraulic one - with five positions or as they say, with "five gears". Although common in other engines, this type of "gearbox" (as they say in slang) could be a reliability problem, as happened with other Fiat models. However, given that these compositions were intended for journeys with few stops, which means few starts, the driving met the delicacy required in manipulating the gears in this type of transmission, since it would be necessary to guarantee the synchronization of the engines in terms of rotations and effort. [Figg.13a-13b] The design, although it followed on from other more modest and less powerful units, was very elegant and compared positively with French railcars – largely, in fact – and with high-quality, exclusive 1st class diesel railcars, produced four years later (entering service in 1957) such as the VT 11.5 of the Deutsche Bundesbahn (DB) and the RAm / DE4 of the SBB¹⁰ and NS¹¹, of the SBB and NS (Swiss and Dutch) (all from the notable TEE network). [Fig.14]

⁶ Martins, "Cotinelli Telmo, arquiteto," 132.

⁷ FIAT, *Materiale ferrotranviario*, file 083/087.

⁸ FIAT, *Materiale ferrotranviario*, file 083/087.

⁹ FIAT, *Materiale ferrotranviario*, file 083/087.

¹⁰ SBB/CFF/FFS (Schweizerische Bundesbahnen/Chemins de fer fédéraux suisses/Ferrovie federali svizzere).

¹¹ Nederlandse Spoorwegmaatschappij.

Figg. 7a-7b-7c

Towers of Pinhal Novo (1935-1937), Campolide (1940) and Ermesinde (1937; demolished), <https://imovel.patrimoni-ocultural.gov.pt/detalhes.php?code=4980645>, Accessed March 2026



8



9

087
CP
PORTUGAL

autotreno diesel idromeccanico condizionato (M + Rp + M)
tren automotor diesel hidromecánico acondicionado (M + Rp + M)
air conditioned triple-car diesel hydromechanical set (R + dT + R)
rame autorail diesel hydromécanique climatisé (M + Rp + M)

potenza potencia power output puissance 2 x 505 CV
tara tara weight tare 54,4 + 43,8 + 54,4 t
velocità massima velocidad máx. max. speed vitesse max. 120 km/h
rodiggio disposición de los ejes wheel arrangement disposition des essieux 2 — B — 2 — 2 — 2 — B — 2
posti seduti asientos seats places assises 64 + 46 + 64 = 174
bar e cucina bar y cocina kitchen and bar bar et cuisine
scartamento ancho de vía gauge écartement 1.668 mm
comando múltiplo mando en múltiple multiple control commande multiple

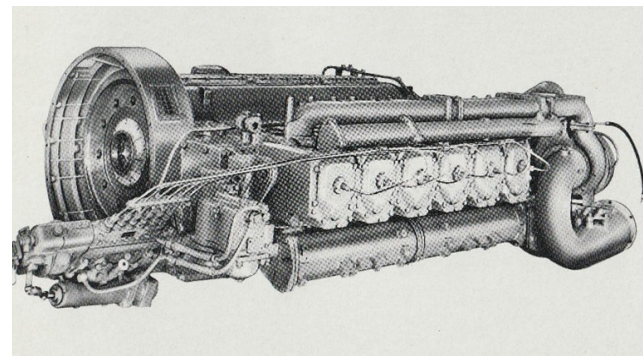
10

The front of the trains was rounded, equipped with one large headlight and double upper signaling lights at the top ends, and two main headlights at the bottom, according to the Iberian standards in force at the time. The driving screen was divided into six, four across the face, two on each side for side vision. The inclination and curvature of the structure was effectively aerodynamic and a special touch was provided by the shock plates that are integrated into a rounded rectangular box. Side skirts covered the wheels of the three vehicles, also as an aerodynamic solution. The silver-colored composition would be, later on, painted dark blue with red stripes, while maintaining its elegance and even renewing its image, following the color range in effect at CP during the 60s and 70s. [Fig.15]

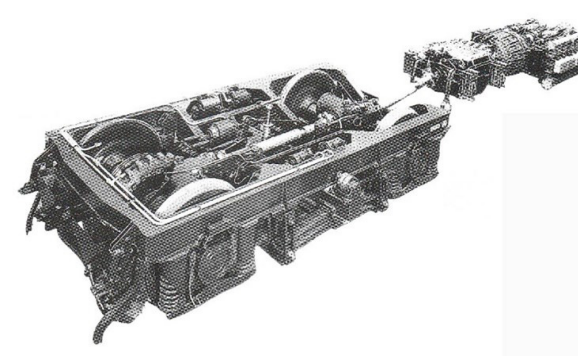
Fig. 8
O Foguete. CP class 0500 (FIAT, Materiale Ferrotranviario), silver with red lining

Fig. 9
O Foguete. CP class 0500's logo

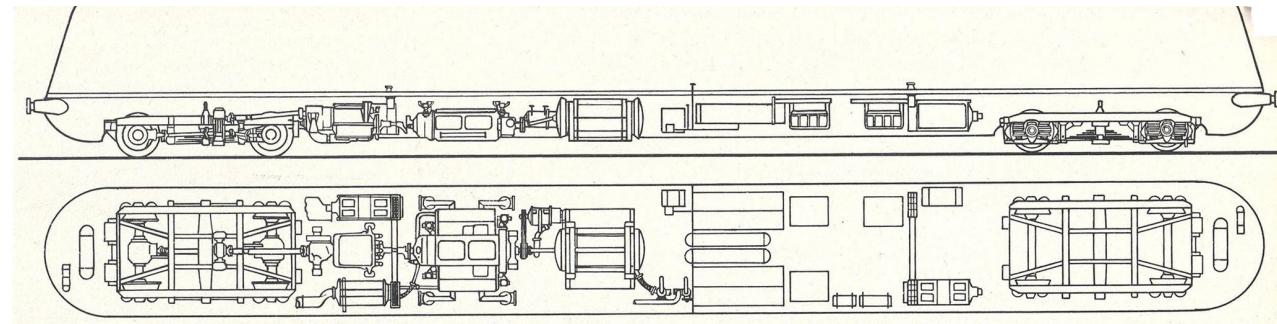
Fig. 10
O Foguete. CP class 0500, technical description, (file 087, in FIAT, Materiale Ferrotranviario, catalogue)



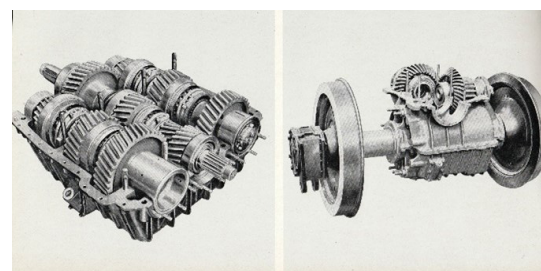
11a



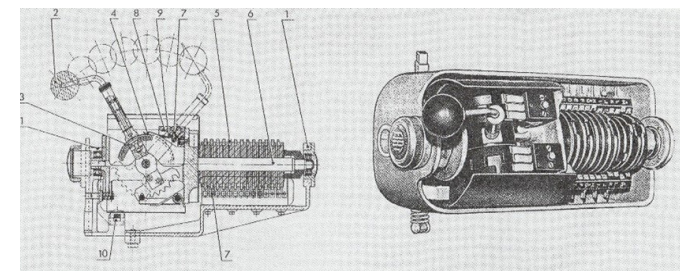
11b



12



13a



13b

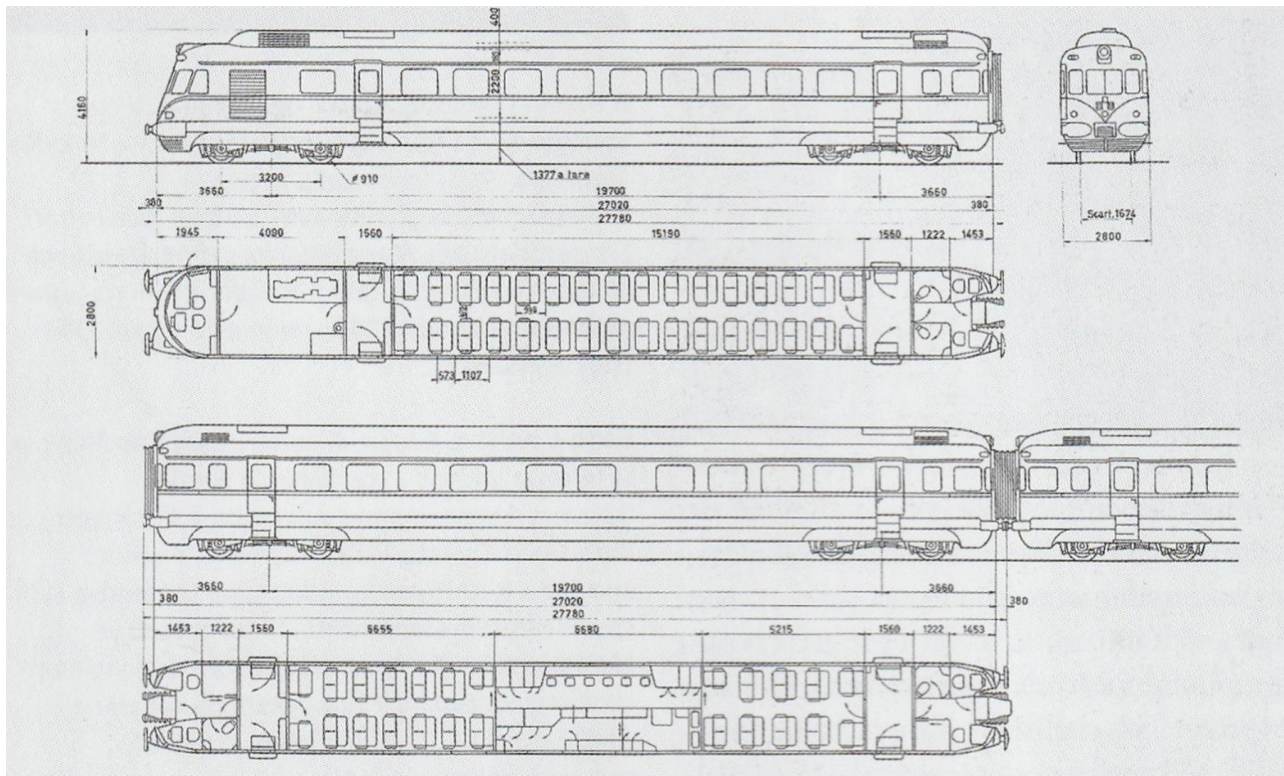
The service, in the main axis of the country, lasted until 1966, with the trains later being transferred to services in the South of the country, initially (1973) with exclusive 1st class and then, from the 80s onwards with 2nd class. [Fig.16] It would soon begin to serve only the Algarve axis, connecting Lisbon from Barreiro (after a river crossing) to Vila Real de Santo António. For this line, the combi would gain its third paint version, more flashy and substantially less elegant, but quite striking: white, with a red base and red stripes. The fronts received red signal bars, with the lettering "Sotavento" on the flanks. [Fig.17]

It is abandoned (still!) at Barreiro station, and is in the care of the National Railway Museum while it awaits funding from the European Union and crowd-funding for its necessary and, I would say, very urgent restoration, costing more than 1.5 million euros. Miniature models of this composition are scarce. But the Ibertren factory produced a CP version in silver in the H0 scale (1:87), and two others in RENFE colors (silver and blue). Versions of CP models in blue and in the Sotavento version are even rarer and are the result of artisanal transformations, which are now considerably expensive if they appear at model

Figgs. 11a-11b
Twin-cylinder engines, 505 h in FIAT, Materiale ferrotranviario, file 083/087. Detail

Fig. 12
Motor unite profile and plan, Cardan shaft: motor bogie in FIAT, Materiale ferrotranviario, file 083/087. Detail

Figgs-13a-13b
Transission gears in FIAT, Materiale ferrotranviario, file 083/087. Detail



14



15

Fig. 14
CP class 0500 / RENFE class 9501, overall profiles (FIAT, Materiale Ferrotranviario, catalogue)

Fig. 15
CP class 0500 / RENFE class 9501 (photo CP archives)

railway conventions. The adoption of Fiat railcars – or better yet, the “Foguete” – was a huge success, and although it only offered first-class seats, it was frequently used on Lisbon-Porto journeys, replacing steam locomotives, with a significant advantage, as the large Pacific steam engines could only reach Gaia, as their weight prevented them from crossing the D. Maria I Bridge with re-entry trains, which was not the case with diesel trains. [Figg.18a-18b] A notable political moment occurred in 1958 involving the Rocket. This is the apothecotic arrival of Gen. Humberto Delgado, an opponent of Salazar’s dictatorial regime, and a candidate in the presidential elections of that year, which were thought to be, for the first time, “free”, which did not happen...

The candidate’s acclaim in Porto, and then on his return to Lisbon, was a sign of the regime’s deterioration, even before the start of the so-called War in Africa. And the fact put the regime’s police on high alert. Now the journey between the two cities was made in the “Foguete”, which was in itself a symbol of the regime, and the fact was recorded in the media at the time, and in a recent and excellent documentary about, precisely, the Foguete train, by SIC television channel¹².

Humberto Delgado would be murdered in 1965 by the PIDE/DGS regime political police in a desert in Los Almerines near Olivença. The Humberto Delgado Foundation, in fact, organised a special train on the 40th anniversary of the event, on the 3d. of October 1998, connecting the S. Bento station in Porto to the Santa Apolónia station in Lisbon, to commemorate the event, for which CP provided a 5600 electric locomotive¹³ and eight Corail type carriages with dedicated liveries. [Fig.19a-19b]

This was not the only contribution of Fiat production to the national railway network. In fact, known as TER trains (Tren Español Rapido), (previously called TAR – Tren Automotor Rápido), from the company in neighboring Spain, the incumbent operator RENFE (class 597, former class 9000), circulated from 1967 until around 1989, connecting Madrid to Lisbon and back, with equal excellence of performance. It was a two-element composition, with a motor vehicle and a trailer, and could be used in a double composition of four vehicles with multiple control. [Fig.20] There were many differences between this design, which dates back to 1962 when RENFE first ordered it, and the previous TAF or CP’s “Foguete”. Lighter, with a horizontal engine under the floor, they nevertheless had a single traction bogie, in this case located at the rear of the motor vehicle, next to the trailer¹⁴. [Fig.21]

12 “História do foguete Portugal abandonado,” produced by Isabel Mendonça, directed by Pedro Mourinho, SIC, <https://www.youtube.com/watch?v=h7IXxTTIpuw>, Accessed March 2026.

13 Siemens Eurosprinter, first generation.

14 FIAT, *Materiale ferroviario*, file 155.



16

Fig. 16
CP 0500 “Sotavento” (archive photograph), final livery



17



18a



18b

Leaving from Santa Apolónia or from one of the main stations in Madrid (Atocha, Chamartin or Delicias), it travelled along the Cáceres branch line, entering the Alentejo border and passing through Abrantes towards Santa Apolónia. Flashy, relatively quiet for diesel machines, they delivered 800 hp and reached a speed of 120 km on the flat. The 1st class vehicle offered 56 seats and the 2nd class vehicle 72, with bar and restaurant service. The service, nor any other that replaced it and that took the place of the also extinct Lusitania Expresso, exists today. It should be noted that, surprisingly, Lisbon and Madrid are two of the only European capitals in the EU without any direct rail connection at the moment.

Once again, Fiat technology was chosen for these trains and, in Spain, its life was long and eventful and, although demoted to current regional services, it covered the entire Spanish network with dozens of units¹⁵. It should also be noted that many of these vehicles have been remodeled and modernized by RENFE, with the introduction of driver's cabins that comply with the recent safety

15 Orestes Santanera, *I treni Fiat: ottant'anni di contributo Fiat alla tecnica ferroviaria* (Cremona: Automobilia, 1997), 75–76.

Fig. 17
CP 0500 "Sotavento" in Barreiro
(Wikipedia Commons, 2020)

Figs. 18a-18b
Gen. Humberto Delgado
arriving in Porto, 1956; and
returning to Lisbon (Wikipedia
Commons)



19a



19b

standards imposed in the EU¹⁶. It is no coincidence that currently, the most modern element of CP's high-speed trains consists of the locally called Alfa Pendular, class 4000 (Portuguese version of the Fiat Pendolino ETR 460 with an upgrade from the 480 class), also manufactured by FIAT and a regular presence in "Linha do Norte" and today reaching Braga, to the North, and Faro to the South. Design pieces, some fifty years apart, but in both cases referencing the modernization of railways and long-distance passenger transport.

The development of tilting train technology had been tested since the 1930s, but it would only be enjoyed with some consistency during the 1970s, with several manufacturers looking for the best solutions for a tilting system. In fact, tilting offered the possibility of increasing operating speed without requiring expenditure on profiling and geometry of road layouts with sharper curves, being able to behave comfortably and better overcoming curves with a smaller radius, such as those that existed in Spain or Italy, for example.

It is no coincidence that these two countries were the ones to propose and market tilting train solutions. The TALGO patents with a natural tilt, i.e., with gravitational tilt of the boxes, while FIAT, in Italy, would develop what is called active or controlled tilt, in fact so that it could be used in electric traction trains depending on the pantograph-catenary binomial, with bogies registered and patented in 1967, however improved and largely perfected with on-board electronics and optical monitoring of the wheelset/box/track ratio, under the direction of Eng. Paolino Camposano. In reality, the process results from an hydraulic process included in each bogie, and from a weight distribution in which the center of gravity, in compliance with a gyroscope setting, is maintained for vertical alignment of the pantograph axis.

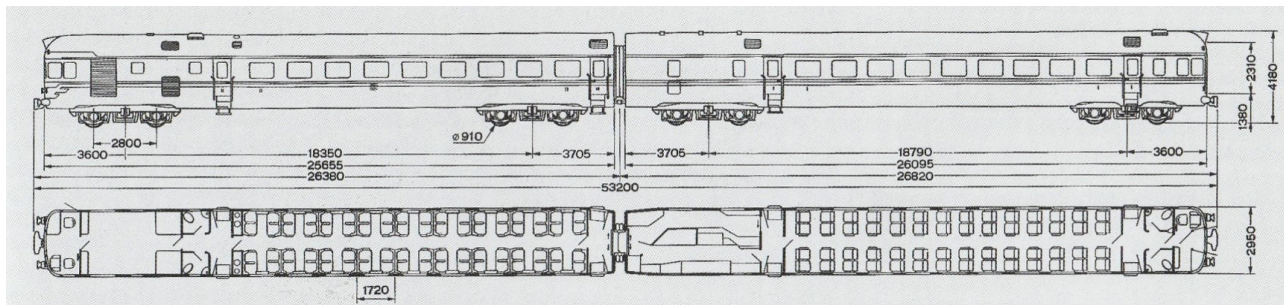
The intermediate research periods led to the first Italian pendulum trains from Fiat Ferroviaria, which soon attracted the interest of European operators (and those in North America and North Africa). A series of designs, almost always signed by the factory, initially gave rise to great classics that allowed to ensure, through experimentation, the reliability of the Italian pendulum system, with the famous ETR 401 (ETR = Elettro Trene Rapido) standing out, notably due to its unusual appearance. Adopted by the Italian FS and explored there, it would later be tested in other countries. [Fig. 22a-22b] But the next step would consecrate

Figs. 19a-19b
"Comboio da Liberdade", special train by CP, 1998 (photos by Jaime Amaro)

16 Santanera, *I treni Fiat: ottant'anni di contributo Fiat alla tecnica ferroviaria*, 75–76..



20



21

the system with the presentation of the ETR 450, which constituted the first pendulum train for current operation definitively adopted by the FS with great success. A railcar, of course, with electric drive and the same aggressive aerodynamic lines. With the ETR 450, the use of the pendulum system in Italy became a sensation, and the increased speed even provided an alternative to the high-speed category, when competition from the very fast TGV of French origin began. Fiat developed the pendulum train, and its name would come to explain its fundamental characteristic: "Pendolino"¹⁷.

The versions that follow correspond to a simple restyling, based on Giugiaro's initial design and offer an elegance that blends with lightness and speed. The same can be said of the first interior arrangements and respective design, with an approach to commercial aviation logistics in the organization of spaces and seats but with greater spaciousness and comfort. The standard will henceforth be the ETR 460¹⁸, known in Italy as "Freccia Bianca".

17 Santanera, *I treni Fiat: ottant'anni di contributo Fiat alla tecnica ferroviaria*, 187-219.

18 From ETR 460, derived the ETR 470 and the ETR 480. They are distinguished by detailed aspects related to the requirements of each operator, but it is in the core of the engine and the energy captured that the differences lead to these different classifications. Thus, while the ETR 460 is defined by the capture of 3 kV in DC (direct current), the 470 model is bi-current and can capture 3 kV DC or 15 kV in alternating current. The 480 version can operate at 3 kV DC or 25 kV AC. The British 390 class, the Slovenian 310 class, the Finnish Sm3 and the Spanish Alaris class are derived from the ETR 460 version. The Swiss version TABDe 500 is more advanced, with design by Pininfarina and was manufactured by a consortium of Adtranz, Schindler Waggon and Fiat-SIG. A new Pendolino 1000 is currently explored as lightweight fast train passenger service in Italy, known as Frecciarossa.

Fig. 20

RENFE class 597 (FIAT, Materiale Ferrotranviario, catalogue)

Fig. 21

RENFE class 597 (FIAT, Materiale Ferrotranviario, catalogue)



22a



22b

This platform will give rise to the Alfa Pendular, technically known as the CP 4000 class, with the number designating the power of the composition (4000 hp), provided by 12 asynchronous motors, with onboard components from ADTranz and Siemens. [Fig.23] CP's Alfa, is objectively, it is a version of the ETR 460, for 25 kV at 15 Hz, consisting of six vehicles, all with traction bogies with integrated motor and two pantographs on the end carriages, in perfect symmetry from a structural point of view. It has two classes, Tourist and Comfort, having been manufactured under license by the -unfortunately- extinct SOREFAME. [Figg.24-25]

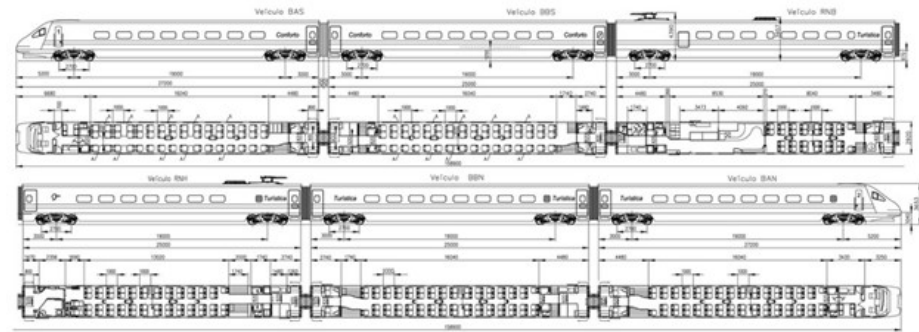
The first examples entered service in 1999 featuring white, red and blue chromatism, horizontal fins and a red front. In their second phase of use, in the so-called mid-life review, they were completely revised and reformulated, with new interiors and a more sober presentation color – metallic gray with numbering on each car. It has a maximum speed of 220 km, only reached on properly prepared stretches, but offering an average of 3h 27m on the Lisbon-Porto route. As you can see, it was only in the late 1990's that the record of the first FIAT portuguese train – the "Foguete" - was broken by a train by FIAT.

Figg. 22a-22b

FIAT, Laboratory train, type 7199 experimental highspeed and variable axis; ETRs 450 from FS (Santanera, 1997)



23



24



25

Bibliography

Castro, Francisco Almeida, and Augusto Cerveira. *Material e tracção: Os caminhos de ferro portugueses nos anos 1940–1970*. Lisbon: Caminhos de Ferro Portugueses, 2006.

Fiat. *Materiale ferroviario: Catalogo*. Turin: Fiat Ferroviaria, 1970.

Joel, António Augusto. *Attila Mendly de Vétyemy: Um artista húngaro na lezíria*. Benavente, Portugal: Museu de Benavente; Câmara Municipal de Benavente, 2023.

Martins, João Paulo, Madalena Brion, Miguel de Sousa, Maurício Levy, and Óscar Amorim. *O caminho de ferro revisitado: O caminho de ferro em Portugal de 1856 a 1996*. Lisbon: Caminhos de Ferro Portugueses, 1996.

Reis, Francisco Cardoso dos, Rosa Maria Gomes, Gilberto Gomes, et al. *Os caminhos de ferro portugueses 1856–2006*. Lisbon: Comboios de Portugal; Público - Comunicação Social, 2006.

Santanera, Orestes. *I treni Fiat: Ottant'anni di contributo Fiat alla tecnica ferroviaria*. Cremona: Automobilia, 1997.

Tavares, João, and Joaquim Esteves. *100 obras de arquitectura civil no século XX: Portugal*. 2nd ed. Lisbon: Ordem dos Engenheiros, 2000.

Viegas, Francisco José. *Comboios portugueses: Um guia sentimental*. Lisbon: Círculo de Editores, 1988.

Fig. 23
Alfa Pendular, 1st livery (photo
CP archives)
Fig. 24
CP class 4000 (CP archives,
technical layout)
Fig. 25
Alfa Pendular, "second life" new
livery (2012) New livery