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Passenger Rolling Stock of Indian Railways in the First Half-Century of Their Operation

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ABSTRACT In India, as in many countries, railways originated as industrial gauge tracks for the transportation of ore, timber, stone, and other building materials. These were the first industrial railways in India to deliver supplies to construction sites, in particular, Chintadripet in Madras (1835), Red Hill Railroad line (1837), Godavari Dam Construction Railway (1845), and others. Initially, the promoters of the construction of railways, based on the general social and economic situation in the country, did not count on the development of passenger traffic, taking into account the virtually impoverished situation of the vast majority of the population. Efforts were focused on freight transportation. The colonialists proceeded from the need to develop railways as an important exploitation tool for exporting the country's natural resources to the parent country and to the world market. Throughout almost the entire period of British colonial rule, passenger transportation was intended for a narrow stratum of colonizers and a few of the richest representatives of the country's indigenous population. By the 1860s, there was a system of dividing passenger traffic on the railways of India into four classes. Saloon coaches were used to serve the ruling elite. The difference in travel conditions in luxury saloon coaches and first-class compartment carriages in comparison with third- and fourth-class carriages was huge. It reflected the social class structure of Indian society. At the same time, railway passenger transportation did not affect the interests of the majority of the population at all, as with their level of wealth they could not afford to travel by rail at all, remaining outside the line of progress in transport of the 19th century.

KEYWORDS: history of Indian railways; origin of passenger transportation; types of passenger rolling stock; classes of passenger services

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Обзорная статья

Пассажирский подвижной состав железных дорог Индии в первые полвека их работы

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АННОТАЦИЯ В Индии, как и во многих странах, железные дороги зародились как промышленные колейные пути для перевозки руды, леса, камня, других строительных материалов. Именно такими были первые рельсовые промышленные дороги, обеспечивавшие строительные площадки, в частности, Chintadripet in Madras (1835), Red Hill Railroad line (1837), Godavari Dam Construction Railway (1845) и др.

Первоначально организаторы строительства железных дорог, исходя из общего социально-экономического положения в стране, не рассчитывали на развитие пассажирских перевозок, принимая во внимание фактически нищенское положение подавляющей части населения. Колонизаторы исходили из необходимости развития рельсовых дорог как важного инструмента эксплуатации колонии для вывоза в метрополию и на мировой рынок природных богатств Индии. Пассажирские перевозки на протяжении практически всего периода колониального владычества британцев ориентировались на узкий слой колонизаторов и немногочисленных богатейших представителей коренного населения страны.

К 1860-м годам сложилась система разделения пассажирских перевозок на железных дорогах Индии на четыре класса. Для обслуживания верхушки правящей элиты использовались вагоны-салоны. Разница условий проезда в роскошных вагонах-салонах и купейных вагонах первого класса в сравнении с вагонами III, IV классов была огромной и отражала социально-классовую структуру индийского общества. Железнодорожные пассажирские перевозки не затрагивали интересы бóльшей части населения, которая по уровню своего достатка не могла позволить себе поездки по железным дорогам, оставаясь за чертой достижений прогресса на транспорте XIX столетия.

КЛЮЧЕВЫЕ СЛОВА: история индийских железных дорог; происхождение пассажирских перевозок; типы пассажирского подвижного состава; классы пассажирских перевозок

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THE BEGINNING OF PASSENGER TRANSPORTATION ON THE INDIAN RAILWAYS

India's transportation communications were underdeveloped before the construction of railways. The few and poorly maintained overland roads could not be used during the monsoon period[1]. Waterways were limited to the sea coast and the Indus and Ganges River systems, important trade arteries connecting the north of the country to the western and eastern sea coasts, respectively.

The Indian railways were established as colonial railways, conceived as a project designed primarily to meet the needs of Anglo-Indian ties. Colonial character colors the entire history of Indian railways until almost the middle of the 20th century [1].

The founders of the first railways, the merchants of London and Manchester, intended to use rail transportation to reduce transportation costs and facilitate British traders' access to Indian raw cotton [2]. The Metropolis saw railways as a means of transporting British troops and supplying them with supplies.

Initially, the traction of trains on India's small railways was done by animals. The first steam locomotive began operation in 1837 on the Red Hill Railway which was built by Arthur Cotton to haul granite in the area near Madras for the construction of the Red Hill Bridge.

April 16, 1853, when the first public railway was inaugurated, is considered to be the birthday of rail transport in India. A train of 14 coaches, which accommodated about 400 passengers, travelled 33.8 km along the railway between Bori Bunder (Bombay, now Mumbai) and Thane [3, 4]. This was the first section of the future Great Indian Peninsula Railway (GIPR) built with a gauge of 5 feet 6 inches (1,676 mm), which became standard for most of the country's railway network.

Almost throughout the 19th century, rolling stock for the Indian railways was manufactured in Britain and delivered to India by sea. The colonial authorities protected the interests of British industrialists and prevented the admission of equipment from other countries to the Indian railway market: "Imperial preference excluded most other suppliers" [5].

Naturally, the rolling stock of the Indian railways repeated the design of steam locomotives and cars used on the UK railways. The exclusive focus of this study is on the development of passenger car fleet. At the same time, the authors understand the importance of the topic of the development of the design of locomotives and freight wagons, realising that this requires a detailed review.

Initially, the UK, which was the undisputed trendsetter in this field of engineering in the first decades of the existence of railways in the world, built two-axle passenger cars on wooden frames with wooden bodies. The creators of the first passenger cars proceeded from two design lines. The first one continued the technical idea realised in closed carriages of horse stagecoaches. In fact, the first passenger railway cars were these carriages placed on a railway track.

The second line is the construction of open platforms for transportation of goods that were horse-drawn and were used on dirt roads. With the development of railway tracks, they were put on railway wheels. When organizing passenger services, seats

[1] Monsoon or rainy season is from June to September when humid south-westerly air masses arrive over much of the country; during the south-west monsoon season most parts of the country receive up to 80 % of the annual rainfall.

Fig. 1. India's first passenger coaches. Train pulled by oxen. The middle of the 19th century [6]

Fig. 3. Enclosed coach with two separate compartments with doors opening outwards. Bodmin & Wadebridge Railway – Cornwall's first steam railway. 1834. One of the three surviving coaches from England's first railways. The National Railway Museum, York. Photo: Hugh Llewelyn [8]

Fig. 2. Passenger rolling stock of the first railways. Liverpool and Manchester Railway coaches — the first class. England. 1830. The National Railway Museum. York, England. The coach has three isolated compartments with individual doors that open outwards. The exterior colouring of the car emphasises the continuity with the design of a stagecoach body: the impression is that three carriages are placed on the carriage frame [7]

Fig. 4. Bodmin & Wadebridge Railway third-class open carriage. Cornwall's first steam railway, 1834. One of the three earliest surviving coaches of England's first railways. The National Railway Museum, York. Photo: Hugh Llewelyn. [8]. Figure 6 shows coaches of this type of the Liverpool and Manchester Railway

(wooden benches) were installed on these platforms, which were actually intended for freight, to turn them into passenger coaches. Often, they were not equipped with a roof, but only had a light canvas cover, or did without it.

The two constructional types of passenger cars considered were used on all first railways of the world: in the USA (Baltimore & Ohio, 1830; South Carolina Railroad, 1831), in France (St. Etienne, 1831), on the Belgian railway (1835), the German railway (1835), in Austria (1837), and in Russia on the Tsarskoselskaya railway (1837) [4].

Very few full-scale samples or images of the first passenger coaches of the Indian railways have survived (*Fig. 1*). The authors used British models to illustrate the design solutions, especially since most of the rolling stock of India in the 19th century was produced in Metropolis. Some examples are taken from the history of passenger rolling stock of other countries (*Fig. 1–4*).

In most of Europe, in the United States, Australia, etc., the predecessors of regular passenger transport by rail were horse-drawn stagecoaches[2] — closed carriages pulled by three, four, or sometimes up to six horses,

[2] In Great Britain, regular carriage transport for a fixed fee, which later turned into stagecoaches, began in the 17th century. By the end of 1797, there was a developed system of 42 stagecoach routes in Great Britain [11]. In the early 19th century, numerous stagecoach routes operated on a regular basis in France, a number of German states, Russia, the USA, Australia, and many other countries.

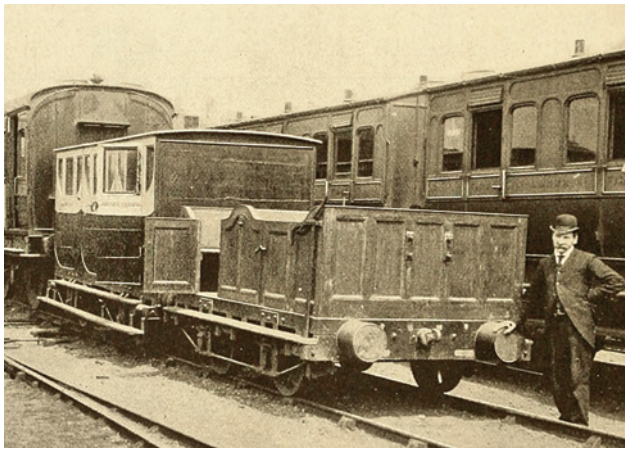

Fig. 5. A photograph dated 1896 (a fragment) and signed "The oldest rolling stock in England from the Bodmin & Wadebridge Branch, London & South Western Railway, in use for fifty years", may show the same or similar carriages to those in the National Railway Museum (Fig. 2 and 4) [8]. Possibly, this shows the same or similar carriages as those in the National Railway Museum (Fig. 3, 4)

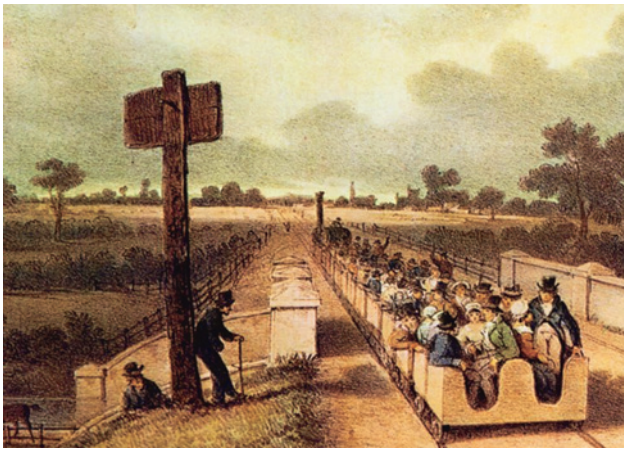

Fig. 6. Third-class open carriages on the Liverpool & Manchester Railway. "View of the Liverpool & Manchester Railroad" (crosses Bridgewater's canal).
Print. lithograph. Fragment. (Clayton).
Science Museum Group Collection.
The Board of Trustees of the Science Museum [9]

which travelled along designated routes and according to an announced schedule.

The authors failed to find in the available sources any description to conclude that any carriages similar to stagecoaches (European, American, Australian, etc.) that would operate on the principles of European stagecoaches traveling between stage stations with the change of horses, were in use in India on a regular basis for passenger transportation. On the Internet, the authors found several photos taken in India by English photographers, probably at the end of the 19th century, which show open carriages resembling stagecoaches with camels harnessed to them[3].

In European countries, the United States, and Australia, stagecoach travel was available to everyone for a set fee. Depending on the class of transportation, carriages had seats for four or six passengers inside. In stagecoaches, in addition to seats inside the body, passengers could sit on the roof of the carriage[4] where the fare was cheaper (*Fig. 8*)[5].

The first railways also attempted to transport passengers in seats placed on the roofs of carriages. However, unlike stagecoaches, on which travelling on the

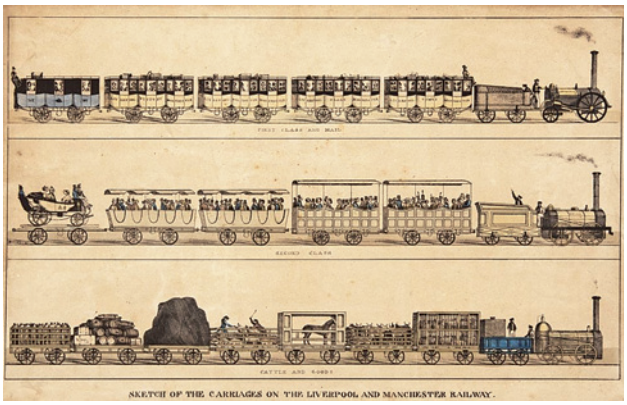

Fig. 7. Lithograph titled "Sketch of carriages on the Liverpool & Manchester Railway" and subtitled "First Class and Mail", "Second Class" and "Cattle and Goods", by W. Crane, Chester, c. 1830.
Let's pay attention to the fact that the middle picture shows an open platform included in the train, on which a crew with passengers is installed. This type of travel was available to wealthy people who travelled by train in their own carriage without horses, which were hired at the terminal station [10]

[3] Photos are available at: https://www.dreamstime.com/vintage-photo-twin-camel-stagecoach-jaipur-state-rajasthan-india-asia-vintage-photo-twin-camel-stagecoach-jaipur-image238579899 and https://www.bridgemanimages.com/en-US/english-photographer/camel-carriage-india-b-w-photo/black-and-white-photograph/asset/877775

[4] In France, and then in other countries, these relatively cheap seats, compared to those inside the carriage, received the joking name "imperial" (French: Impérial) as "elevated above all, located in the carriage above all". In Russia, imperial was a place on the roof of a stagecoach or horse-drawn tram carriage. According to modern English-Russian dictionaries the word "imperial" is defined, as its first meaning, as seats on the roof, seats on the first floor of a stagecoach, omnibus, bus of a railway carriage.

[5] According to numerous published materials, in particular engravings, drawings and photographs, postal stagecoach carriages often carried up to 8–10 passengers on their roofs.

Fig. 8. James Pollard (1792–1867) Coaching: Stage Coach & Opposition Coach in Sigh. Aquatint, hand-coloured. 1819. The Yale Centre for British Art. The drawing shows that in addition to the coachman, the top of the stagecoach, including the roof, accommodated nine passengers[6]

Fig. 9. A preserved historic double-decker double-axle carriage with the imperial of the French railways. The ground floor of the carriage has four eight-seat compartments occupying the full width of the carriage body, each with individual exterior doors. The 36-seat imperial (first floor) is an open compartment (without side walls) with wooden benches[7]

Fig. 10. Bombay, Baroda and Central India Railway's third-class double-axle double-decker open carriage. (Image: Getty Images) 1860s. A section of the carriage clearly shows that the first floor, where the stairs led to, has a low ceiling, which allowed passengers to bend down to pass or sit on the benches [12]

roof was a common, widespread and, one could even say, mass phenomenon, the idea of passengers travelling on seats located on the roofs of railway carriages was not particularly widespread, with the exception of France. Steam locomotives spewed smoke and sparks, which made the passengers' stay on unprotected roofs not very pleasant and even dangerous[8].

Nevertheless, in France, double-decker carriages, rather than just roof seats, became quite common. Until the 1870s, more than 200 such carriages were in use.

Open double-decker wooden third-class coaches with a roof and unglazed windows, which were common on the first railways in India, were used by the poorest passengers (*Fig. 10*).

DEVELOPMENT OF PASSENGER CARRIAGE DESIGN WITH ISOLATED COMPARTMENTS AND SEPARATE EXTERNAL DOORS

At the initial stage of railway development in most countries, and until the end of the 20th century in India, carriages commonly had isolated compartments, which were not connected to each other: there was no passage along the carriage. The first carriages built on the example of stagecoaches usually had three or four sections (compartments) with seats across the body that were designed for three or four people, depending on the class of the carriage. In the first-class carriages, there were upholstered armchairs, the second class offered hard wooden armchairs, and the third–class coaches had wooden benches. No passage (corridor) along the carriage was arranged, with each compartment having its own individual external doors for boarding and alighting of passengers, which made it possible for a passenger to go out to a platform during a train stopover at a station or to an "open field" during the journey (*Fig. 2, 11–13*). Let us place a special focus on such carriages, as they were popular with passengers in India until the end of the 20th century.

The operation of compartment coaches with outside doors for each compartment posed a number of problems for both operators and passengers. These problems eventually led to a decline in the number of such carriages on most of the world's railways in the late 19th century. India was among the last countries to abandon them — here they were in use and popular with passengers until the late 1990s. Let us consider

[6] Yale Center for British Art. URL: https://upload.wikimedia.org/wikipedia/commons/d/d7/James_Pollard_-_Coaching%2C_Stage_Coach_%5E_Opposition_Coach_in_Sight_-_B1985.36.834_-_Yale_Center_for_British_Art.jpg
[7] URL: https://en.wikipedia.org/wiki/Bilevel_rail_car#/media/File:France_Paris_Champs_Elysees_Wagon_a_imperiale.JPG
[8] The early railways attempted to carry passengers' luggage on the roofs of carriages, but fire precautions had to be observed. The burning of luggage from locomotive sparks on the roofs of the first railway carriages in the UK was not uncommon, so guards were placed on the roofs to prevent fires. Figure 2 shows the roof railings for luggage and the guard's position.

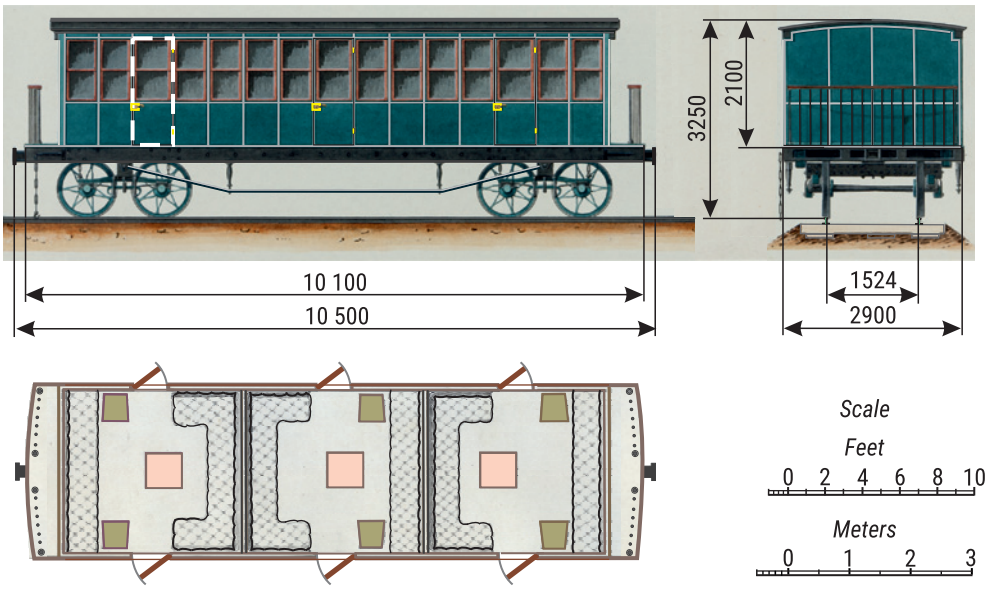

Fig. 11. Small first-class coach with separate compartments with doors for each compartment opening outwards. The St. Petersburg – Moscow Railway. 1851. For clarity, the figure outlines the outer door of the left compartment with a dotted line [13]

Fig. 12. First-class compartment (separated from other compartments in the coach) with its own external doors. The historic Bluebell Railway. The Bluebell Railway is a heritage line. UK. The authors have already noted the lack of handles on the inside of the doors to open the door lock. In order to open the door, a passenger had to turn the handle on the outside of the door by sticking his hand out through the open window[9]

Fig. 13. First/second class mixed metre-gauge coach of the Indian Railways with separate compartments, without a passage (corridor) along the coach body, with each compartment having its own external door. First class compartments — the two outermost doors on the right are labelled "A" and "B" (the letters are shown below the Roman numerals indicating the compartment class). The Nilgiri Mountain Railway is recognised by UNESCO as a world cultural heritage site. The coach has a route plate with the name of the city to which the train is travelling: Mettupalaiyam (in the Coimbatore district of the Indian state of Tamil Nadu). The coach was built in the 1960s. The historic railway is operated for excursion and tourist activities[10]

the disadvantages of such coaches and then turn to the peculiarities of their perception by affluent Indian passengers, many of whom believed that these coaches had significant advantages.

Firstly, in such carriages, the compartments were completely segregated while the train was in motion. It was virtually impossible for either train staff or passengers to walk along the carriage or the train. This made it difficult to serve passengers and protect them while travelling. This design delayed the start of equipping trains with toilets for decades, as it was necessary to place a toilet in each compartment. Although some sources say that it was possible to get from one compartment to another or from one carriage to another

[9] Radlinski, Bob. Photo. 2015. URL: https://www.flickr.com/photos/httpwwwflickrcomphotosbobrad/21908250260
[10] Nilgiri Mountain Railway. Typical rolling stock at Mettupalaiyam. URL: https://www.flickr.com/photos/megaanorak/34004624278; The Nilgiri Mountain Railway. URL: https://www.tamilnadutourism.tn.gov.in/destinations/the-nilgiri-mountain-railway

using the outer step, while holding on (or rather clinging) to the handrails, but it is hardly believable (see *Fig. 9*, *13*).

On the first railways with a short length of routes and frequent stops this disadvantage, apparently, did not bring inconvenience to passengers and service personnel.

A serious problem of carriages with separate compartments was to ensure safety of passengers during the train journey. It is known that stagecoach passengers were often attacked by robbers up to the 19th century [11]. This began to happen to passengers of the first trains, not only in the Wild West of the North American United States, but also in relatively peaceful countries of Europe. Travellers in compartment coaches were ideal targets and easy prey for robbers. There is a lot of historical evidence of how robbers riding horses would catch up with a train, open a compartment door, jump inside the coach, rob the passengers and disappear [14, 15].

By the middle of the 19th century many signalling systems were proposed to signal the train crew not only in case of a threat to the train operation or technical malfunction, but also about an attack of bandits. Various mechanical systems were proposed, including red flags that would unfold when a guard or a passenger pulled a cord to signal the train crew (or signal lights facing the locomotive that would light up red in the night time), electric bells installed in the locomotive cabin that were activated by buttons placed in compartments of carriages, and so on. All these devices were very unreliable and often failed.

The most effective device was the so-called "signal rope", which was stretched along the whole train from the last coach to the locomotive where it was attached to the handle of the locomotive horn. The rope was supported on the walls of the carriages by special rings and any train attendant, guard or passenger could pull it by sticking their hand out of the window. Pulling the rope would turn the handle of the locomotive steam whistle which signaled the Locomotive driver. These signalling devices appeared in England in the 1830s and were used on many railways around the world in the first decades of the 20th century [16]. However, it happened that bandits, having caught up with the train, would cut the signalling rope in the first place...

Another problem for countries with long cold weather seasons (many European countries, northern areas of the USA, and Canada) was that in the autumn-winter period passenger compartments with doors opening directly outside (no vestibules, entrance platforms, corridors, etc.) were very cold[11].

Clearly, for much of India, the problem of carriage heating was not only irrelevant, but it was opposite as railway passengers suffered from heat. Throughout the existence of passenger railway transport in India and other countries with similar climates, these issues were key to improving train travel conditions.

Just like horse-drawn stagecoaches, the first English and later Indian coaches had doors that opened outwards. This was not essential from the point of view of maintaining a proper air temperature inside the carriage, but from the point of view of passenger safety it required attention. Passengers could inadvertently open the carriage door while moving. To avoid this, in English and later Indian carriages the catch handle that opened the outer door was usually installed only on the outside of the carriage, so as not to accidentally open the door on the move (*Fig. 14*).

In spite of all the above-mentioned disadvantages, the design of a carriage with totally separate compartments and doors opening outwards became widespread on the Indian railways in first- and second-class coaches. These coaches continued to be used in India almost until the end of the 20th century. By that time, most countries of the world had almost completely switched to the use of coaches with longitudinal inner corridors and end entrance platforms (vestibules). In India, until 1908, the outer doors of all passenger coaches opened outwards, which was very dangerous for passengers [17].

The advantage of compartment coaches with external doors for each compartment and without a longitudinal corridor is that it is possible to use the whole width of the coach body for the arrangement of spacious compartments. The corridor inevitably "eats up" 60 to 80 cm of the coach body width.

Historians of the Indian railways note another important factor. For first- and second-class passengers who, as a rule, were very rich people, it was of great importance that with such a compartment arrangement they were completely isolated from the other passengers in their carriage, and more importantly, from the others on the train. Privacy was important for high-ranking passengers[12].

[11] Initially, pseudo-heating of passenger coaches was provided by placing heaters in the form of metal boxes with heated bricks under the feet of passengers in first- and second-class coaches (often at an extra charge). The bricks were replaced at stations as they cooled down. In the 1850s–1870s, stove heating began to be installed in first- and second-class coaches on the railways of Europe, including Russia, as well as in the USA, followed by steam heating with steam supply from locomotives or special steam carriages with boilers.

[12] URL: http://dipakrc.blogspot.com/2015/08/classes-of-accommodation-in-indian_16.html

Fig. 14. Preserved third-class standard gauge carriages with compartments occupying the width of the carriage body on the historic Isle of Wight Steam Railway, UK. The individual outside doors of each compartment open outwards. The photo clearly shows that the side of the door facing the inside of the carriage (the right photo, an enlarged detail of the door) does not have a handle to open the door lock (2), it is only available on the outside (1), which is clearly visible in the left photo. On the right photo: 3 — a traditional for British carriages strap for lifting the movable glass of the door window; 4 — the movable glass of the carriage door window [18]. To open the door the passenger had to stick his hand out of the window and turn the handle of the door lock from the outside to open it

Fig. 15. India Railways — Great Indian Peninsula Railway - GIPR First Class passenger coach with separate compartments and individual entrance doors (no corridor). The door on the far right is probably for a single compartment; the door on the far left labelled "Servants" leads to a service room; the door on the right is probably to the largest compartment designed for several passengers. On the photo you can see that the upper part of the carriage is covered with wooden boards, the so-called "planking". There was a gap between the planking and the wall which was blown with air to reduce heating of the upper part of the coach by sun rays. The end of the 19th century[13]

Looking ahead, the last, very worn-out broad-gauge first-class coaches with separate compartments (no corridors) and individual external doors built in the 1940s–1950s were withdrawn from service on the Indian Railways in the early 2000s. They did not have air-conditioning but were more attractive to wealthy passengers than the newer-built first-class coaches with air-conditioning systems where compartments opened to a common longitudinal corridor of the coach, which could not provide privacy for the journey [5].

[13] Historical Railway Images. URL: https://www.flickr.com/photos/124446949@N06/48030146788/in/photostream

THE MELTING LUXURY OF ICE... THE FIRST AIR CONDITIONING DEVICES FOR RAILWAY COACHES

Among the various factors determining the comfort of travelling in railway carriages, one of the most important is the air temperature. While in a large part of the countries, the efforts of builders of railway passenger coaches were directed towards solving the issues of heating the rolling stock for most of the year, India faced the exact opposite task.

When the British swaggered into India in the 18th century, they were paralyzed by the sun-charred summers of the country they had colonized.

In letters to their homeland, they wrote that many longed to escape to the mountains for the summer. Others, lost in the bustling cities, indulged in sentimental whining. *Plain Tales of the Raj*, for example, records the grumbling of a certain gentleman named Reginald Savory, "The wind drops, the sun gets sharper, the shadows go black and you know you're in for five months of utter physical discomfort" [19].

The British found various coping mechanisms to tame the season's cauterizing heat. They slept sashed and scarved in water-drenched garments. The wealthiest with power and influence had their servants slosh ice from northern India's rivers and then drew it to the plains at tremendous expense. They hired *abdars*[14] to cool water, wine, and ale with saltpetre. They hung wet tatties (mats) made of cooling khus (a type of grass) on their windows and doors. Ice pits were built and small pots of water placed outside on wintry nights. In the morning, the coating of ice that formed was sliced away and stored in the pits, but this ice was usually too gritty and slushy to be consumed [19].

Only an understanding of this discomfort of the Indian heat for the British colonisers makes it possible to determine the root causes of the newcomers' attempts to arrange artificial cooling of their dwellings and then of train coaches. Travelling around the country to deal with various military, political, organisational, administrative, commercial and other issues was an important part of the service of British colonial officials, military officers, and businessmen. Travelling in trains made the hardships of unbearable Indian summers and sultry monsoons manifest with all their acuteness. The owners and management of the first railway companies began to take various measures to improve ventilation of saloon coaches, first- and, in some cases, second-class carriages. They even made the first attempts to provide primitive cooling of passenger compartments and saloons. Of course, it was not about third- and fourth-class coaches.

In the 1870s (and according to some sources even earlier), experiments of equipping passenger coaches with air cooling devices began. Air cooling is a key issue of comfort in trains in countries with hot climate. The presence or absence of air-conditioning systems in passenger coaches in the Indian railways at present serves, figuratively speaking, as the main divide between two large groups of service classes: the first group is air-conditioned coaches denoted as "AC" (air conditioning[15]) in the class list and in the travel documents and the second group is coaches without these installations.

The first devices for cooling, humidification and dust cleaning in coaches, the so-called Saunders system, which was actually the first air conditioners[16], began to be installed in first-class coaches on the Great Indian Peninsula Railway in 1872 [20].

The operation of the system is based on the method known since ancient times in Persia, China, and India, which was used to cool the air in dwellings. It uses the technology which is known today as evaporative cooling technology[17]. Wealthy homes in India also used another method[18], which is realised in Saunders' de-

[14] Abdar is a table servant in wealthy Indian families and to British military and colonial officers, who was hired to cool down drinks

[15] The use of the abbreviation "AC" for air conditioning units in English texts leads to an amusing situation where its meaning in translations into other languages is distorted, because in English the abbreviation "AC" is most often understood as "alternating current". As a result, translations often translate the original text "AC railway carriage" (a railway carriage with air conditioning) as "alternating current railway carriage".

[16] Saunders. It can be assumed that this is the surname of the inventor of the system, but the authors have not been able to find reliable information on that.

[17] It is successfully applied in dry and hot climates and is based on the effect of air cooling by water evaporation. For this purpose, shallow cellars (wells) were built under houses, in which they placed many porous ceramic vessels filled with water which formed a water film on the outer walls of the vessels. The cellar was connected by an air duct to the dwelling, from which a high ventilation pipe removed warm air by natural draught. This caused rarefaction in the room, as a result of which the air from the cellar was sucked into the room, and the dry and hot outside air was sucked in. It evaporated moisture from the surface of the vessels, as a result of which it cooled and moistened before it entered the dwelling.

[18] The idea is that the air from outside the building, which has a naturally high temperature, is channelled into the interior, while being forced (blown by draught, primitive fans or punkahs) through an artificial curtain of tattis (mats) called "khus khus". They are woven from the roots and stems of several common plants, notably Saccharum Munja, Bambus nana, Vetiveria Zizanioides, and Setariapumila. Sources note that in khus khus mats, these plants can be used both all together and in various combinations.

vices, which were used to equip first- and sometimes second-class coaches. A wide air duct was laid along the coach body, with funnels extending to the end walls installed at each of its opposite ends. During the journey, the inlet socket of the air duct on the end wall of the coach directed in the direction of movement was opened, and the one at the opposite end was closed. The air was forced by the pressure of the moving train into the duct and distributed to compartments, passing through water-wetted khus khus mats. The Saunders' system also included ventilation baffles on the roof of the carriage, which, when the train was in motion, created a draft and sucked air from the interior. The resulting rarefaction increased the supply of air to them via khus khus mats [5].

In addition to these relatively complex systems, primitive devices using ice were used to cool the air in first- and, rarely, second-class coaches on the Indian railways[19] almost from the first years of their existence. For the purposes of ice delivery, distribution and sale, railway companies created administrative, transport and logistics structures that usually used the facilities of ice trading companies opened in India in the late 1830s.

Let us recall that attempts to deliver ice, which was a "melting luxury" in the hot tropical environment of India, as the Russian researcher S.E. Sidorova aptly put it [21], from the Himalayas to palaces of the nobility were made since the 17th century. It required colossal expenses and was a rare phenomenon. The late 18th and early 19th centuries, largely under the influence of the needs of English colonisers, who suffered immensely from the dry hot climate [19], saw the active development of "cooling technologies" of abdars using saltpeter[20] and sulphuric acid that were known from antiquity and passed from generation to generation, and also the art of making ice (art is the word, as it is difficult to call it otherwise) in porous clay vessels which were placed in the hollows of the soil in the morning hours. Thin plates of ice that formed on the surface of the vessels were called hooghly ice[21].

The real "ice revolution" in India, as well as in a number of other countries with hot climates, was brought about in the 1830s by Frederic Tudor (1783–1864), a Boston businessman who made ice an expensive but basically affordable commodity for the wealthy classes of colonisers and rich Indians.

Fig. 16. Harvesting morning hooghly ice in ice pits at Allahabad. Fanny Parks. Wanderings of a Pilgrim in Search of the Picturesque (1850)[22]

On 6 September 1833, the sailing ship *Tuscany* docked in the port of Calcutta and its arrival created a furore and became news that overshadowed other events for a while... On board was a cargo that aroused admiration, surprise, and delight in the British colonists watching it unloaded. And for many Indians, who had never seen snow or ice before, this spectacle created amazement, incomprehension, and even fear and awe. They came into contact with (literally "touched") something supernatural.

Blocks of transparent ice were unloaded from the holds of the *Tuscany*. More than three months ago, on May 12 of the same year 1833, the ship set sail from Boston, USA, with 180 tonnes of ice on board, which was harvested in winter on the lakes of Massachusetts and stored in icehouses. On the ship *Tuscany* the ice was loaded into storage tanks in the form of huge boxes with double wooden walls and double bottom. The space between the walls was filled with insulating material — crumbs from cork oak processing waste, sawdust, etc. On the way from Boston to Calcutta, about 80 tonnes of ice turned into water, which was pumped overboard with pumps, but about 100 tonnes reached their destination[23].

[19] As well as in other regions with hot climates, including a number of US states.
[20] Ammonium nitrate is a common fertiliser with a low price which is mixed with water in the mass proportion of water and nitrate of 60 % to 40 %. When dissolved in water, nitrate absorbs a large amount of heat. While table salt when dissolved lowers the temperature by 3 degrees, the same amount of saltpeter will lower the temperature by 23 degrees.
[21] Named after the locality of Hugli-Chuchura or Hooghly-Chinsurah in the state of West Bengal, where this production was first created.
[22] American Ice in British India: the art of keeping cool! *By The Heritage Lab*. 2022. URL: https://www.theheritagelab.in/icebritish-india-art/
[23] The first unloading of ice was indeed a sensational event. Many Indian loaders, as well as curious onlookers, got "burns" trying to hold shards of the never-seen-before substance in their hands. Funny things happened — several rich people who had bought ice demanded their money back when it melted.

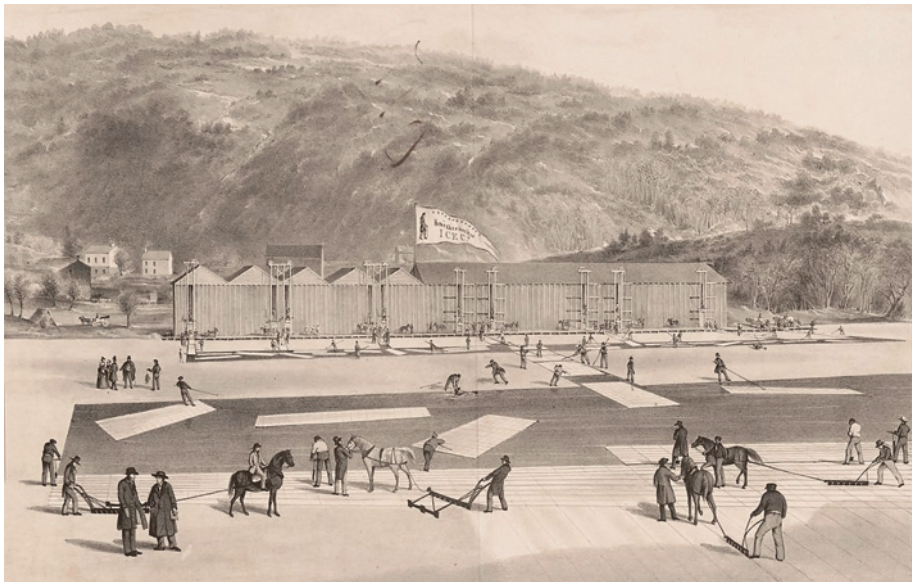

Fig. 17. Ice harvesting at Rockland Lake, NY, USA. Around 1846. The Library of Congress/LC-DIG-PGA-06287[24]

This voyage of the *Tuscany* marked the beginning of the successful supply of ice harvested in winter on New England lakes near Boston to India which continued until almost the 1890s. In his system of harvesting, storing, selling, and shipping ice Tudor materialized an idea that was initially derided by many. The ice trade earned him an enormous fortune and the title "Ice King"[25] [22, 23].

At that time, India exported more goods to the US than it imported. As a result, ships were sent to the US fully loaded and returned, as a rule, half-empty. This virtually worthless carrying capacity utilised by Frederic Tudor made it possible to minimize the cost of shipping ice from the US to India. Tudor built large icehouses in Calcutta, Mumbai (Bombay), and Chennai (Madras) where he stored ice delivered from Massachusetts.

The simplest way to cool the air in a coach was to place an open galvanised metal box with pieces of ice weighing about 50 kg in total in a compartment, which, with the doors and windows tightly shut, reduced the indoor air temperature. Passengers in first- and second-class coaches could pay for and pre-order ice to be delivered to their compartment by the arrival of the train at most major stations in India.

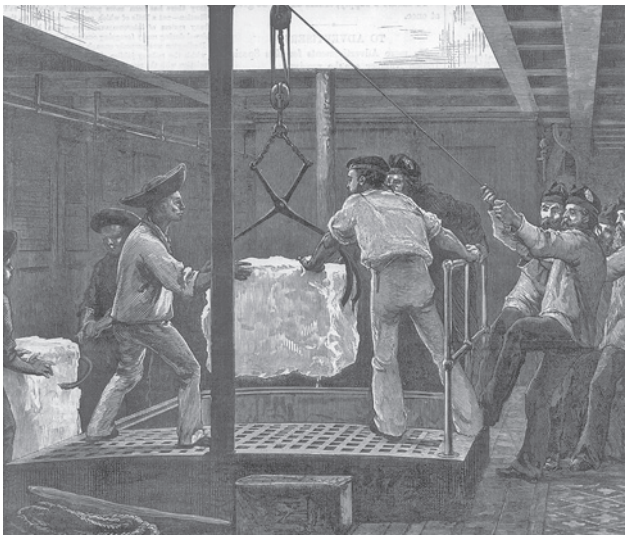

Fig. 18. Sailors unload ice from the ship. Around 1875[26]

In the mid-1880s, electric fans began to be used in homes in advanced countries. At the turn of the 1890s and 1900s, with the spread of electric lighting in trains electric fans appeared in the compartments of Indian coaches. The air jet from a fan was directed at ice boxes

[24] How ice shipped all the way from America became a luxury item in colonial India. URL: https://scroll.in/article/720912/how-ice-shipped-all-the-way-from-america-became-a-luxury-item-in-colonial-india

[25] Frederic Tudor began his research in the first decades of the 19th century by attracting talented inventors to his business. He created a system for harvesting and storing pure fresh lake ice using special tools and the then best heat-insulating materials and built huge icehouses for storing its reserves. By the 1840s, Tudor had created, figuratively speaking, an ice empire that supplied ice to many countries of North and South America, South-East Asia, and Australia. Tudor delivered the purest ice even to England, where by that time the industrial revolution with its thousands of steam engines and steam locomotives had already destroyed the virgin purity of natural ice of rivers and lakes.

[26] The British Couldn't Take India's Heat, So They Imported Ice From New England. URL: https://www.atlasobscura.com/articles/how-did-people-get-ice

Fig. 19. Landing Ice at Bombay. Engraving Published in the Graphic, Nov. 1880[27]

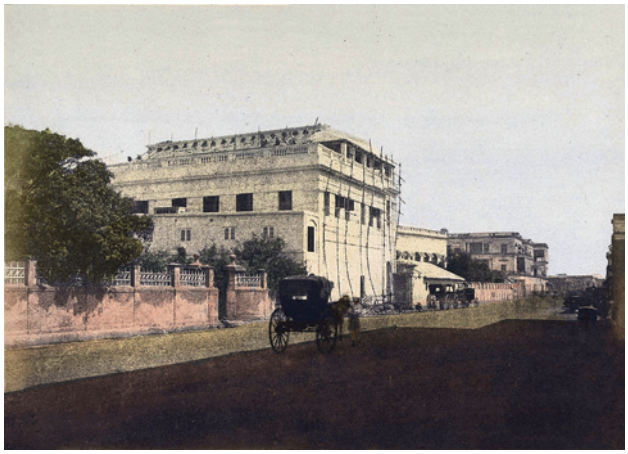

Fig. 20. The Calcutta icehouse built by Frederic Tudor. Hand-coloured print of the Calcutta icehouse from the Fiebig Collection: Views of Calcutta and Surrounding Districts, taken by Frederick Fiebig in 1851[27]

to accelerate the circulation of cooled air. This method was used as late as the late 1950s. In those years, ordering artificial ice for carriages was cheaper than travelling in carriages equipped with air conditioning systems which had appeared by that time. The fare for these coaches was about twice as high as in ordinary carriages [5].

During the first half a century of its existence, the Indian railways became an efficient transport system forming the basis of the economic life of the colonial country which was aimed at draining the colony of its wealth in every possible way for the benefit of the mother country and robbing the indigenous population. By the 1860s, the Indian railways operated 77 steam locomotives, 228 passenger coaches, and 849 freight cars. All of them were delivered from Great Britain by sailing ships along the route around the Cape of Good Hope [1]. At the end of 1864, the length of Indian railways (in total, including railways of different gauges) was 4,739 km [24].

CONCLUSION

During the first half-century of the existence of railways in India, an efficient system was established for providing comfortable travel for colonial officials, local government officials, British servicemen and wealthy Indian businessmen. By the beginning of the last decade of the 19th century the level of service in first- and second-class carriages on railways in India became quite comparable with the comfort of travelling on the railways in its parent country and other leading countries, and the first air cooling systems began to be used in passenger carriages.

As the volume of railway passenger traffic increased and broader masses of the Indian population, most of whom were in poverty, got access to it, the gap between the conditions of travel in palaces on wheels — saloon coaches and first- and second-class carriages, on the one hand, and third-class and even more so fourth-class carriages, on the other, widened. The latter, according to contemporaries, actually differed little from cattle wagons.

By the end of the first fifty years of Indian railways, these ugly cattle wagons used for carrying people were almost universally withdrawn from service. But as passenger traffic from the poorest sections of the population increased manifold by that time, third-class coaches became so crowded that they soon surpassed the abolished fourth-class coaches in terms of the lack of comfort, unsanitary conditions, and safety for passengers.

At the turn of the 19th and 20th centuries, third-class coaches of the Indian railways became a symbol of injustice, despotism, and the horrors of British colonial rule.

In his book *The Third Class in Indian Railways* written in 1917, the great thinker and politician Mahatma Gandhi presented these coaches as a model of Indian colonial society and unfolded his programme of political struggle for the country's independence, repeatedly using them as an example and symbol in his publications.

The next and final part of the review of the history of Indian railways will show the development of the country's passenger coach fleet in the last decades of British colonial rule and after the country acquired independence.

[27] American Ice in British India: the art of keeping cool! *By The Heritage Lab*. 2022. URL: https://www.theheritagelab.in/icebritish-india-art/

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