RAILWAYS OF THE WORLD IN COLOR

RAILWAYS IN THE TRANSITION FROM STEAM

1940-1965

O.S.Nock

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by
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Illustrated by
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PREFACE

This volume, the sixth in the series 'Railways of the World in Colour', completes the sequence from *The Dawn of World Railways* up to the year 1965, which can be pin-pointed as a time when steam traction was definitely on the way out in many countries. At the time of writing however there is still much steam traction on the railways of the world, particularly in India, Southern Africa, and parts of the Far East. As in previous volumes there is some overlapping at the earlier date-line, because since *Railways at the Zenith of Steam* was published, covering the period 1920–40, much information has come to hand about areas that had to be omitted in that previous volume, especially concerning the equipment of the Japanese National Railways. The artists and I are pleased that we have been able to fill at least some of the more obvious gaps.

The passing of steam is certainly not lessening the interest, or the colourful character of world railways, and this present volume appears when there is a tremendous upsurge of development in railway engineering technique, of greatly increased speed, and in utilisation of the mass-transportation attributes of railways for enormous mineral traffic hauls. If at some future time the opportunity comes to take up the story of world railways once again, one can be fairly sure that story will be no less enthralling.

Silver Cedars,
High Bannerdown,
Bath.

O. S. Nock

July 1973

ACKNOWLEDGMENTS

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They would like to thank also the design departments and publicity managers of the various railways concerned.

All have kindly provided details of machinery and liveries which have helped to ensure the accuracy of the illustrations in this book.

INTRODUCTION

The period from 1940 onwards was one of the most interesting and critical in the history of railways. The years immediately preceding the outbreak of war in 1939 had seen a tremendous advance in alternative forms of transport. The private motor car and the long-distance motor coach had made serious inroads into railway passenger business, and it was not only in crossing the narrow seas and the great oceans that civil aviation was advancing in popularity. During the Great Depression of the 1930s railways everywhere in the world had little chance of making capital investment in new equipment. It was a case of 'making do', and to the credit of everyone concerned the standards of maintenance and safety measures were kept unchanged, even though it meant paying little or nothing to the shareholders of those railways that were privately owned. This was of vital importance when war came. Then, with a reduced labour force available for railway work, locomotives had to run for longer periods between periodic overhauls; track was not so constantly maintained; and this latter point was met by reducing train speeds.

One of the earliest effects of war conditions in all the belligerent countries of Europe was the rationing of petrol, and eventually the prohibiting of its use for all private motoring. Many more people had to use the trains, and with attenuated services the coaches were often very crowded. It was not very agreeable. Children approaching their 'teens' were making their first-ever journeys by railway, and were not enjoying them, after the go-as-you-please atmosphere of the family car. Trains were not only crowded; they were much slower than in pre-war days, and they were dimly and miserably lit at night. Stations were blacked out, carriages were dirty, and very often there were long delays *en route*. It was the same all over Europe, especially of course, in the proximity of the actual battle areas on the Continent. Posters exhorted people not to travel unless their journeys were necessary. One can however be very sure that no one travelled in those days unless he or she had to!

The railway companies of Great Britain in particular were called upon for a tremendous war effort. It was not measured in spectacular performance by high-speed express passenger trains, but in the tonnage of freight moved; and in this respect the results were phenomenal. When a great industry is faced with the need to step up its output it is reasonable to make capital investment to provide additional or improved machinery, to build new factories and to recruit additional staff. But no such facilities were available, or permitted, to the British railways in World War II. As the war situation developed to the crescendo of preparation for the D-Day landings in Northern France, the railways had some 25 per cent of their normal workshop facilities diverted to other than railway purposes; and some 15 per cent of the staff had been released to other duties. And yet with these seemingly crippling handicaps the output, in terms of the tonnage of freight moved, was stepped up by 46 per cent – *forty-six per cent*! And it hardly needs to be added that this was done amid all the constant hazards of air-raid damage, and the need to show constant readiness to use alternative routes.

In the U.S.A. conditions remained unchanged for the first two years of the War. It was not until 1941 that the country was involved as a direct belligerent, and then, although the pressure was soon applied with a vengeance, it was without the harassment of the black-out and the hazards, anxieties and personal grief of aerial attack. Even in the grimmest days of U.S. involvement in the War, American trainmen did not set out on long journeys with the thought that their homes might be bombed and their families killed or injured before they returned – a situation that British and German railwaymen faced almost daily, and which was to be experienced in full measure by the French, Dutch and Belgians at desperate stages of the War, and in the last year by the Japanese. But, although working in less hazardous conditions, the American railroads did a colossal job of transportation during the War.

The period of rehabilitation afterwards was in many places one of much frustration and perplexity. The railways of Western Europe had been so damaged by bombing, destruction by the various 'underground' movements, and exposure to actual battle conditions that in France and Holland in particular there were times when they had been virtually at a standstill. Little short of complete reconstruction was necessary and, with the vital need to get these countries on their feet again, substantial loans were made available for railway development. Almost alone in Western Europe the railways of Great Britain were still in full operation, though fixed equipment and rolling stock had, by 1945, been used almost to the point of complete collapse. Unfortunately none of the funds made available for reconstruction on the Continent came to Britain, and with legislation pending to nationalise the railways the situation at the time was very difficult. While the end of the War brought relaxation in a number of ways, including 'holidays with pay' for millions who had not previously enjoyed them, coal shortages, and the continuance of rationing in most of its forms, threw an immense additional burden on the railways for passenger-carrying in the holiday months.

The experience of many people travelling far afield for the first time in their lives was not to the benefit of the railways. Propagandists railed against the obsolescence and inefficiency of the steam locomotive; American interests and other business circles stressed the advantages of the diesel; but in those immediately post-war years the economic situation in all Europe virtually precluded the consideration of any save indigenous fuel. Foreign exchange was not available to purchase the oil needed to run the diesels; and where the capital cost of electrification could not be justified it had to be steam. R. A. Riddles, the newly appointed member of the British Railway Executive responsible for mechanical and electrical engineering, put the matter succinctly when he said that they were going to buy the form of motive power that gave them the highest tractive effort per pound sterling – in other words, steam.

The same pattern of development was at first to be seen in many parts of the world. In France some magnificent new steam designs were prepared. One or two of the American railways adjacent to the eastern coalfields, notably the Norfolk and Western, made the retention of steam power a major point in policy, while the demand for British-built steam locomotives in many parts of the world kept the export business in a flourishing state, for a time. Some of the locomotives exported in the early 1950s by the North British Locomotive Company, by the Vulcan Foundry, and by Beyer Peacock & Co., were veritable masterpieces of the locomotive designing and constructional art. In the same period, however, some very significant developments were taking place in electric locomotive design, and the work of the Swiss firm of Brown-Boveri, in meeting the requirements of the Bern–Lötschberg–Simplon Railway and then of the Swiss Federal Railways, was to have a lasting influence on the locomotive practice of France and Great Britain.

Despite the major policy decision of British Railways to remain steam, the manufacturers and many railway engineers were alive to the need for keeping abreast of overseas practice, and the English Electric Company in particular made strenuous efforts to develop the export market in the diesels – a development that was to prove of great advantage to British Railways in later years. What are sometimes termed the 'first-generation' diesel-electric locomotives, with the attractively styled 'nose' cabs, followed the fashion set some ten years earlier by the standard General Motors models in the U.S.A., which came to have such an impact on the American railways scene after the War. At the same time alternative methods of non-steam propulsion were being investigated, including the gas turbine and the hydraulic form of drive for diesel locomotives. By the time nationalisation took place, indeed, three out of the four British main-line railways of the 'grouping era' had interesting projects under way, which unfortunately had to be halted for the economic reasons mentioned earlier.

Once economic conditions throughout the world began to approach normality, with the petrol rationing ended, production of new car models in large-scale production, and civil aviation developing very rapidly, a severe recession in railway business began. There was talk that the railways were 'on the way out'. The rosy prospects envisaged by some protagonists of nationalisation did not materialise. The easy but defeatist attitude of closing down lines that individually were unremunerative was pursued ruthlessly in the U.S.A. and to a lesser extent in Great Britain, both programmes failing to halt the adverse trend of revenue; and many observers felt that such a policy was little more than an indirect way of closing down the entire railway system. Little of the same tactics was applied to railways on the continent of Europe, nor to railways in the countries of the British Commonwealth overseas – not that the financial situations there were any more favourable. In Great Britain it became the firm conviction of British Railways that the one solution to the difficulty was to make an end of steam traction, and this was the centrepiece of the Modernisation Plan launched in 1955. The elimination of steam traction in Great Britain took a little over ten years, but once completed the finances of the railways were not improved.

It is remarkable in retrospect to reflect upon the philosophies held by some of those at the centre of affairs, not only in Great Britain but in many places elsewhere, to the effect that the mere act of changing the form of traction would work wonders with the viability of railway operation, and that even when finance was made available, as in Great Britain, for electrification of certain main lines there were those who were prepared to plan for future services very little faster than the best regularly operated by steam in former years. Fortunately there were others who realised that in speed of service railways in all the advanced countries of the world had an asset that was capable of almost indefinite development, and one that needed playing to the utmost, not merely in the interest of railway viability but for the benefit of the community in general.

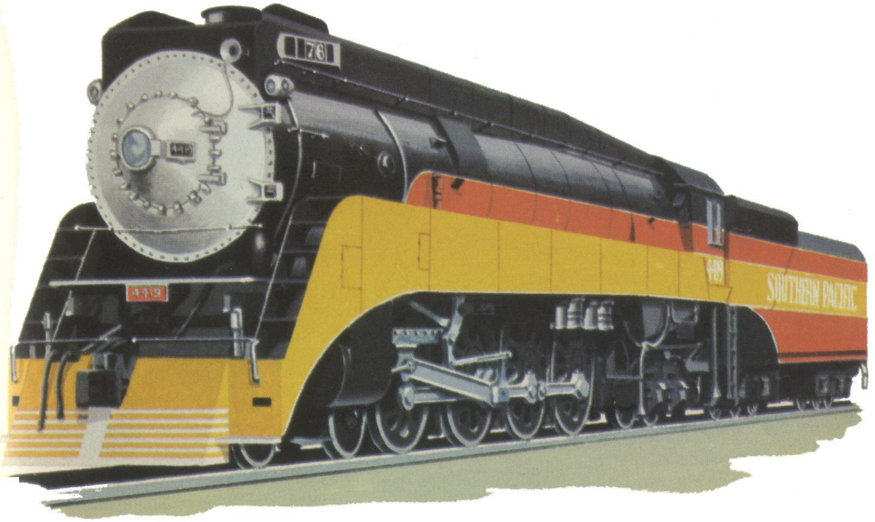
The phenomenal advance in private motoring, the development of heavy haulage by road, and the popularity of the long-distance road coach, by which travel was so much cheaper than train, were between them leading to congestion on the roads, chronic blocking in the city areas, and serious atmospheric pollution from the exhaust fumes. The inherent quickness of transit by internal air lines was offset considerably – on a city centre to city centre basis – by the time taken to reach the appropriate airports, in addition to the time spent on formalities and waiting between the time when a passenger arrived at the airport and the plane was airborne. For journeys of relatively short duration the railway could be made a strong competitor once again for city to city traffic. It was equally realised however, that for this purpose the traditional railway average speed of 55 to 60 m.p.h. would be useless. Speeds must be at least 75 m.p.h. – preferably more.

So, in Europe, the new era of railway service began to evolve. In France the main lines of old were upgraded. Curves were realigned, junctions remodelled, locomotives and coaching stock improved so that stretches of a hundred miles or more could be run continuously at speeds in excess of 80 m.p.h. In Great Britain the electrification of the line northward from Euston to Liverpool and Manchester involved such a metamorphosis as to constitute the building of an entirely new railway over the tracks of the old. It paid off to such an extent that when the new service was fully inaugurated in April 1966, and the journey time between London and Liverpool and between London and Manchester became little more than 2½ hours, the passenger receipts for this service increased by some 40 per cent. For speed the airlines could no longer compete.

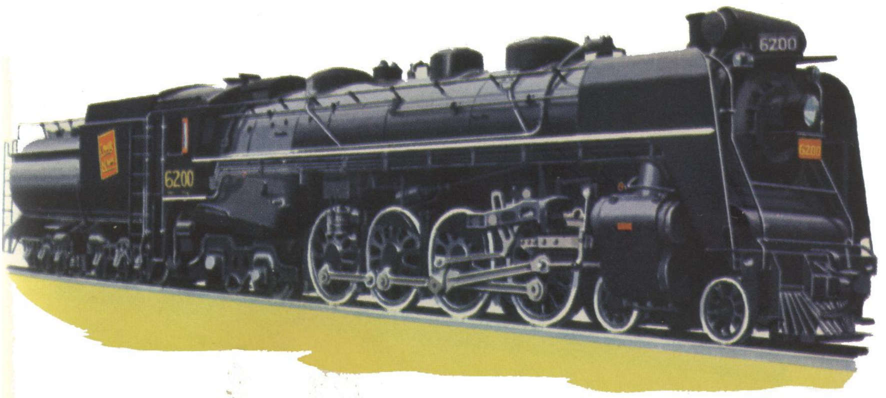
The London Midland case was no more than typical of what was happening in many parts of the world. A resurgence in railway activity had begun. The French were accelerating on all their main lines. The German Federal Railways was about to run trains at 125 m.p.h. between Munich and Augsberg, but the most startling development of all, that had actually reached the stage of commissioning by the time the period of this book ends, was in Japan. For some time there had been urgent need for more rapid communication between Tokyo and the large cities lying along the eastern seaboard. The existing main line, the old Tokaido Line, was laid to the 3 ft. 6 in. gauge and, being built at a time when speed was of little consequence, had a winding and difficult alignment, along the coast, that was virtually impossible to develop for modern requirements.

To have repeated the procedure adopted in modernising the London Midland line in England would have been out of the question; and so, as national development was involved, the enormous finance necessary for building an entirely new line was made available, to be so well aligned as to permit of continuous running at 130 m.p.h. throughout. By any ordinary standards the cost was astronomical, but its eventual success has been quite unprecedented, and at the time of writing the super high-speed system is being extended to cover the entire country, with completely new railways.

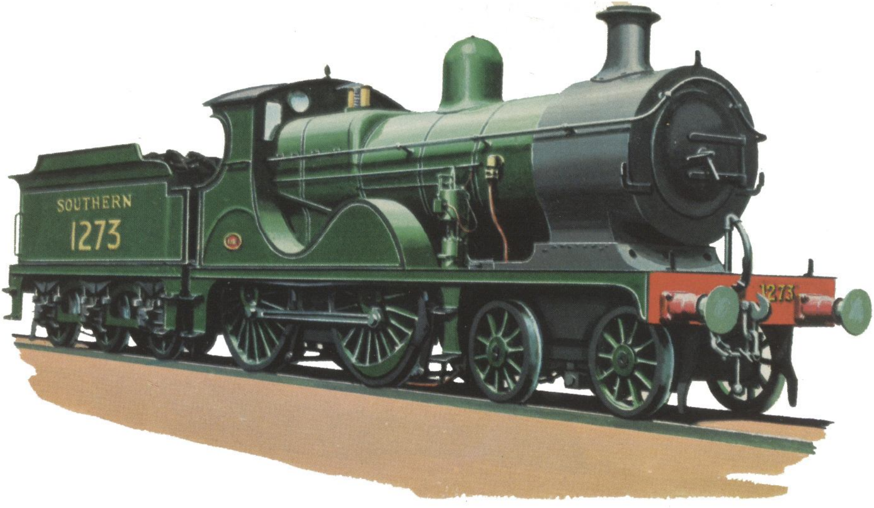
Elsewhere in the world older railways have been modernised and further new ones built for the large scale conveyance of special freights; for the conveyance of minerals from huge inland deposits in Australia to ports for shipment; for acting as a kind of 'belt conveyor' over hundreds of miles between associated industrial plants engaged on different processes in a single integrated enterprise; and again in opening up new districts in developing countries. Far from being 'on the way out', railways are indeed rapidly assuming a new prominence, whether it be in remote areas fabulously rich in minerals, in the teeming industrial evolution of modern Japan, or in the increasingly coordinated Trans-European-Express network, and certainly not least in the country of their origin more than 150 years ago where, by the time this book is published, it will be possible to travel between London and Glasgow at an average speed of more than 80 m.p.h.



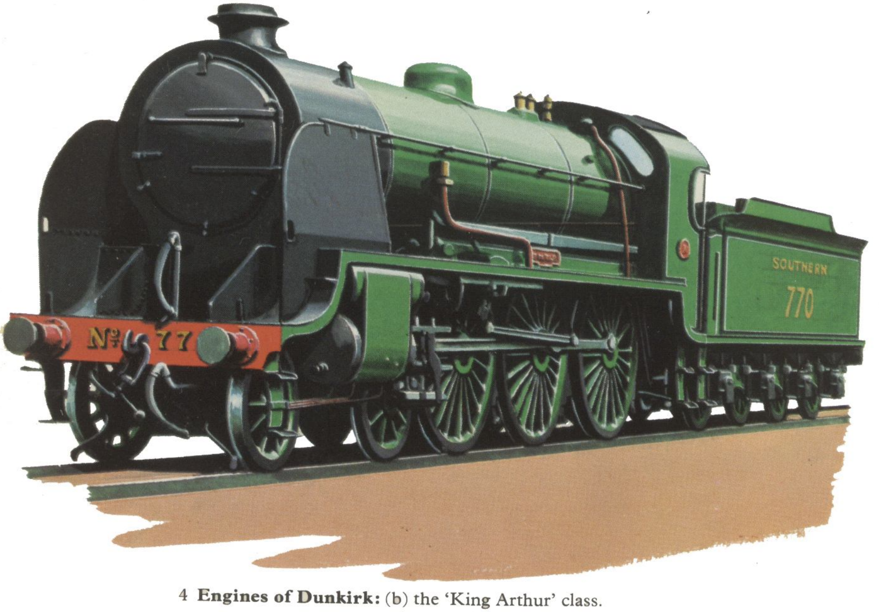
1 **Southern Pacific Railroad:** the 'GS-4' class 4-8-4 used for the 'Daylight Express'.



2 **Canadian National Railways:** the 'U-2-g' class 4-8-4 of 1942.

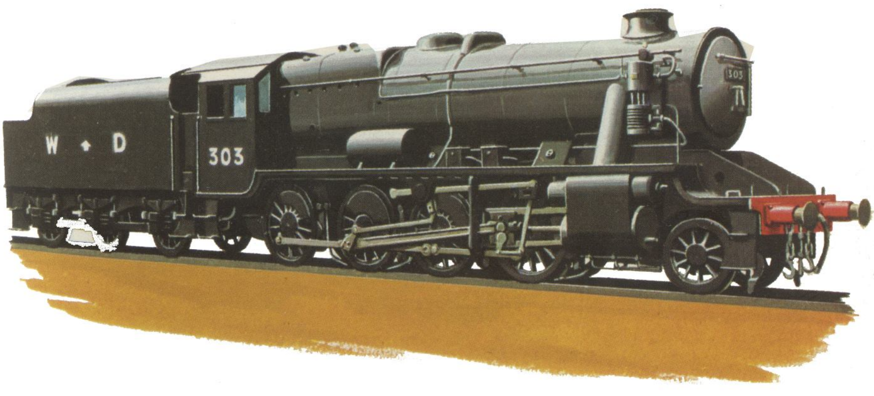


3 **Engines of Dunkirk:** (a) the S.E. & C.R. 'E' class.

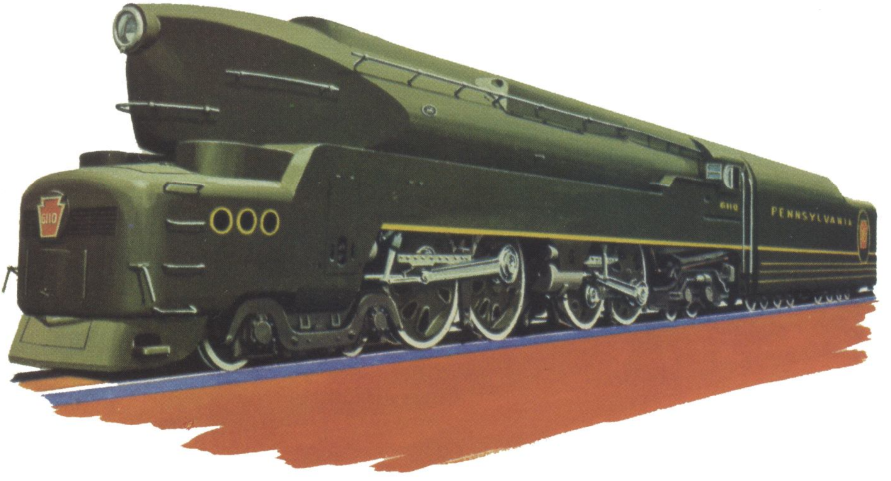


4 **Engines of Dunkirk:** (b) the 'King Arthur' class.

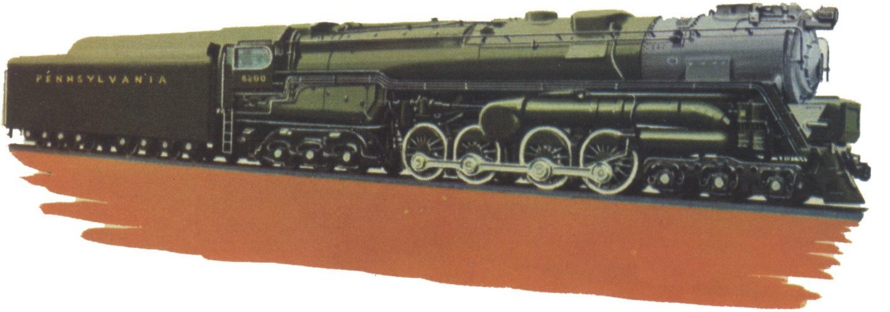
5 **War Department:** G.W.R. 'Dean Goods' 0–6–0 fitted for military service, 1940.



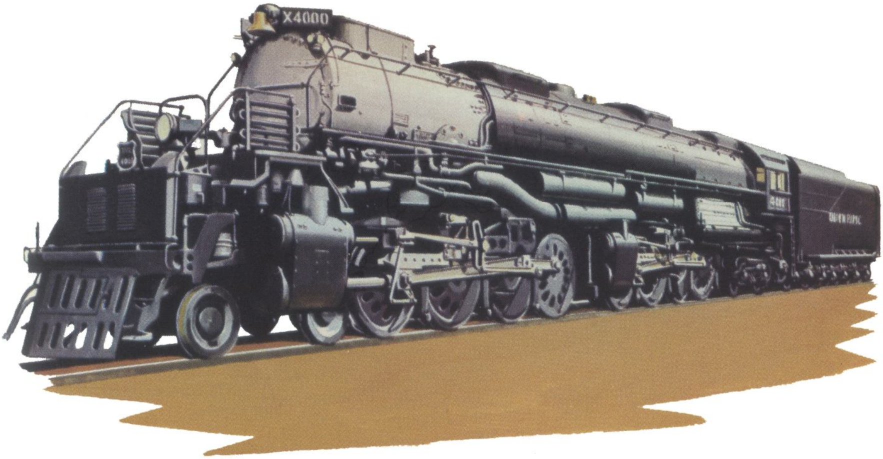
6 **The First British War Department 2–8–0:** 1940.



7 **Pennsylvania Railroad:** 4–4–4–4 express passenger locomotive of 1942.



8 **Pennsylvania Railroad:** 6–8–6 non-condensing geared-turbine express passenger locomotive of 1944.



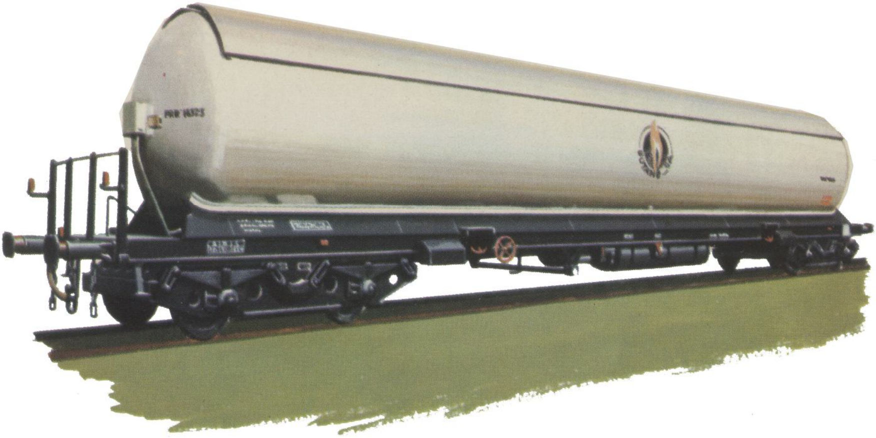
9 **Union Pacific Railroad:** the 4–8–8–4 express freight locomotive of 1941 – 'Big Boy'.

10 **Nashville, Chattanooga and St. Louis Railway:** the 'Yellow Jacket' Class 'J3' 4–8–4.

11 **St. Louis–San Francisco Railway (Frisco Lines):** diesel-electric locomotive.

12 **Western Pacific Railroad:** a modern luxury coach.

13 **Chesapeake & Ohio Railroad:** a typical roundhouse scene.

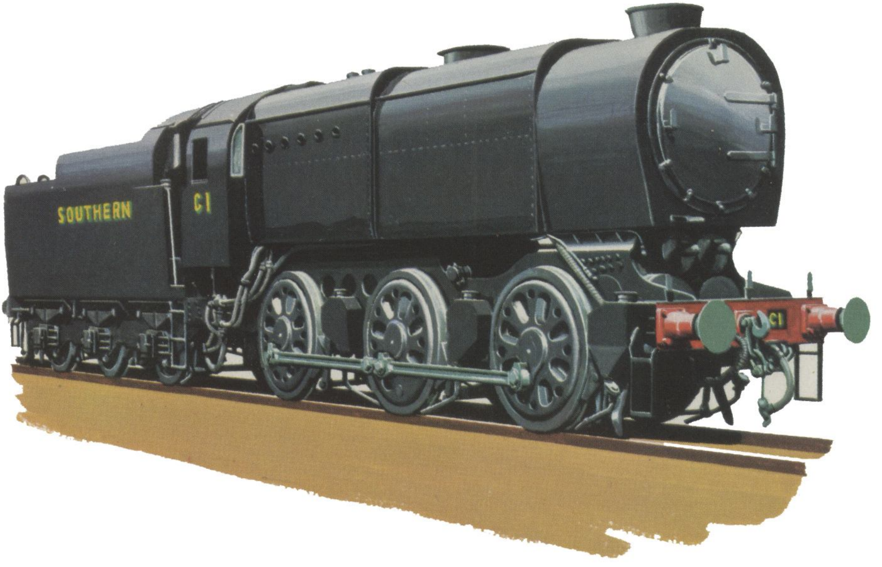


14 **Spanish National Railways (RENFE):** tank car.

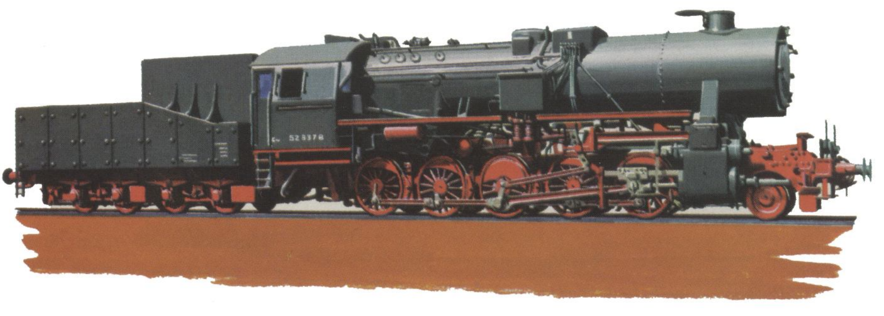
15 **St. Louis–San Francisco Railway:** a triple-deck car carrier.

16 **Norfolk & Western Railway:** high-capacity coke car.

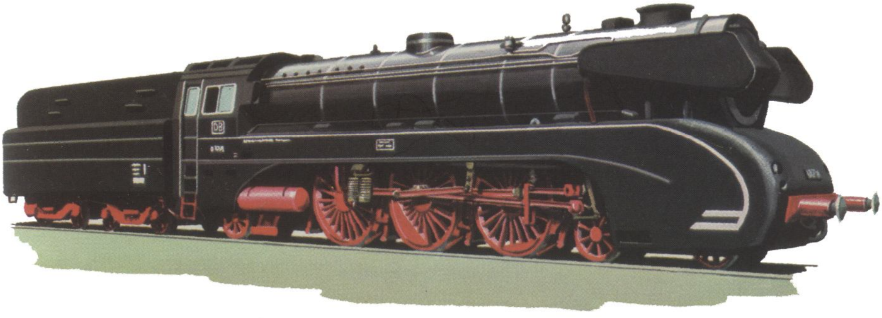
17 **Norfolk & Western Railway:** a modern caboose.



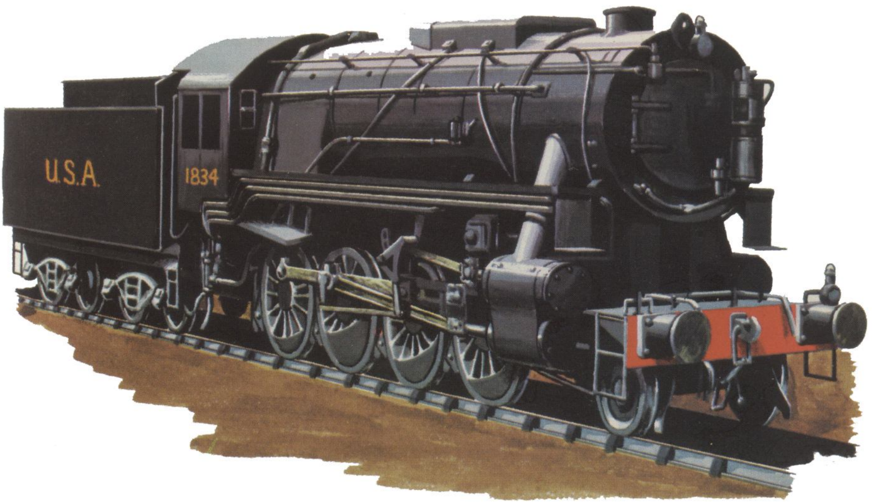
18 **Southern Railway (England):** the 'Q1' Austerity 0-6-0 of 1942.



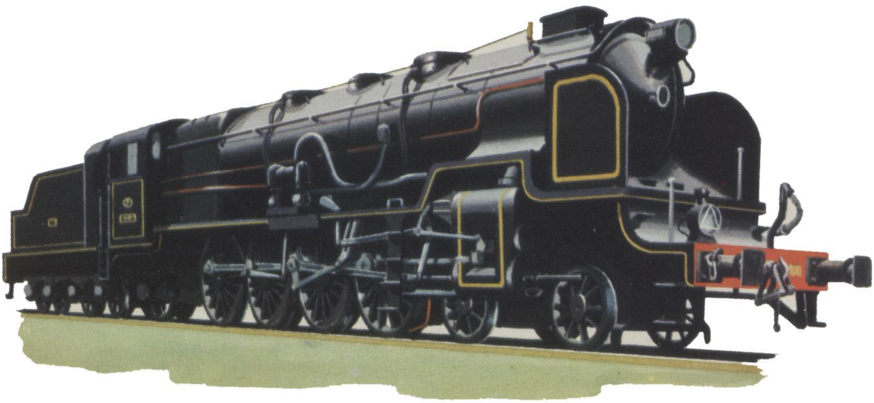
19 **German Federal Railway (D.B.):** 'Austerity' 2-10-0 general service locomotive, Series '52'.



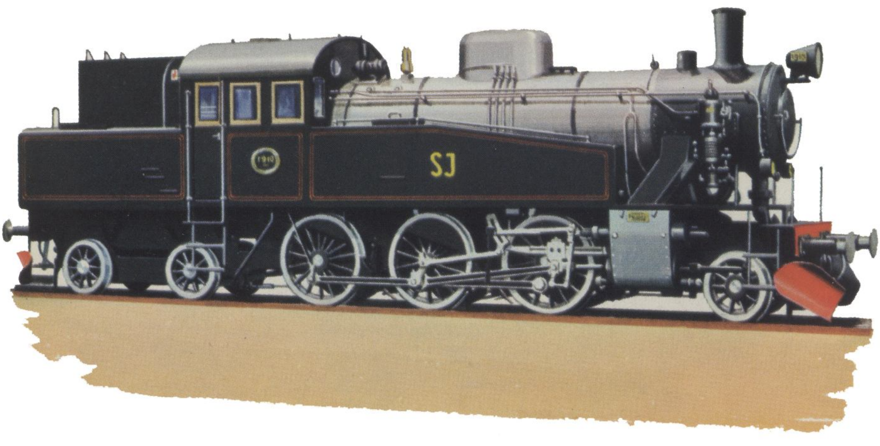
20 **German Federal Railway (D.B.):** the Class '10' three-cylinder 4-6-2.



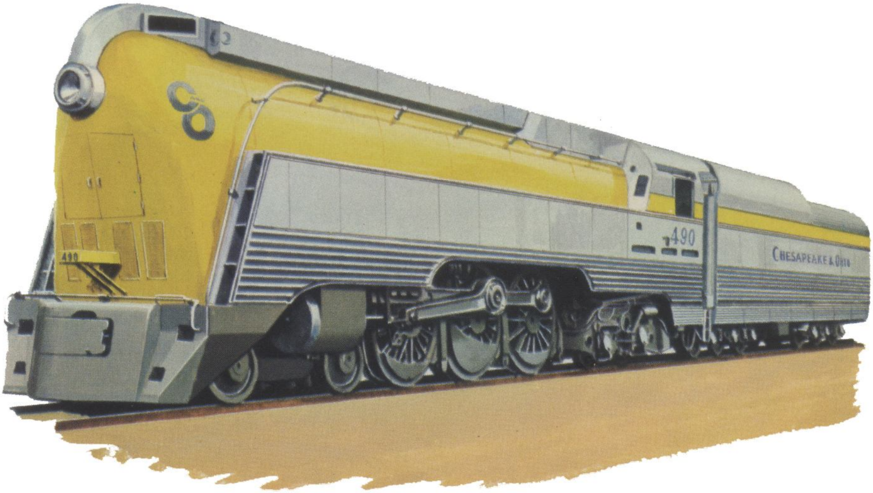
21 **American-Built 'Austerity' 2-8-0:** for service in Great Britain and European war zones.



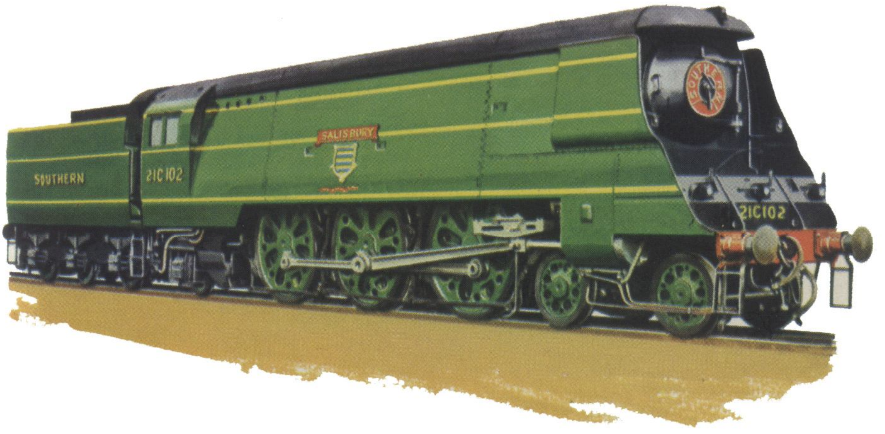
22 **Spanish National Railways (RENFE):** 4–8–2 four-cylinder compound passenger locomotive.



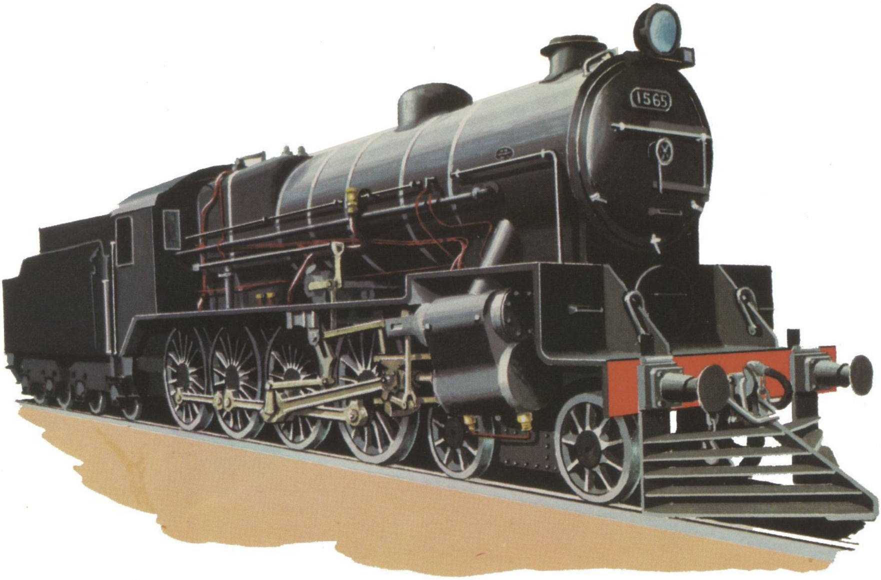
23 **Swedish State Railways:** the 'S1' class 2–6–4 tank locomotive of 1952.



24 **Chesapeake & Ohio Railway:** streamlined 4–6–4 locomotive for high speed.

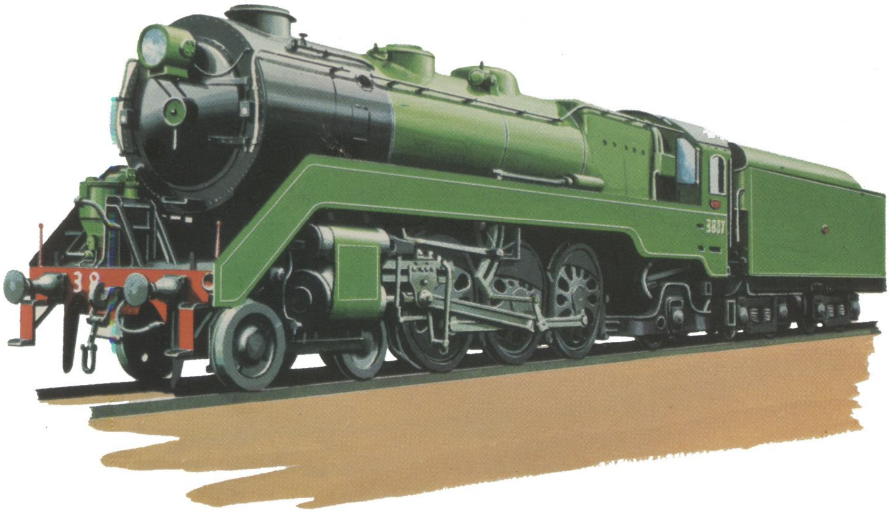


25 **Southern Railway (England):** 'West Country' class 4–6–2.



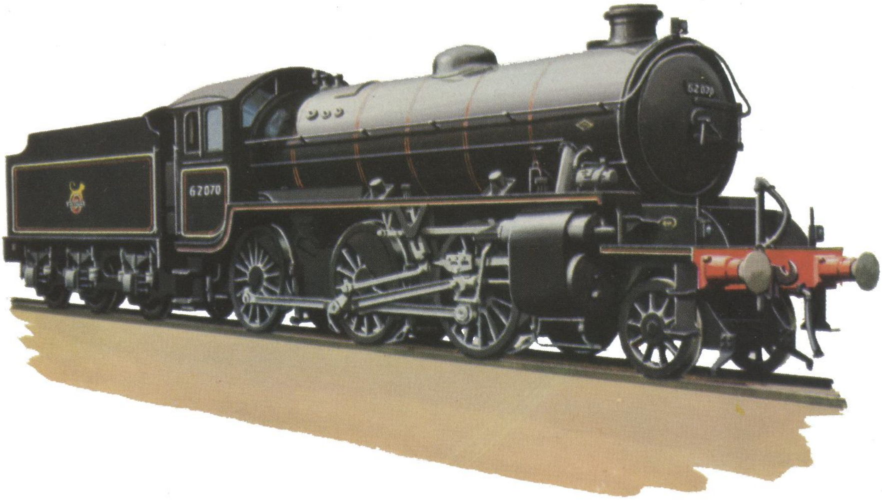
26 **General Roca Railway (Argentine):** 4–8–0 mixed traffic locomotive.

27 **Great Northern Railway (Ireland):** light branch 4–4–0 locomotive.

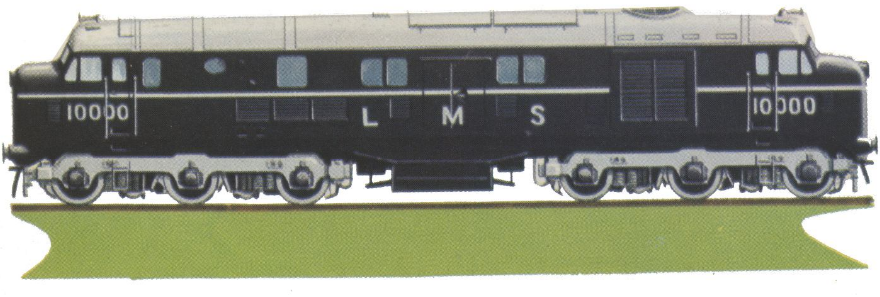


28 **New South Wales Government Railways:** the 'C38' class 'Pacific' express passenger locomotive.

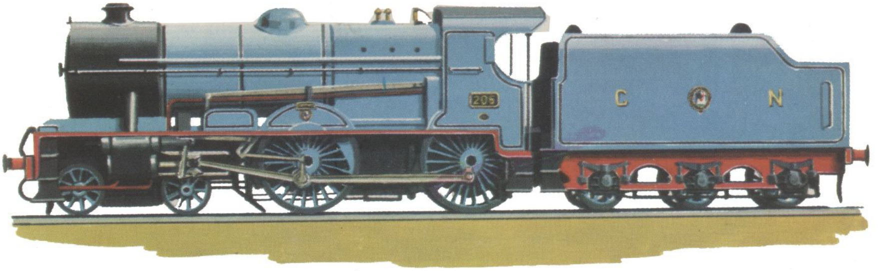
29 **British War Department:** 2–10–0 'Austerity' mixed traffic locomotive.



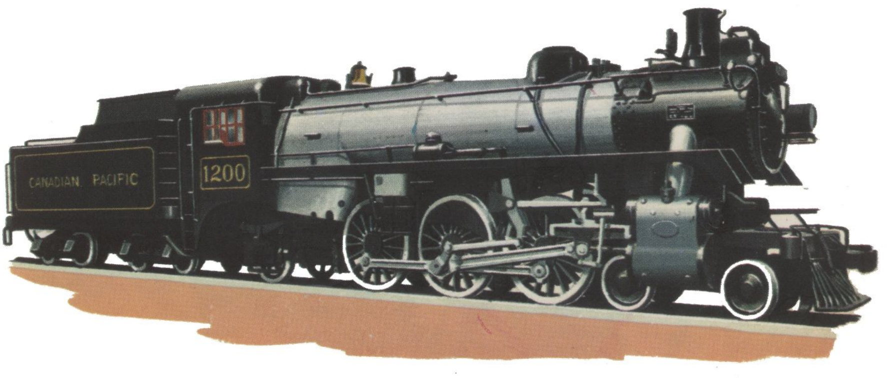
30 **London & North Eastern Railway:** the 'K1' class 2–6–0.



31 **First British Main-line Diesel-electric Locomotive:**
L.M.S.R. No. 10000.



32 **Great Northern Railway (Ireland):** three-cylinder simple 4-4-0 express locomotive.



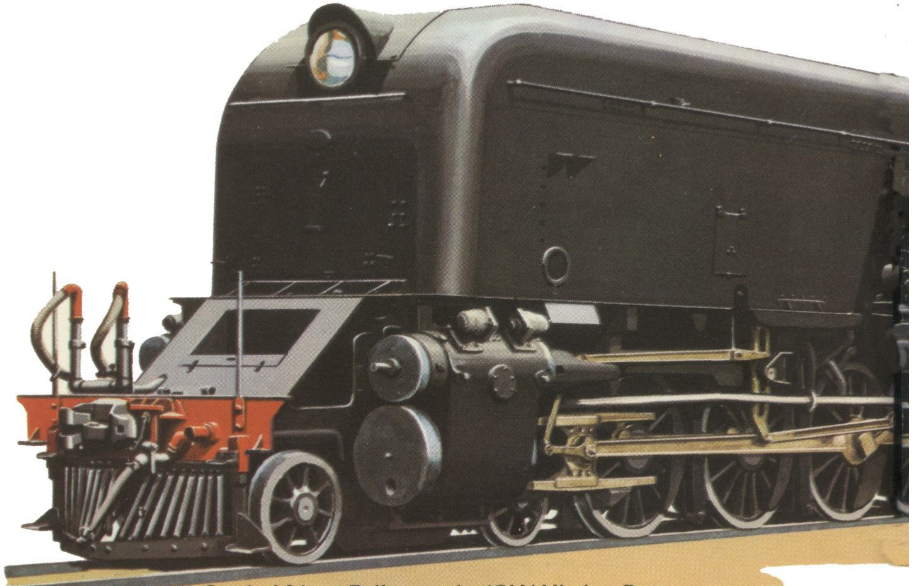
33 **Canadian Pacific Railway:** the 'G5' class mixed traffic 'Pacific' of 1946.

34 **New South Wales Government Railways:** coat of arms.

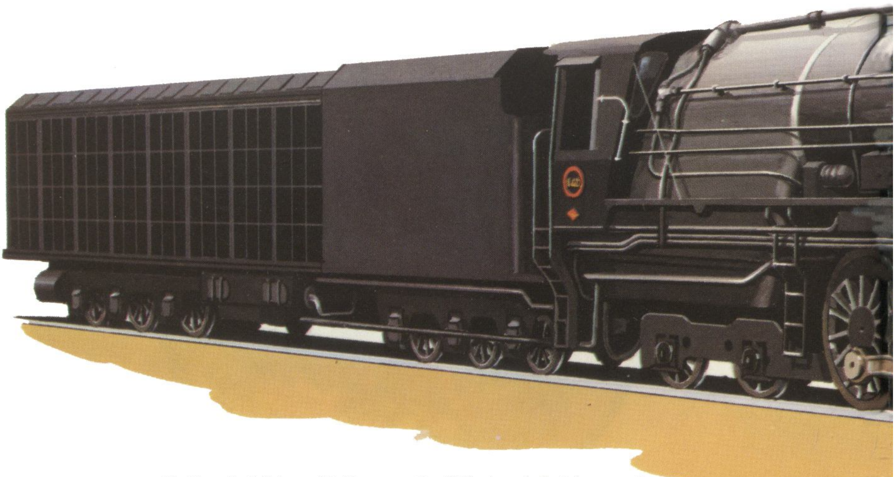
35 **Western Australian Government Railways:** coat of arms.

36 **Victorian Railways:** coat of arms.

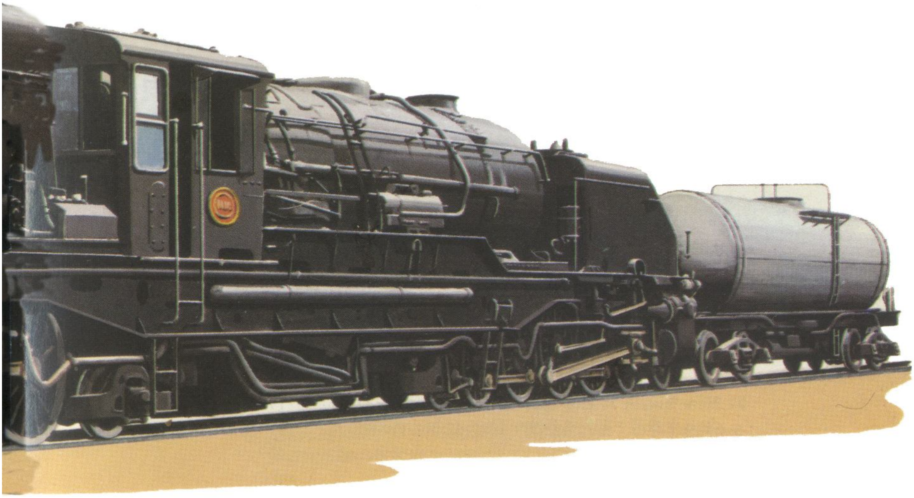
37 **South Australian Railways:** the insignia.

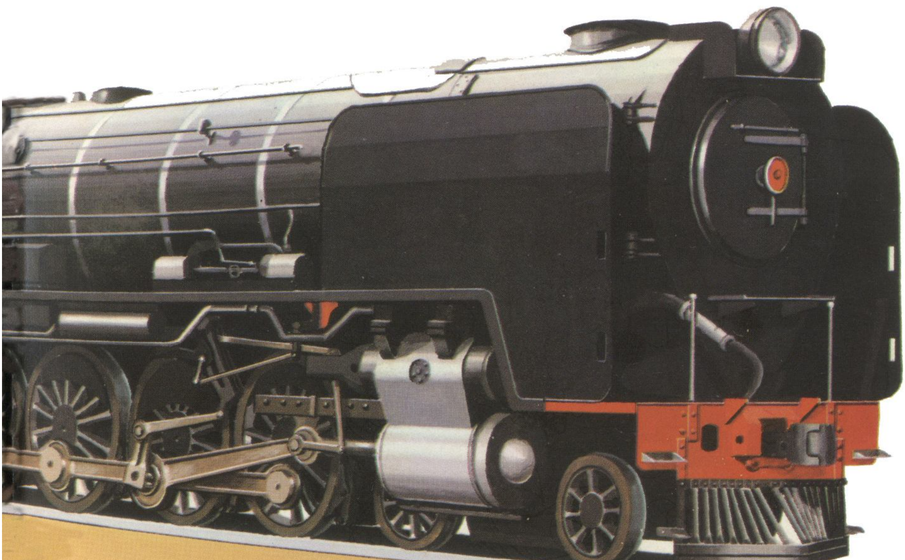


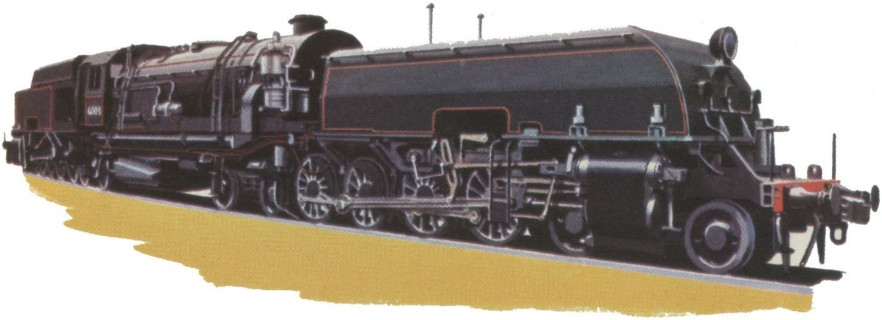
38 **South African Railways:** the 'GMAM' class Beyer-Garratt 4-8-2 + 2-8-4 locomotive.



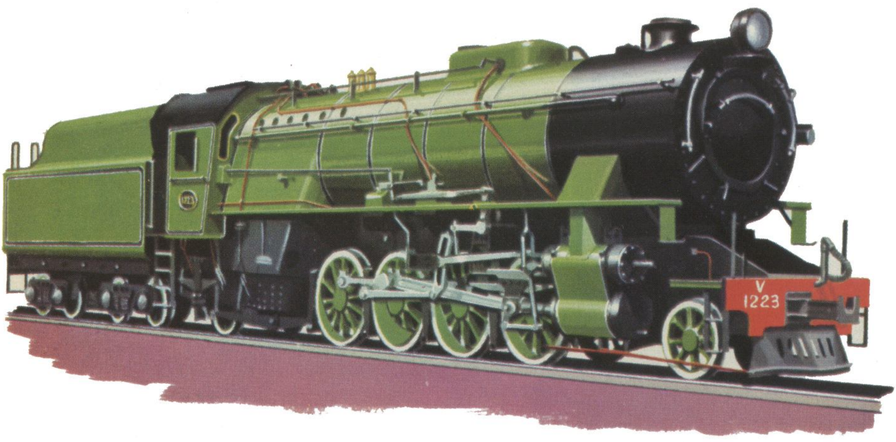
39 **South African Railways:** the '25' class 4-8-4 locomotive with condensing tender.



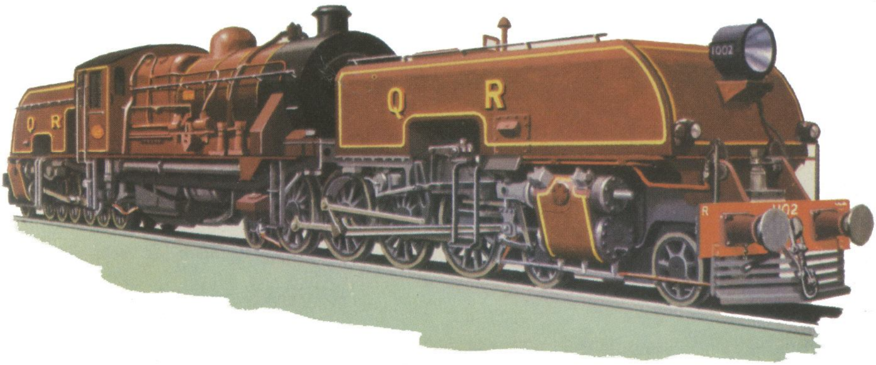




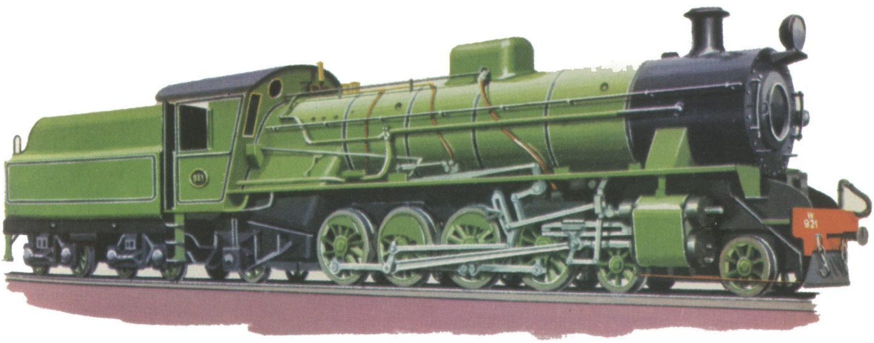
40 **New South Wales Government Railways:** the 'AD 60' class 4–8–4 + 4–8–4 Beyer-Garratt locomotive.



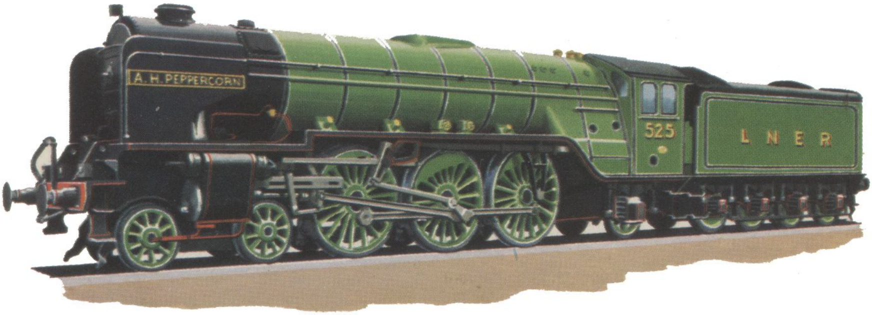
41 **Western Australian Government Railways:** the 'V' class 2–8–2 freight locomotive of 1955.



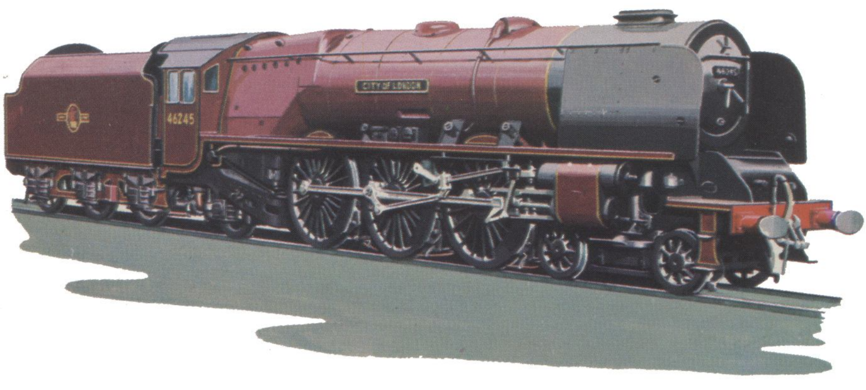
42 **Queensland Government Railways:** 4–8–2+2–8–4 Beyer–Garratt locomotive.



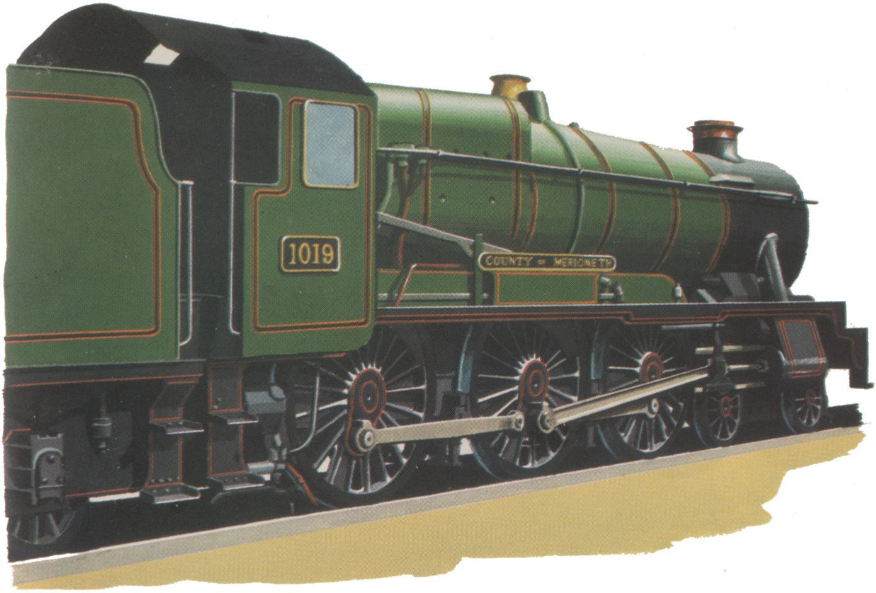
43 **Western Australian Government Railways:** the ‘W’ class lightweight 4–8–2 locomotive.



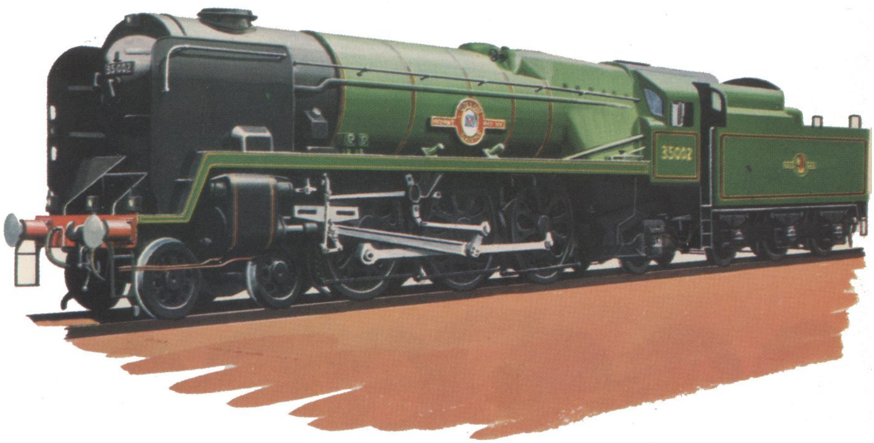
44 **London & North Eastern Railway:** the 'Peppercorn' 'A2' class 'Pacific' of 1947.



45 **British Railways, London Midland Region:** the Stanier 'Duchess' class 4-6-2.



46 **Great Western Railway:** 'County' class 4-6-0 of 1945.



47 **British Railways Southern Region:** modified 'Merchant Navy' class 'Pacific' locomotive.

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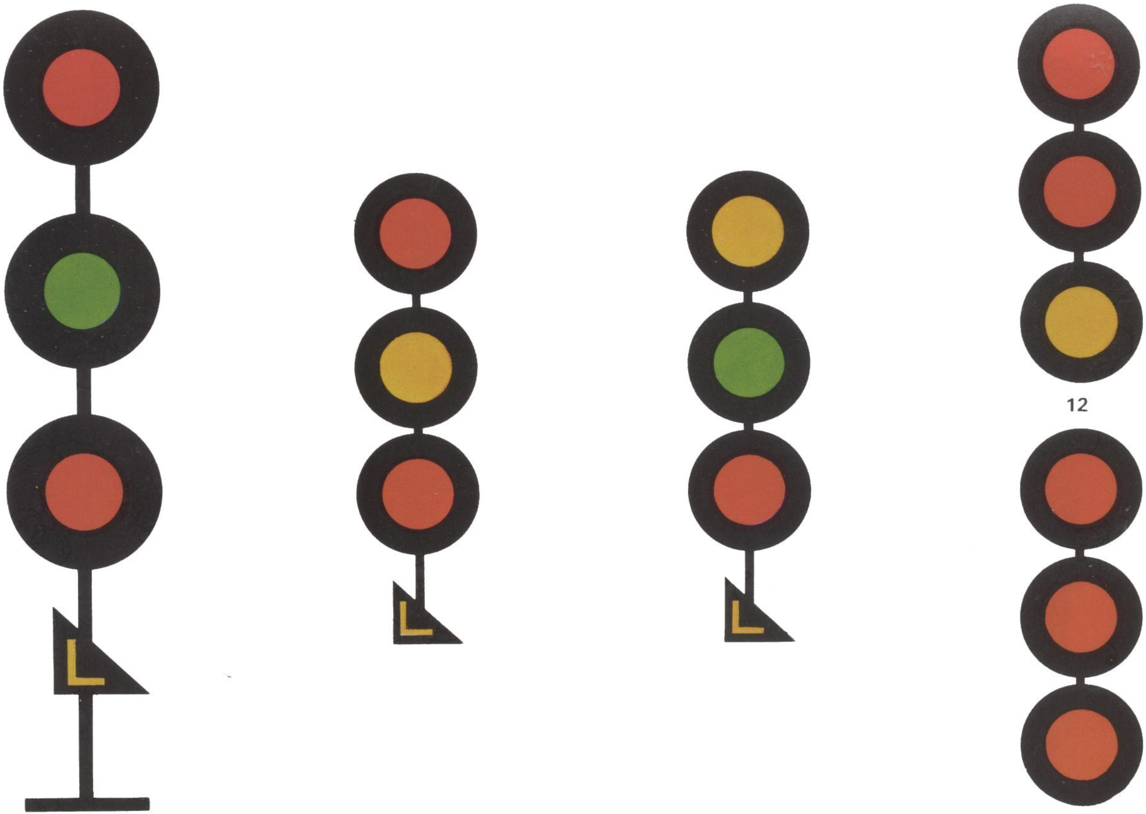


9 10 11 12 13

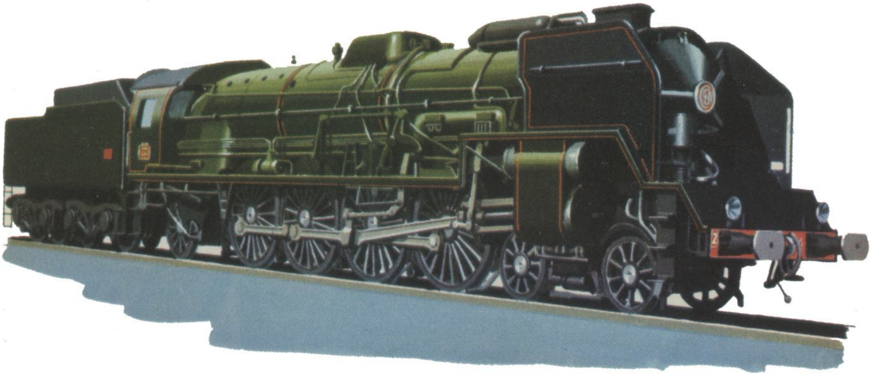
48 **Canadian National Railways:** colour light signal aspects.

49 **British Railways, Southern Region:** Bo – Bo 675-volt D.C. electric locomotive.

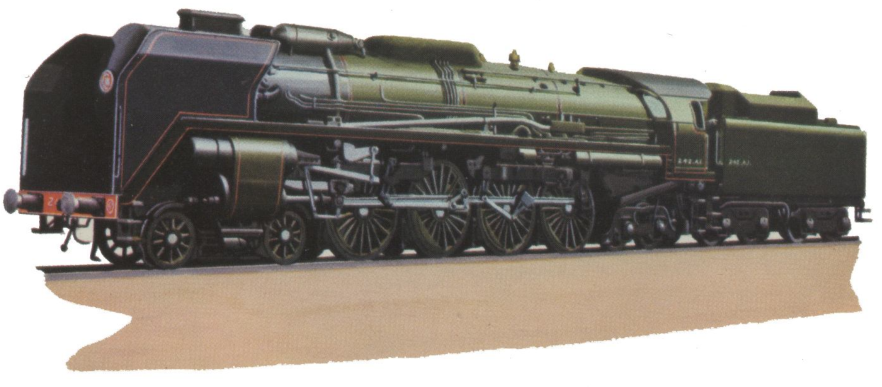
50 **Berne-Lötschberg-Simplon Railway:** the 'Ae 4/4 II' class Bo – Bo electric locomotive.

51 **Swiss Federal Railways:** the 'Ae 6/6' Co – Co electric locomotive.

52 **French National Railways:** the Co – Co '7000' class high-speed electric locomotive.



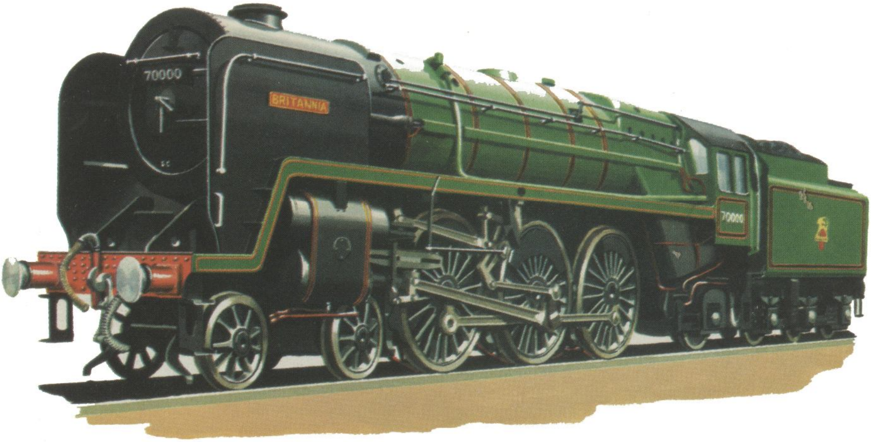
53 **French National Railways (S.N.C.F.):** the '241.P' class 4-8-2 express passenger locomotive.



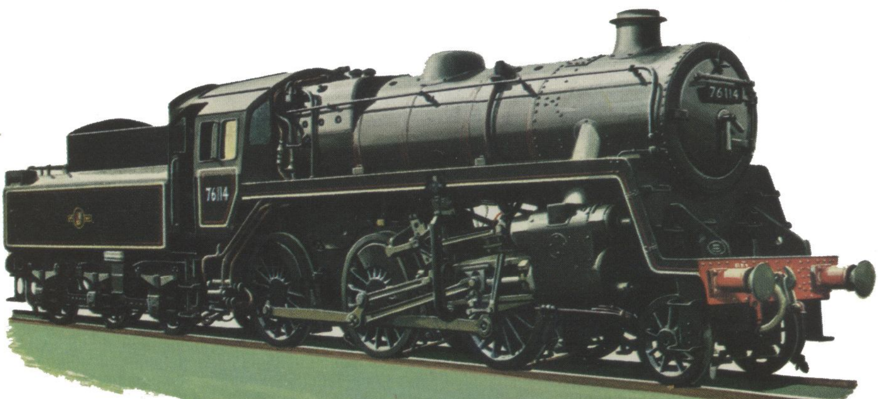
54 **French National Railways:** prototype 4-8-4 three-cylinder compound express locomotive.

55 **French National Railways:** the '232.U1' four-cylinder compound 4–6–4.

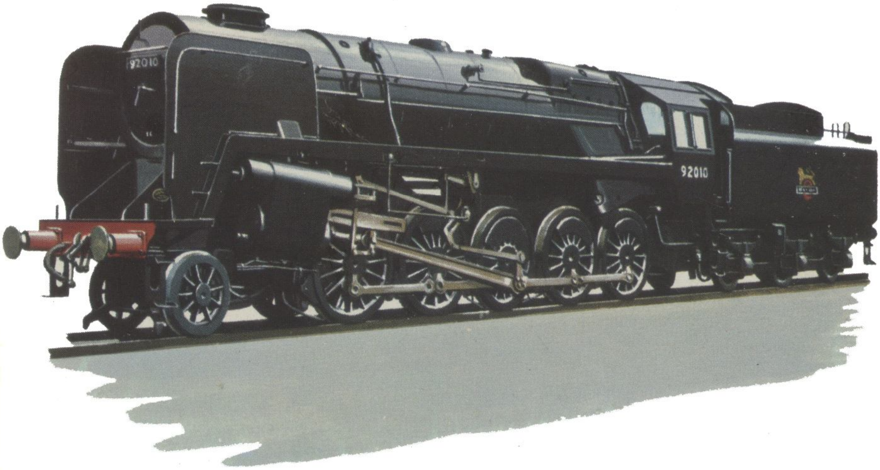
56 **French National Railways:** the '141.R' mixed traffic 2–8–2 locomotive.



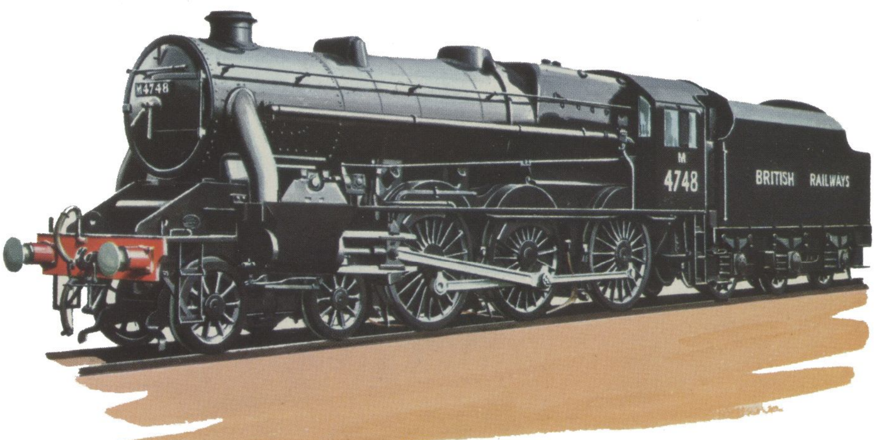
57 **British Railways:** the 'Britannia' Class '7' standard 'Pacific' locomotive.



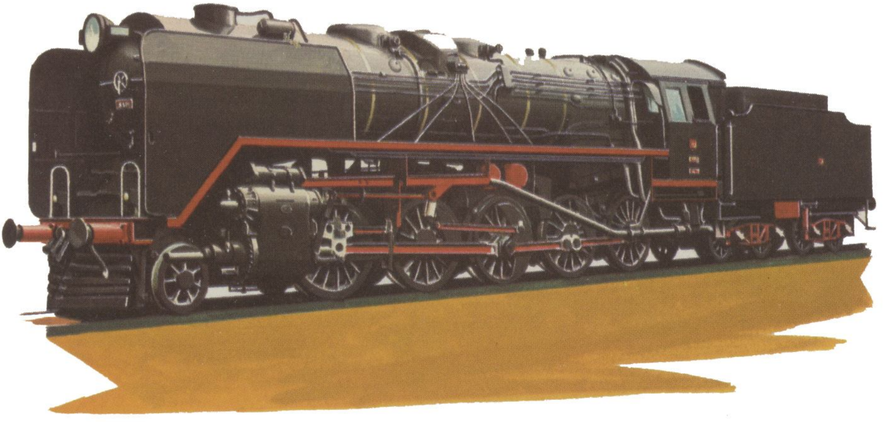
58 **British Railways:** the standard Class 'BR4' 2-6-0 mixed traffic locomotive.



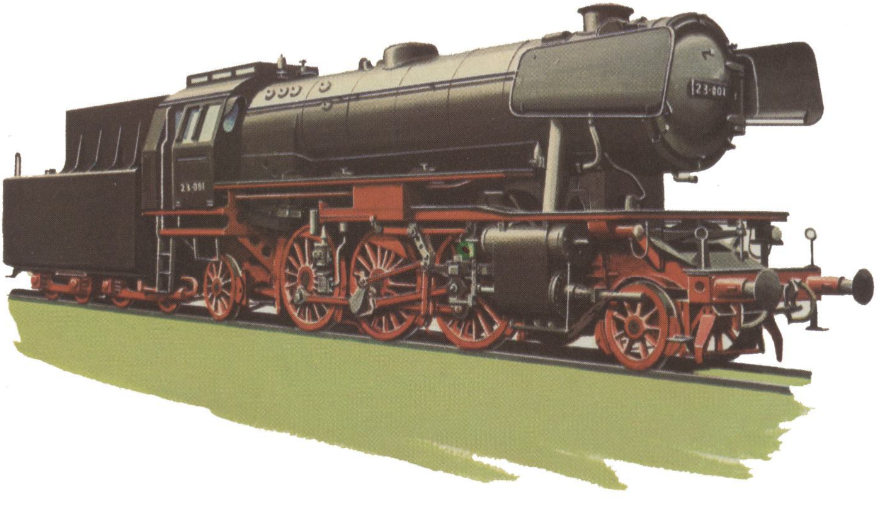
59 **British Railways:** the standard 'BR9' express goods 2–10–0.



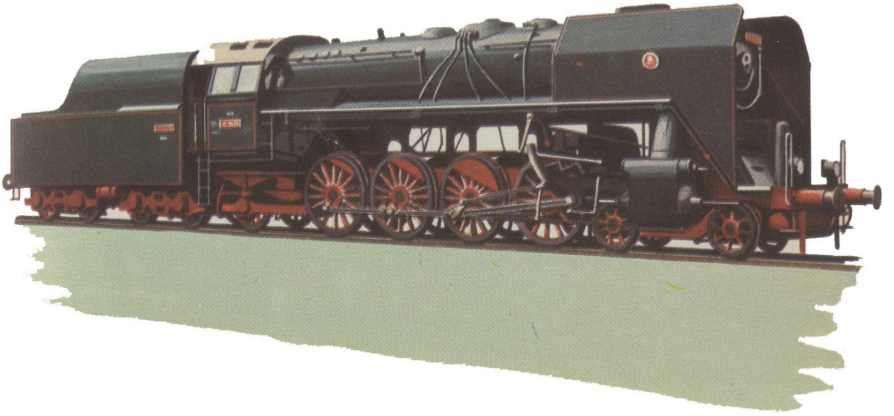
60 **British Railways, London Midland Region:** 'Black Five' mixed traffic 4–6–0, with Caprotti valve gear.



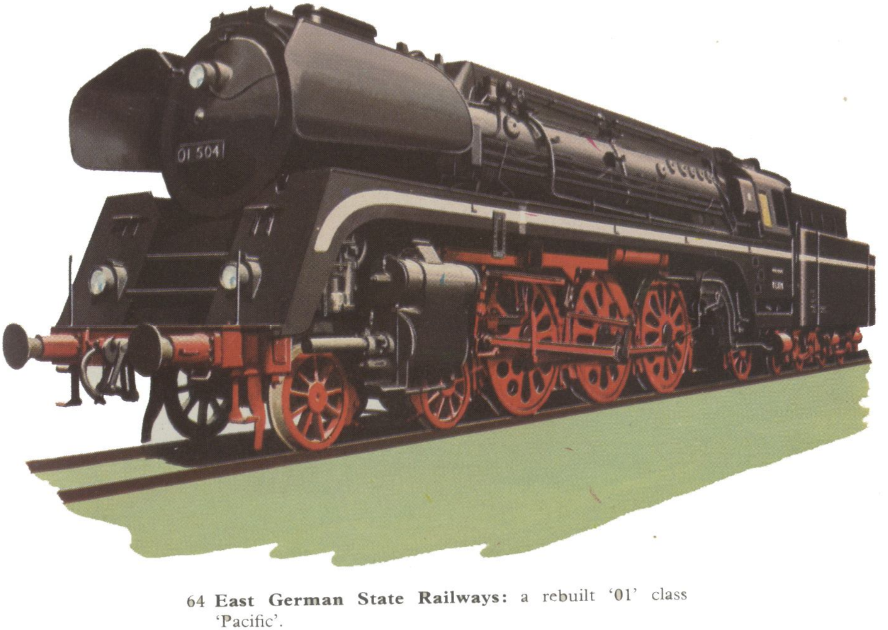
61 **Turkish State Railways:** the '56,001' class 2–10–0 mixed traffic locomotive.



62 **German Federal Railways (D.B.):** the Class '23' 2–6–2 of 1953.

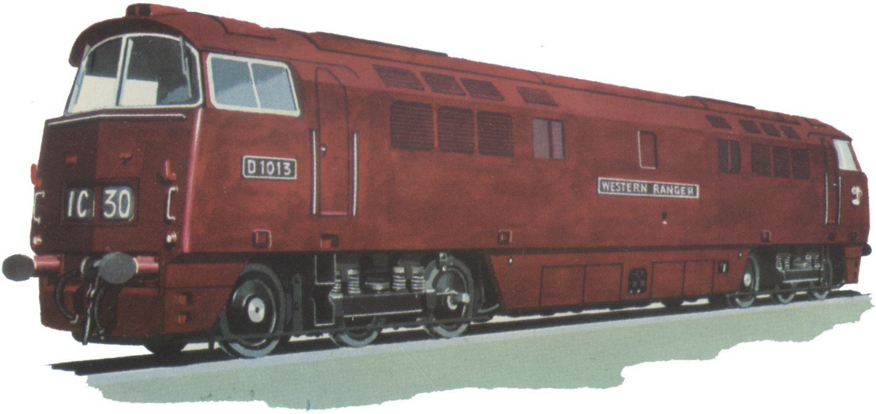


63 **Czechoslovak State Railways:** the Class '498·1' 4–8–2 express locomotive.

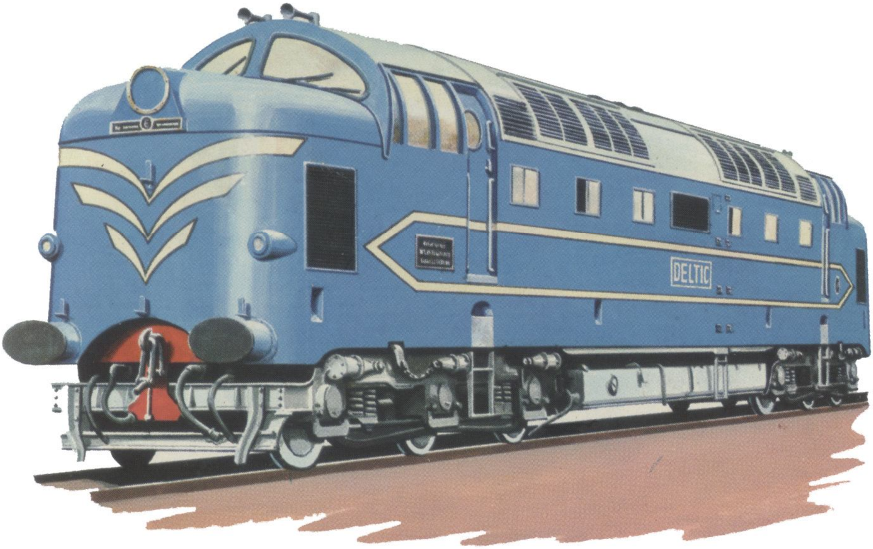


64 **East German State Railways:** a rebuilt '01' class 'Pacific'.

65 **British Railways:** the English Electric Type '4' diesel-electric locomotive, B.R. Class '40'.



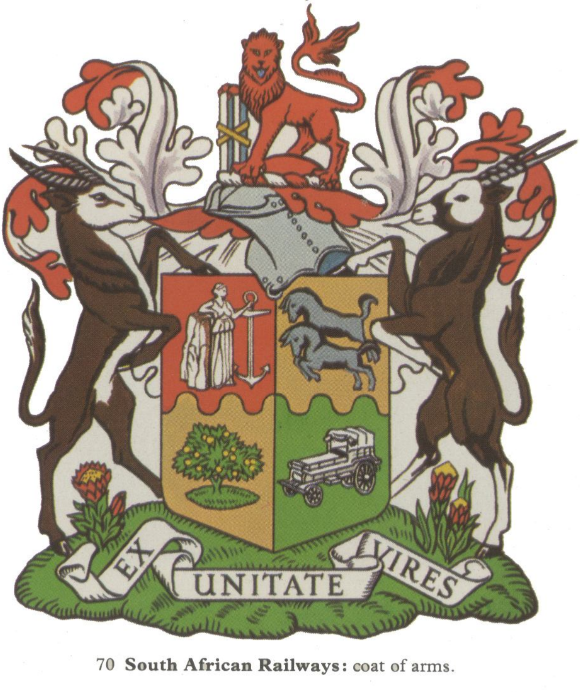
66 **British Railways, Western Region:** the 'Western' class diesel-hydraulic locomotive, B.R. Class '52'.



67 **British Railways:** the prototype English Electric 'Deltic' locomotive.

68 **Great Western Railway (England):** 2,500-horsepower experimental gas turbine locomotive.

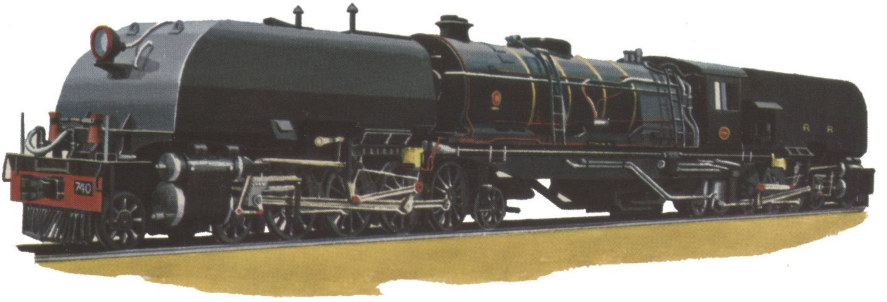
69 **Rhodesia Railways:** coat of arms.



70 **South African Railways:** coat of arms.

71 **Malayan Railways:** the crest, granted in 1957.

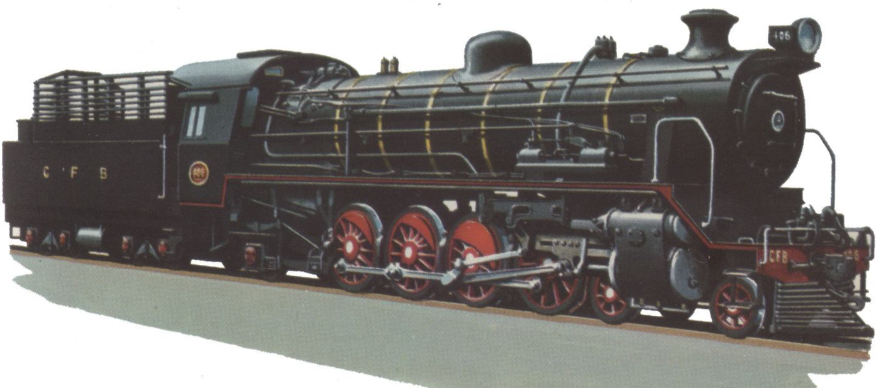
72 **British Railways:** the first insignia.



73 **Rhodesia Railways:** the '20th' class Beyer–Garratt 4–8–2 +2–8–4 locomotive.

74 **New Zealand Government Railways:** the 'Da' class diesel-electric locomotive of 1955.

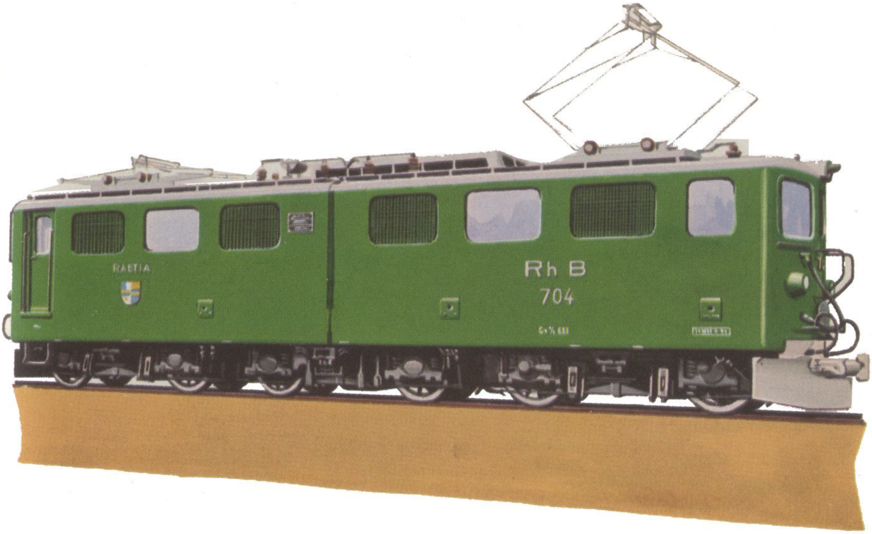
75 **Rhodesia Railways:** fourth class main-line carriage.



76 **Benguela Railway (Portuguese West Africa):** 4–8–2 wood-burning locomotive.

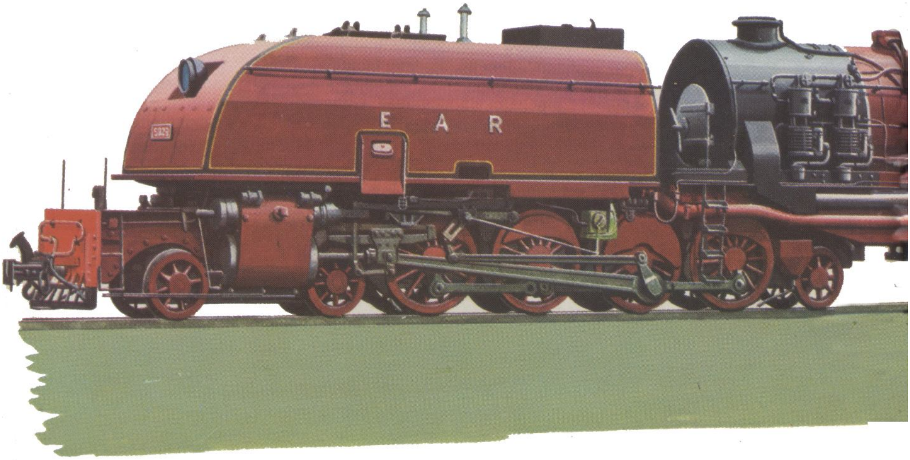
77 **British Railways, London Midland Region:** the 'AL6' Bo – Bo electric locomotive.

78 **German Federal Railways:** the Class 'E.10' Bo – Bo electric locomotive.

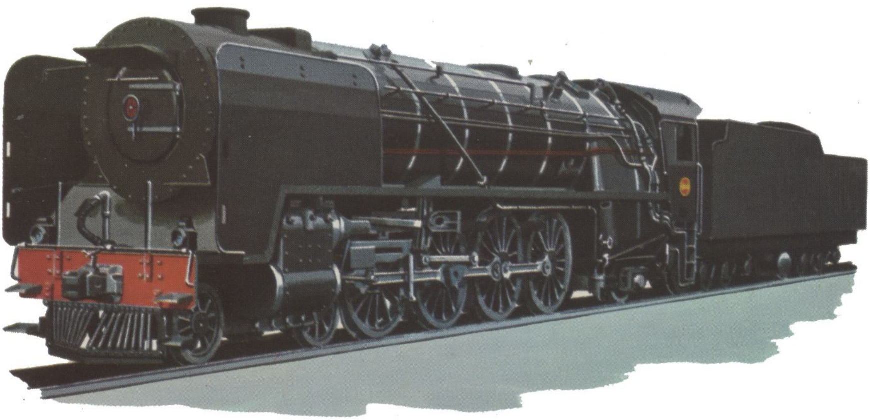


79 **Rhaetian Railway (Switzerland):** electric locomotive of Class 'Ge 6/6'.

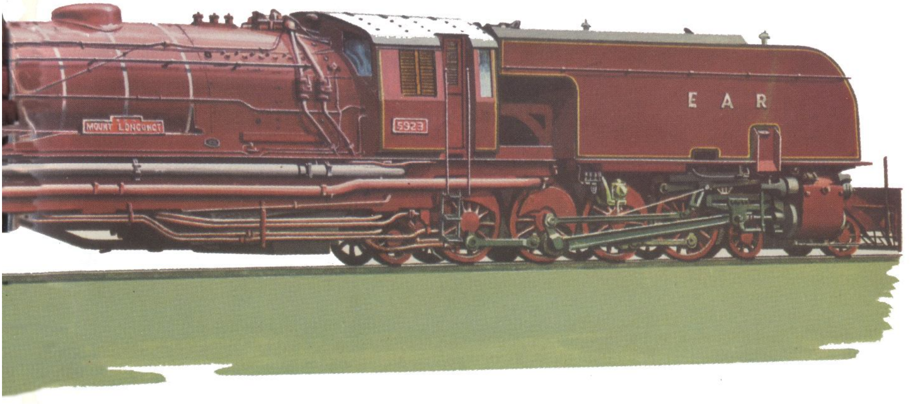
80 **South African Railways:** the '5E1' mixed traffic main-line electric locomotive.

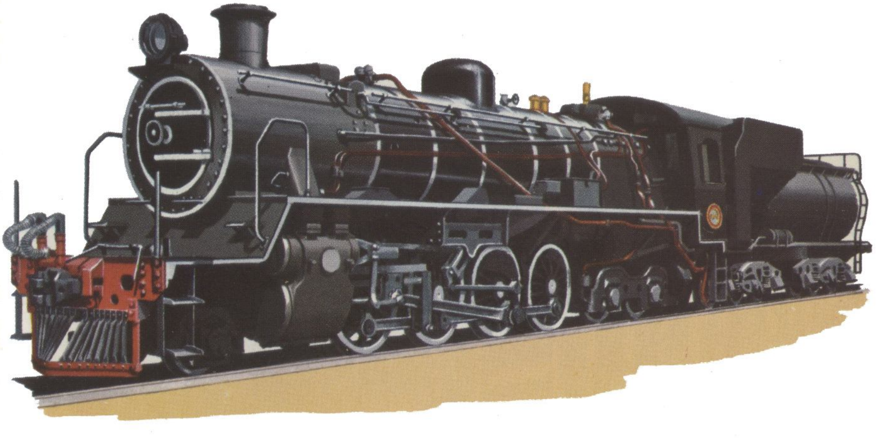


81 **East African Railways:** the '59th' class Beyer-Garratt 4-8-2+2-8-4 locomotive.



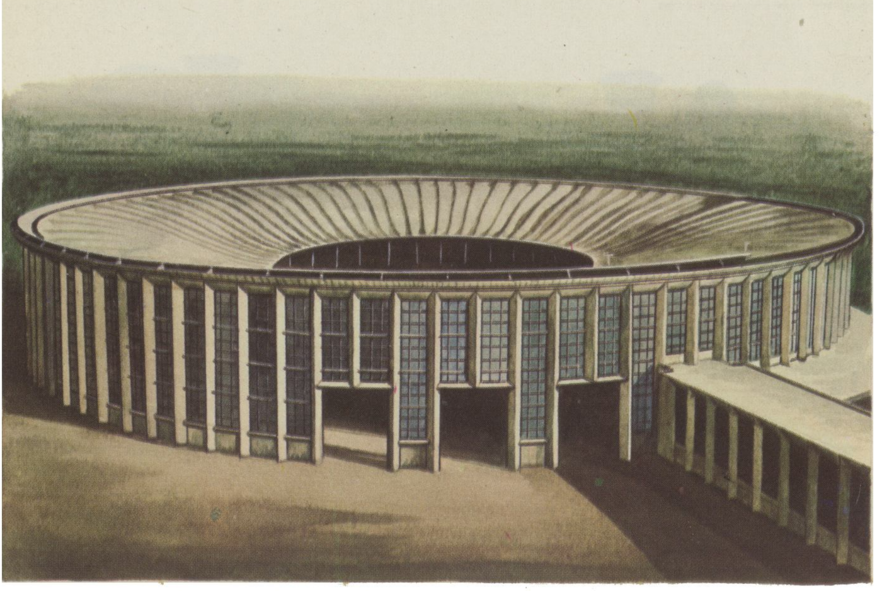
82 **South African Railways:** the '23' class 4-8-2 express passenger locomotive.





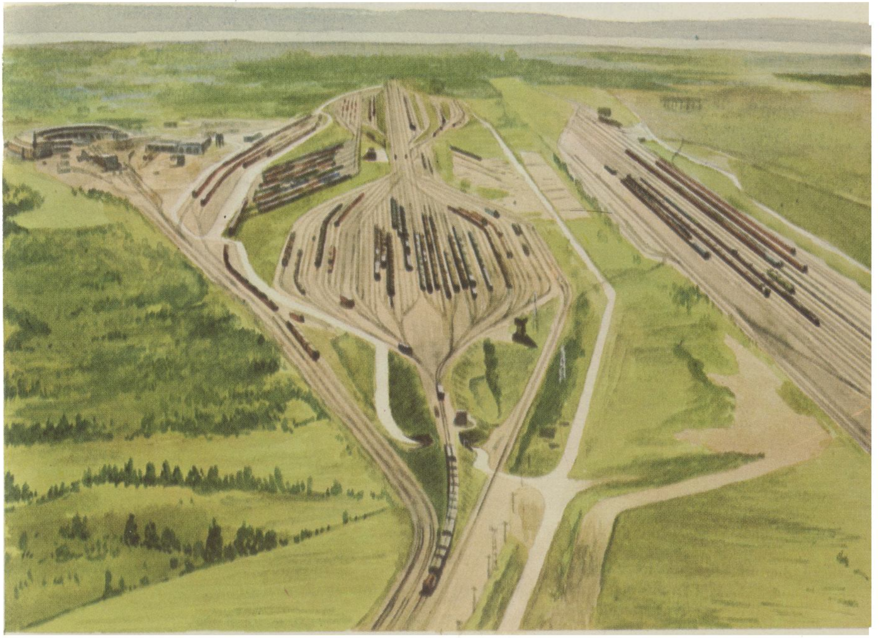
83 **South African Railways:** the '24' class lightweight branch 2-8-4 locomotive.

84 **South African Railways:** Cape Town, new signal box.



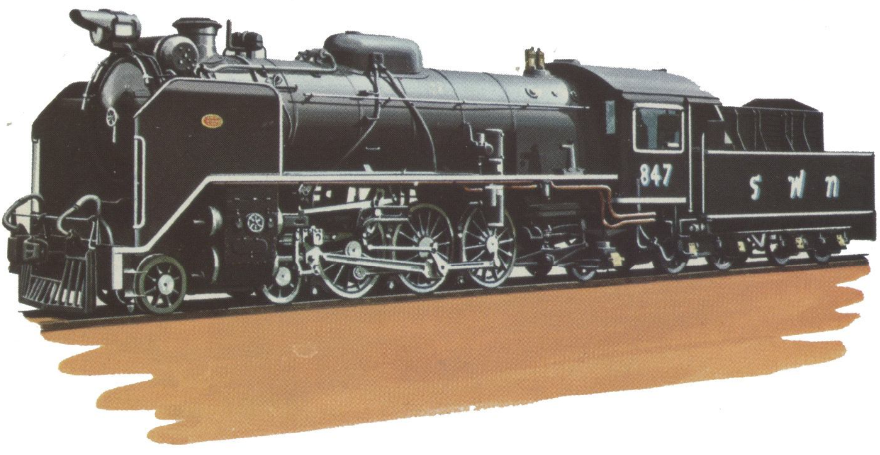
85 **French National Railways:** the new locomotive roundhouse at Avignon.

86 **Canadian National Railways:** Toronto Yard; the 'hump' control tower.

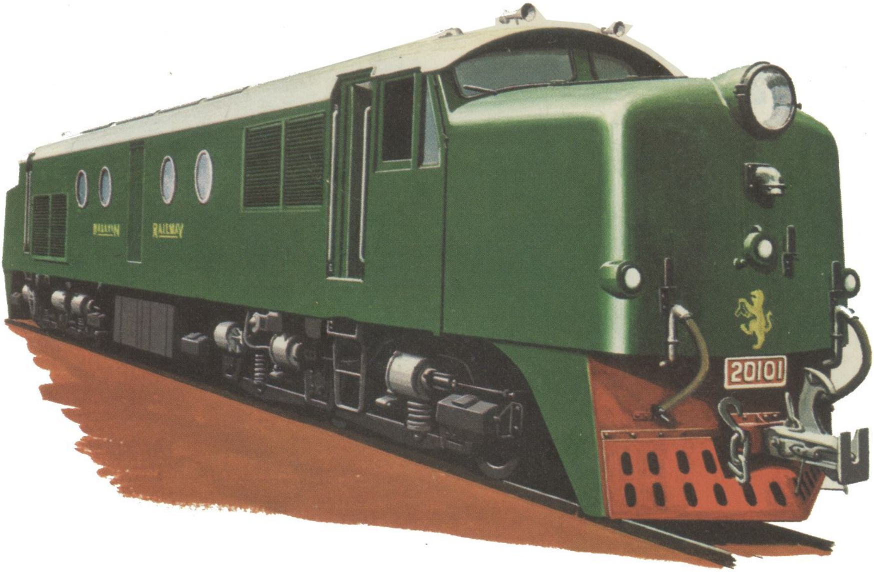


87 **Canadian Pacific Railways:** St. Luc marshalling yard, near Montreal.

88 **Royal State Railways of Thailand:** diesel-hydraulic express passenger locomotive.



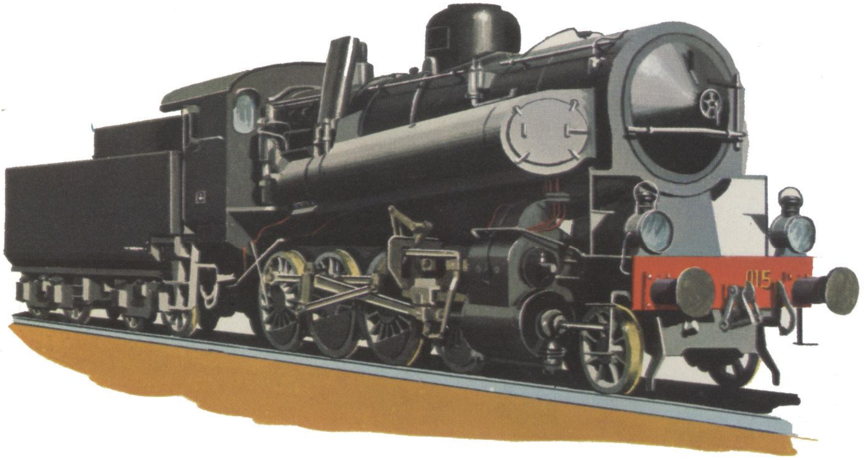
89 **Royal State Railways of Thailand:** 4–6–2 wood-burning express passenger 'Pacific'.



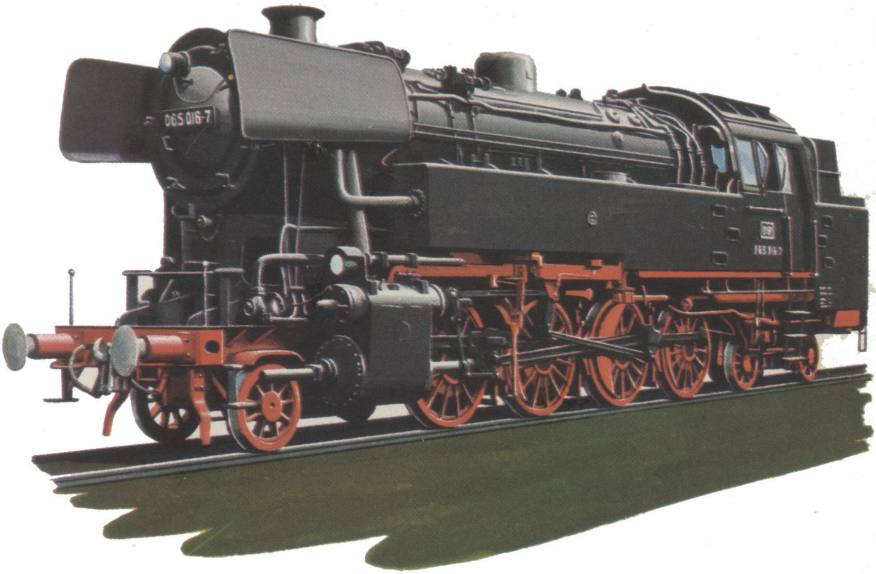
90 **Malayan Railways:** diesel-electric 1,500-horsepower main-line locomotive.

91 **Burma Railways:** diesel-hydraulic general service locomotive.

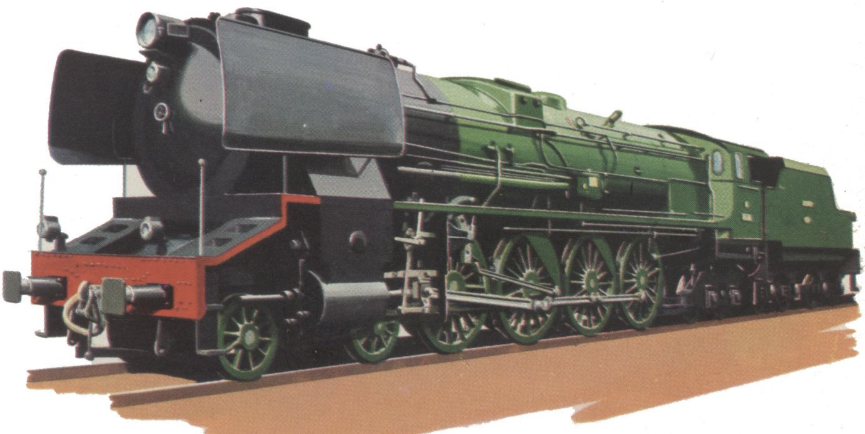
92 **French National Railways:** the ex-P.L.M. 'K' class rebuilt 'Pacific'.



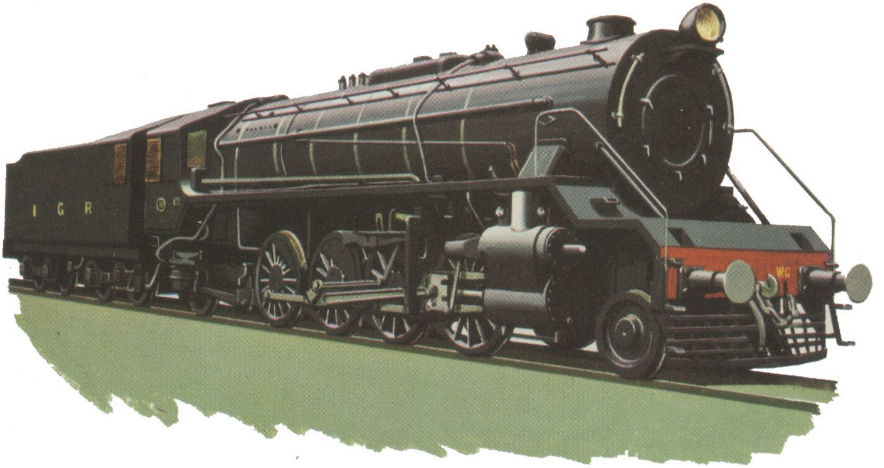
93 **Italian State Railways:** 2–8–0 locomotive with Crosti boiler.



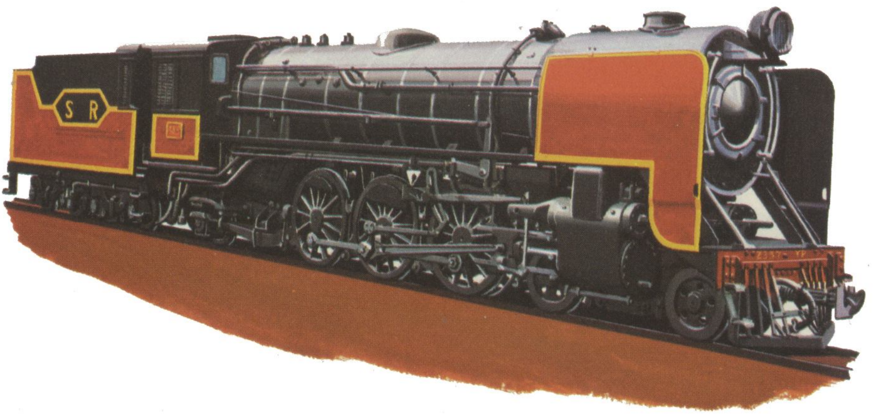
94 **German Federal Railways (D.B.):** the post-war standard 2-8-4 tank locomotive.



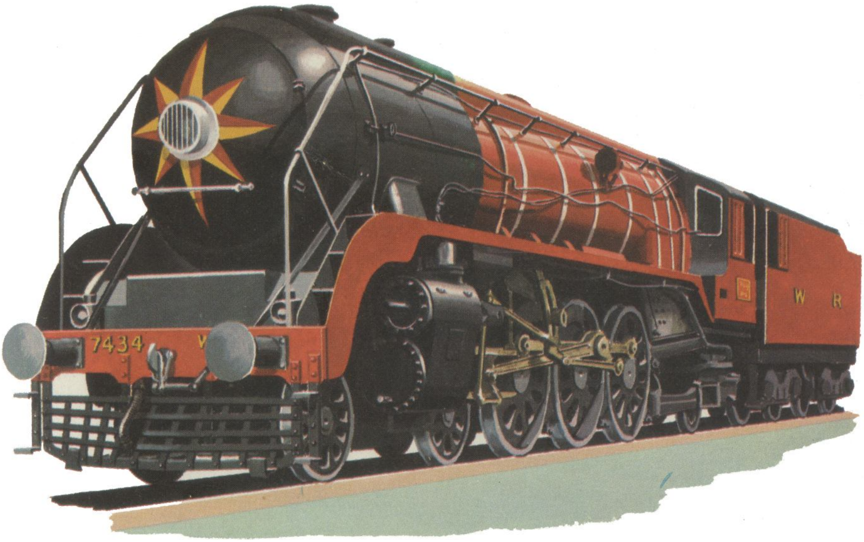
95 **Spanish National Railways (RENFE):** 4-8-4 express passenger locomotive.



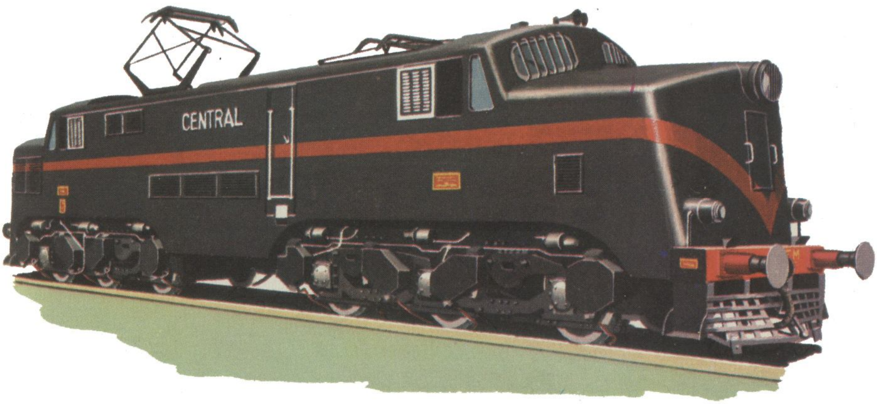
96 **Indian Government Railways:** the 'W.G.' class standard 2-8-2 heavy freight locomotive.



97 **Indian Government Railways:** the 'Y.P.' class metre-gauge standard 'Pacific'.



98 **Indian Government Railways:** the 'W.P.' standard 4-6-2 express passenger locomotive.

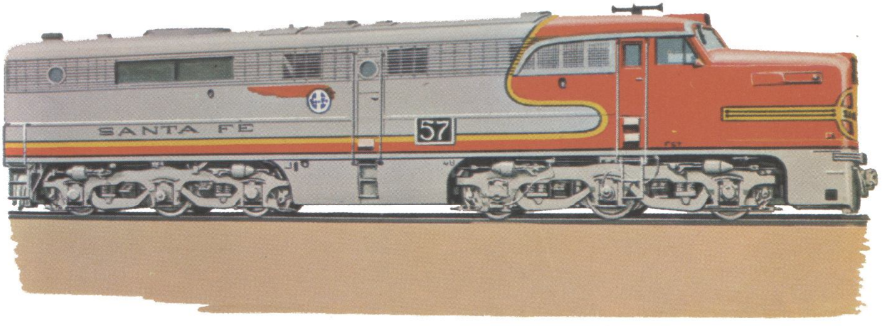


99 **Indian Government Railways:** 3,600-horsepower electric main-line locomotive.

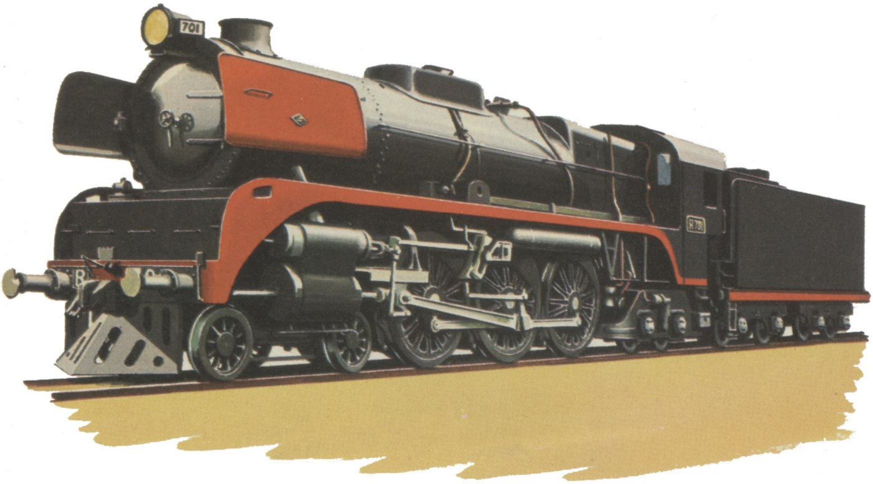
100 **Union Pacific Railroad:** the 'GP20' 2,000-horsepower diesel-electric locomotive.

101 **Central Railway of Brazil:** U.S.-built 'SD 18' diesel-electric locomotive.

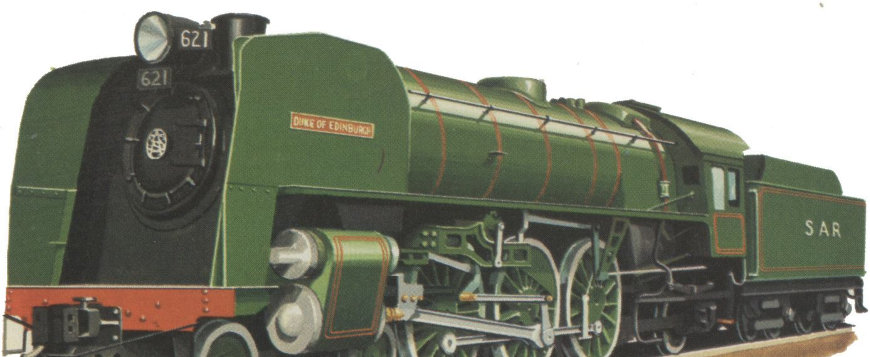
102 **Illinois Central Railroad:** the 'GP-40' general-purpose diesel-electric locomotive, 3,000 horsepower.



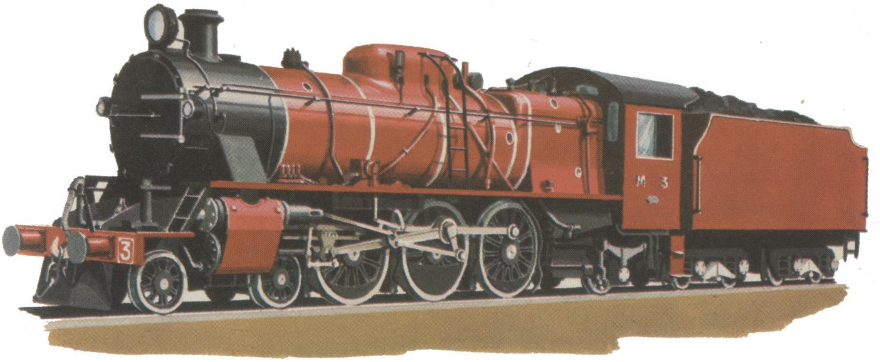
103 **Atchison, Topeka & Sante Fe:** the ALCO 'PA-1' diesel-electric locomotive of 1946.



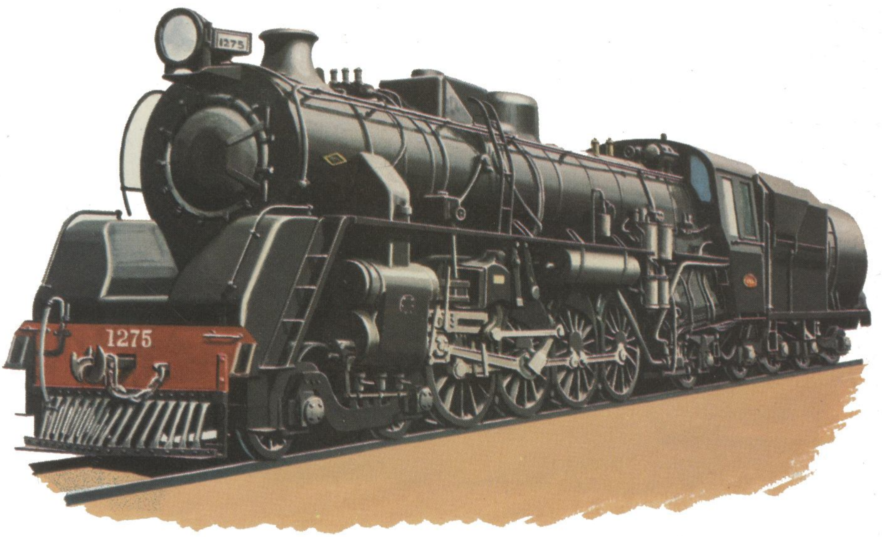
104 **Victorian Railways:** the 'R' class 4–6–4 express passenger locomotive.



105 **South Australian Railways:** the rebuilt 4–6–2 locomotive *Duke of Edinburgh*.



106 **Tasmanian Government Railways:** the 'M' class 4–6–2 locomotive of 1951; 3 ft. 6 in. gauge.



107 **New Zealand Government Railways:** the 'JA' class 4–8–2 passenger and mixed traffic locomotive.

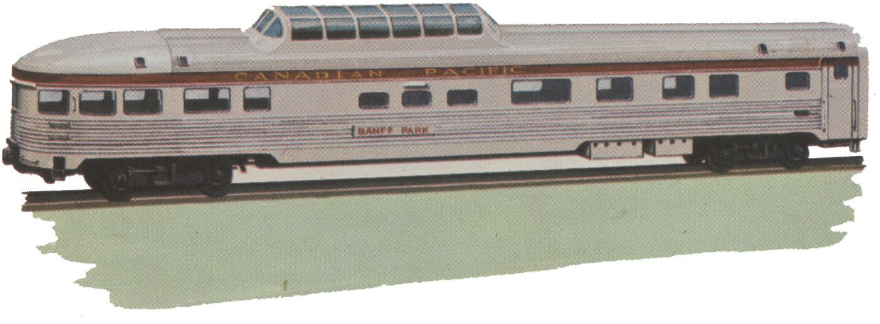
108 **German Federal Railways:** the Krauss-Maffei 'V. 200' diesel-hydraulic locomotive.

109 **French National Railways (S.N.C.F.):** the '68,000' class diesel-electric locomotive.

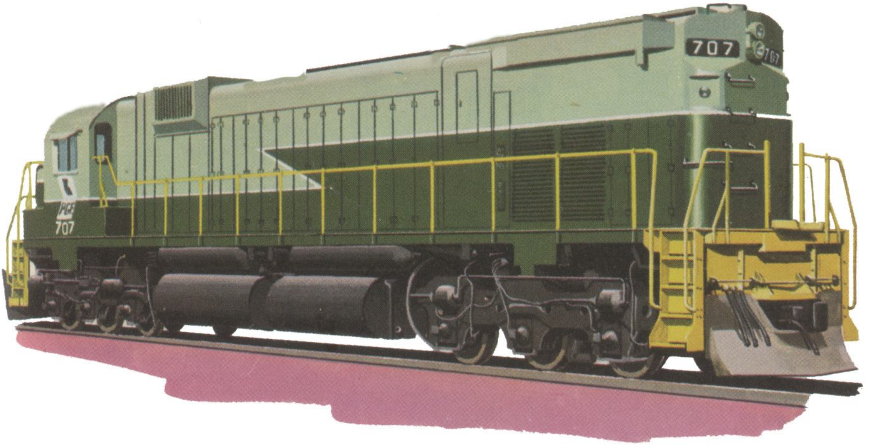
110 **Finnish State Railways:** main-line 1,900-horsepower diesel-electric locomotive.

111 **Danish State Railways:** 1,750-horsepower diesel-electric main-line locomotive.

112 **Canadian Pacific Railway:** 1,500-horsepower diesel-electric locomotive.

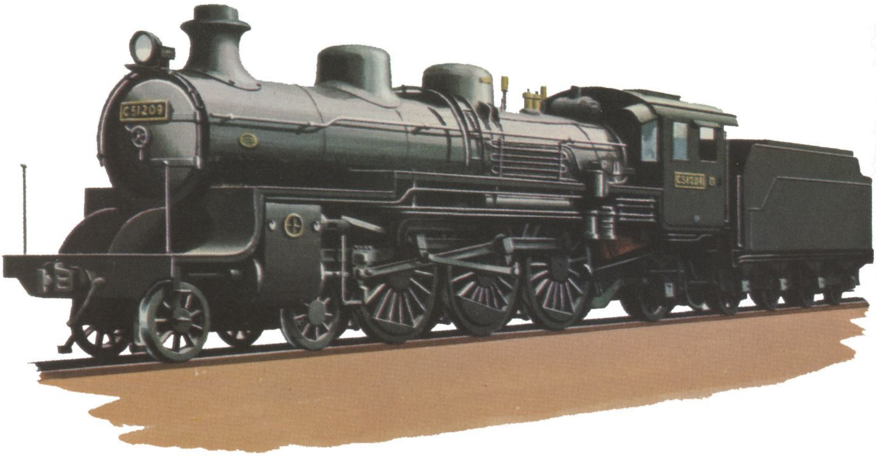


113 **Canadian Pacific Railway:** the 'dome-observation-lounge' car.



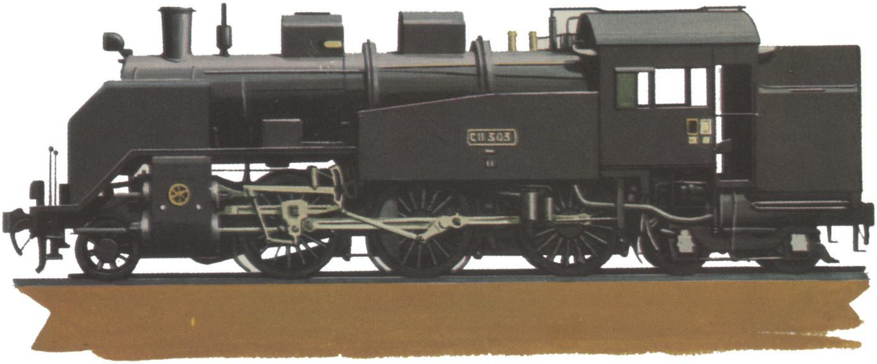
114 **Pacific Great Eastern Railway:** 'MLW'-type 3,000-horsepower diesel-electric locomotive.

115 **Algoma Central Railway:** 'GP 7' 1,500 horse-power diesel-electric locomotive.

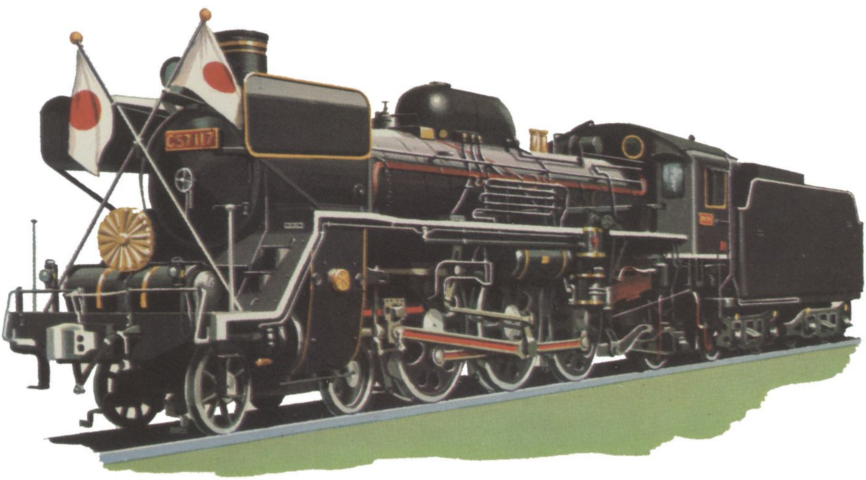


116 **Japanese National Railways:** the 'C51' class 4-6-2 express passenger locomotive.

117 **Japanese National Railways:** the 'C53' class three-cylinder 4-6-2 express locomotive.



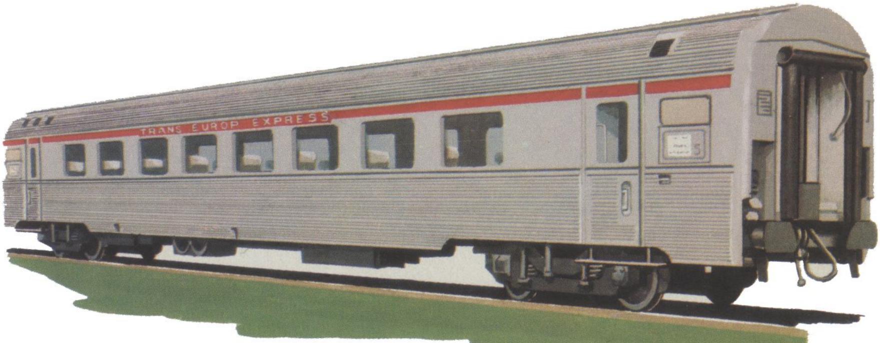
118 **Japanese National Railways:** the 'C11' class 2-6-4 branch passenger tank engine.



119 **Japanese National Railways:** the 'C57' 'light' 4-6-2 passenger locomotive.

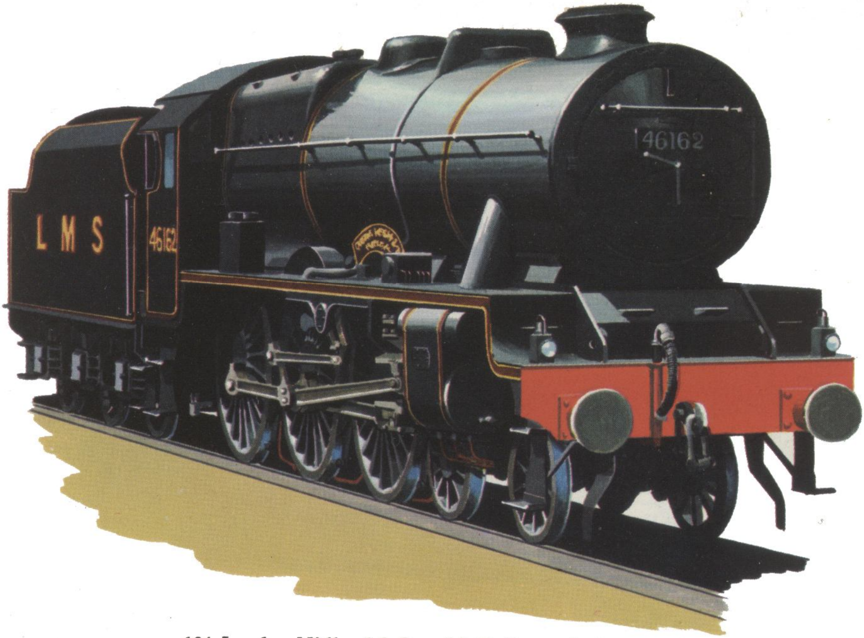
120 **Netherlands State Railways:** Bo – Bo electric locomotive.

121 **French National Railways:** quadri-current high-speed electric locomotive.

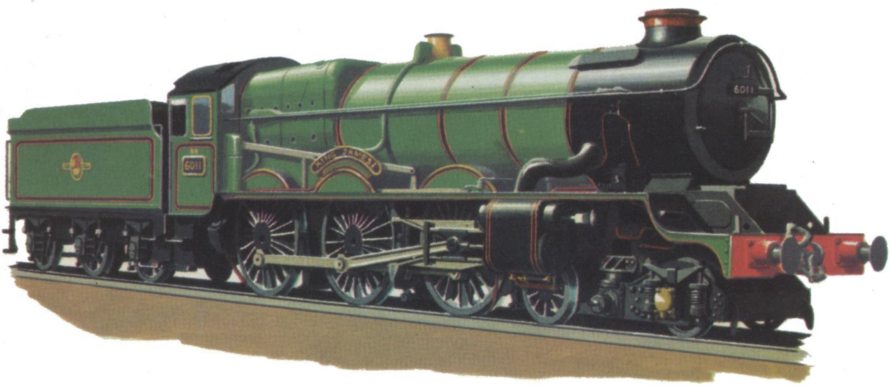


122 **French National Railways:** Grand-confort' rolling stock for TEE services.

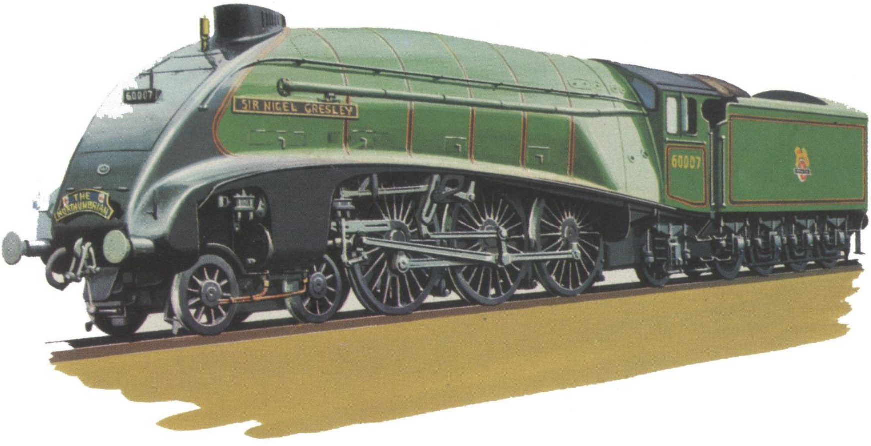
123 **Italian State Railways:** the 'Settebello' de luxe high-speed electric train.



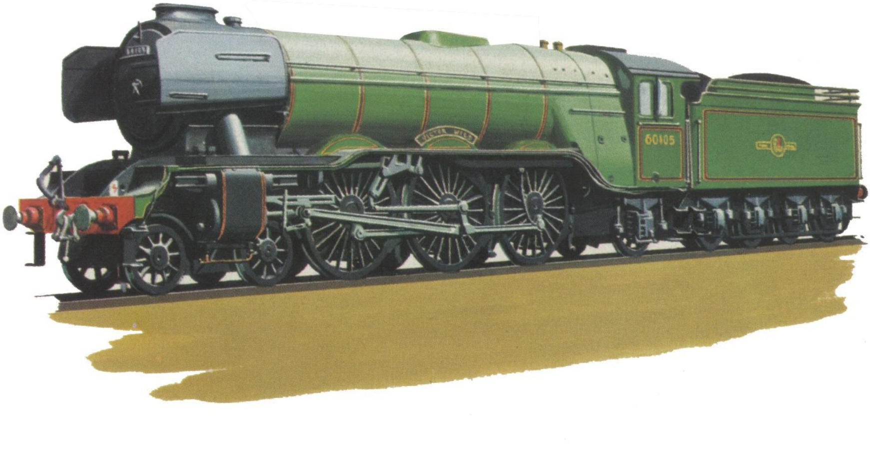
124 **London Midland & Scottish Railway:** the 'converted' 'Royal Scot' class 4–6–0 locomotive.



125 **British Railways, Western Region:** the 'King' class 4–6–0.



126 **British Railways, Eastern Region:** the 'A4' streamlined 'Pacific'.



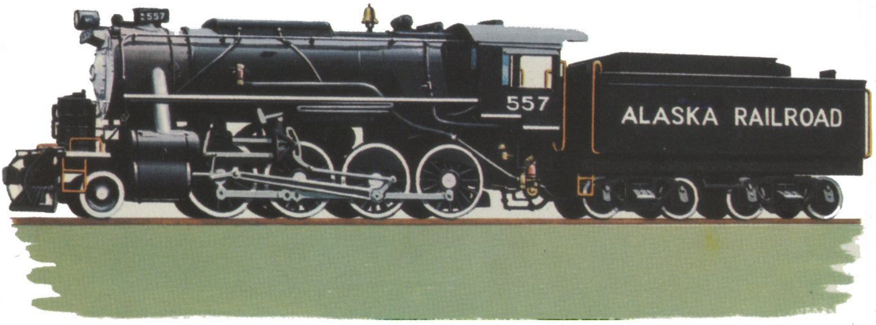
127 **British Railways, Eastern Region:** the 'A3' 'Pacific' express passenger locomotive.

128 **New Zealand Government Railways:** the 'EW' class 1,800-horsepower Bo–Bo–Bo electric locomotive.

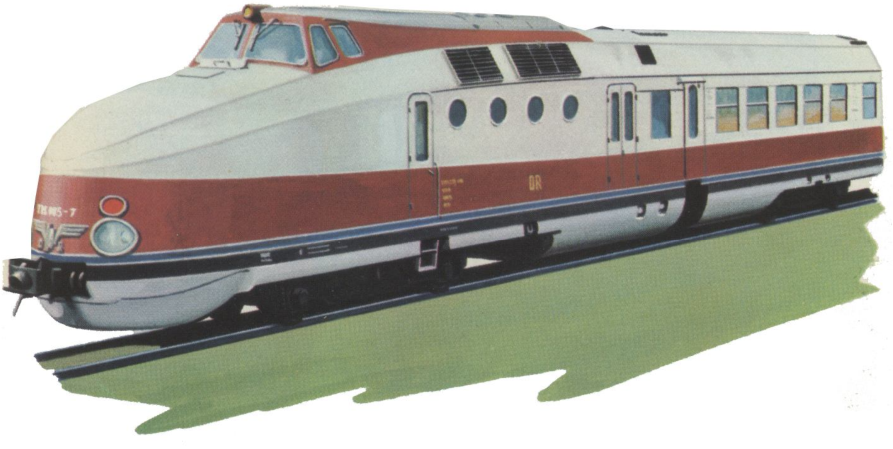
129 **New South Wales Government Railways:** the '46' class main-line electric locomotive.

130 **Commonwealth Railways (Australia):** 1,500-horse-power G.M. diesel-electric locomotive.

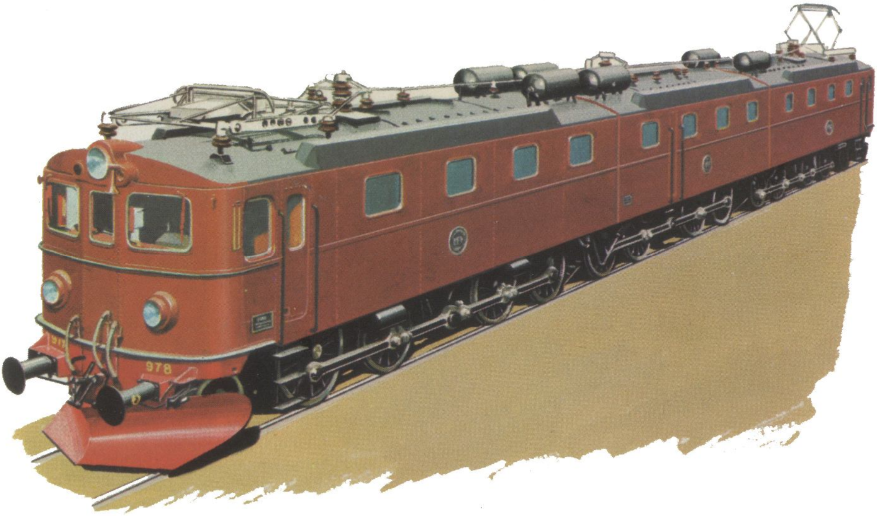
131 **Queensland Railways:** 90-ton Co – Co diesel-electric main-line locomotive.



132 **The Alaska Railroad:** 2-8-0 general service locomotive of 1943.



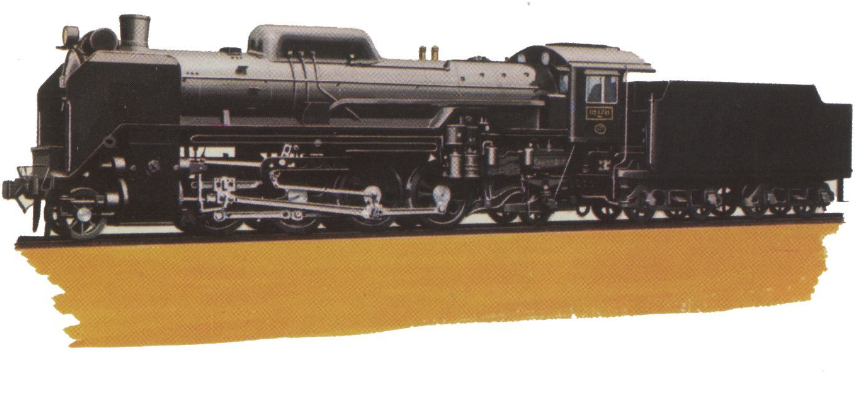
133 **Deutschen Reichsbahn (East Germany):** high-speed diesel railcar train.



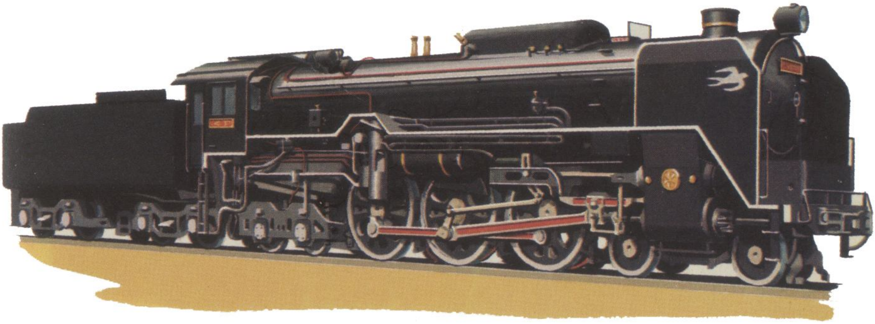
134 **Swedish State Railways:** the 'Dm 3' 9,780-horsepower electric locomotive.

135 **Italian State Railways:** the 'D 341' class diesel-electric locomotive.

136 **Japanese National Railways:** a diesel multiple-unit express train.



137 **Japanese National Railways:** the 'D51' class 2-8-2 mixed traffic locomotive.

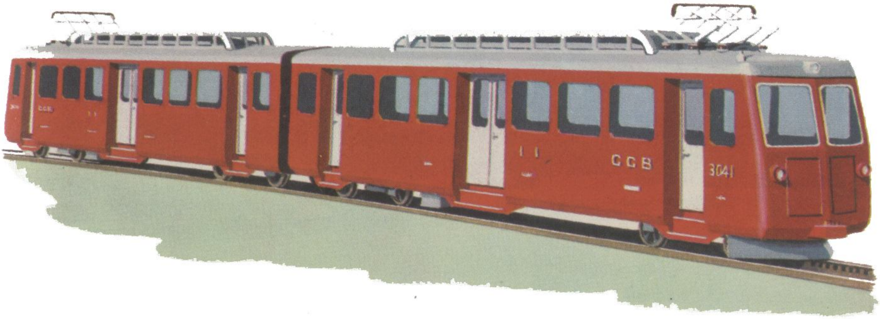


138 **Japanese National Railways:** the 'C62' class 4-6-4 express passenger locomotive.

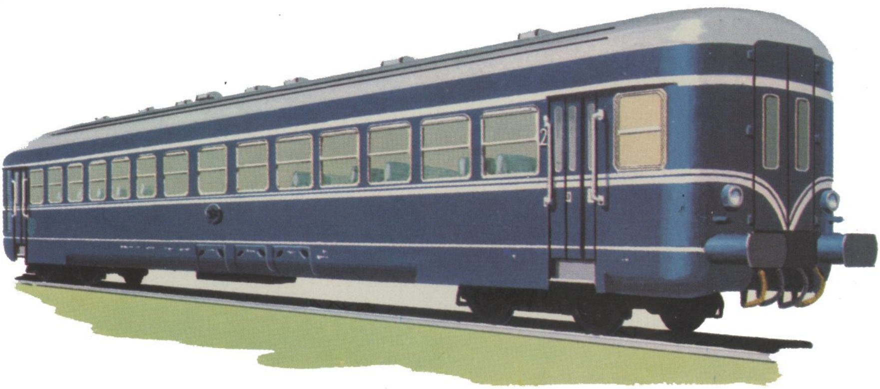
139 **Japanese National Railways:** one of the 'ED' series of electric locomotives.

140 **Victorian & South Australian Railways:** first class sleeping car for the 'Overland'.

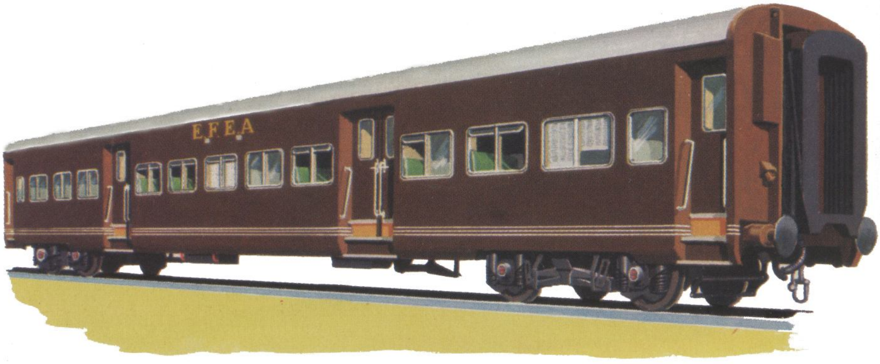
141 **German Federal Railways:** an inter-city double-decker train.



142 **The Gornergrat Railway (Switzerland):** electric rail-car train.

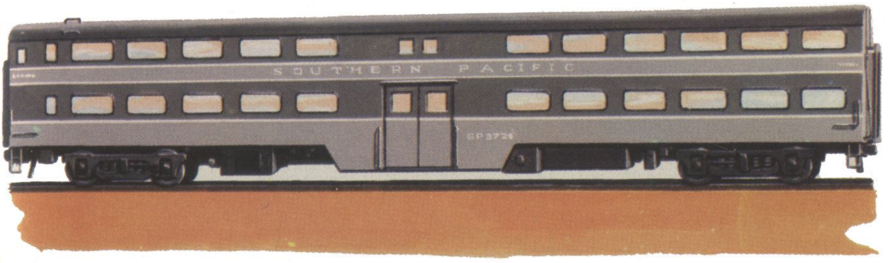


143 **Greek State Railways:** Bogie de luxe coach.



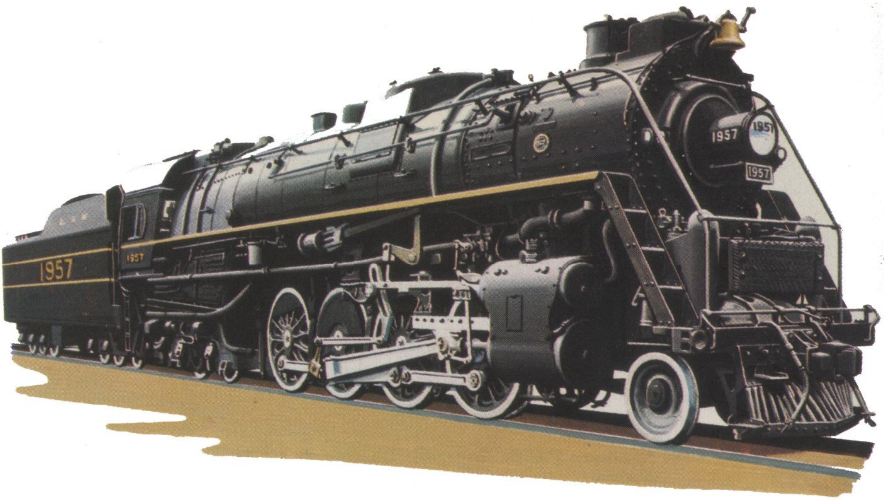
144 **Argentine State Railways:** suburban service first class carriage.

145 **Chilean State Railways:** Co-Co express passenger electric locomotive.

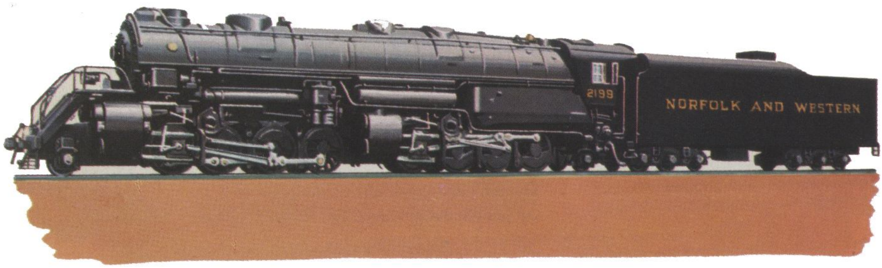


146 **Southern Pacific Railroad:** Double-deck car for San Francisco suburban train.

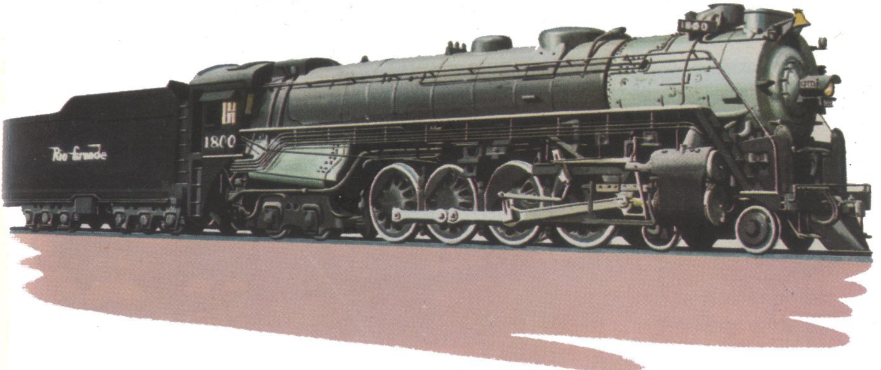
147 **Spanish National Railways (RENFE):** 3,000-volt electric multiple-unit train.



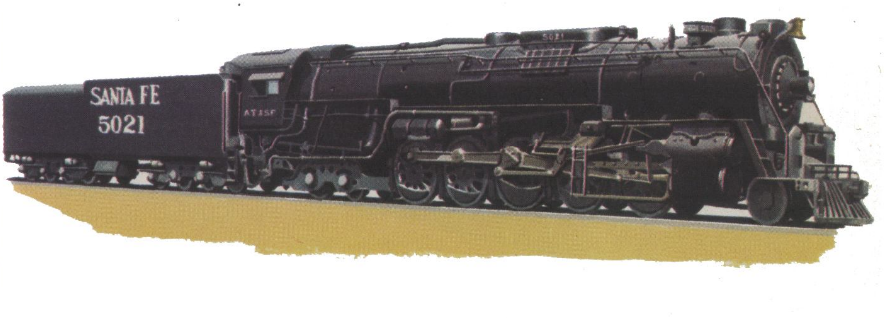
148 **Louisville & Nashville Railroad:** the 'M1' class 2-8-4 of 1942.



149 **Norfolk & Western Railway:** 2-8-8-2 compound 'Mallet' freight locomotive.

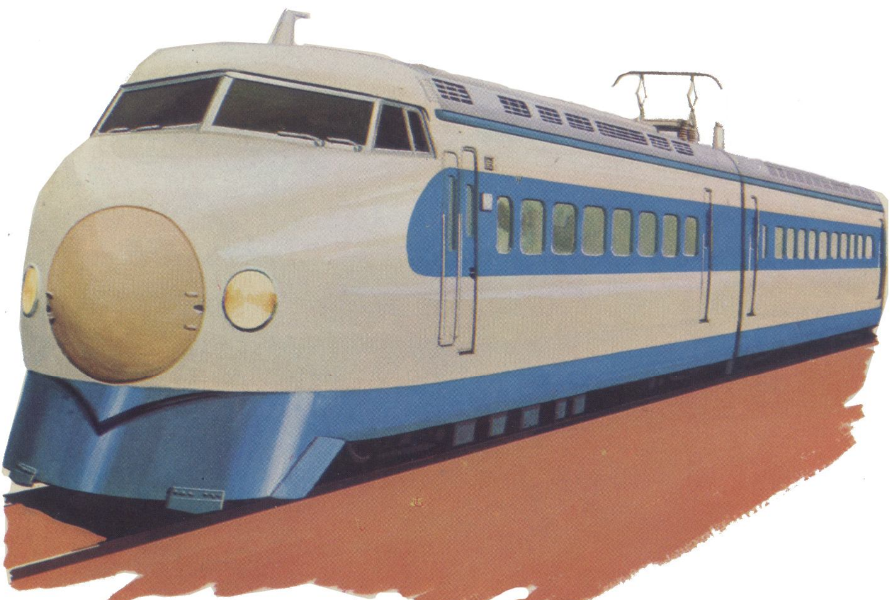


150 **Denver & Rio Grande Western:** 4–8–4 express passenger locomotive.



151 **Atchison, Topeka & Santa Fe:** the '5011' class 2–10–4 heavy freight locomotive.

152 **British Railways:** standard Type '4' diesel-electric locomotive Class '47'.



153 **Japanese National Railways:** 'Hikari' super express train.

RAILWAYS
IN THE TRANSITION FROM STEAM
1940–65

1 **Southern Pacific Railroad:** The 'GS–4' Class 4–8–4 Locomotive used for the 'Daylight Express'.

For a long period, following the highly ornamented styles of early days, American locomotives were devoid of any form of decoration, or even of colour. But in the 1930s, with the advent of streamlining, and the strenuous efforts of most administrations to attract traffic, many fanciful colour schemes were adopted. Of these there was none more striking than that of the 4–8–4 locomotives used to haul the 'Daylight Express' of the Southern Pacific Railroad, running between San Francisco and Los Angeles. The locomotives themselves, quite apart from their highly decorative finish, were of excellent design, generally considered to be one of the finest, as well as most powerful of their wheel arrangement. The cylinders were 25½ in. diameter and 32 in. stroke; coupled wheels were 6ft. 8 in. diameter, and boiler pressure 300 lb. per sq. in. The trailing truck was fitted with a booster engine. In normal working the tractive effort was 64,760 lb. and with booster in action this was increased to 77,760 lb. The total weight of the engine only in working order was 237 tons, and of the tender fully loaded, 156 tons. These engines, of which twenty were built by the Lima Locomotive Works, were oil-fired.

2 **Canadian National Railways:** The U–2–g Class 4–8–4 of 1942.

The Canadian National Railways developed the eight-coupled type of locomotive to a very high degree of power and efficiency, commencing with the 'U' class 4–8–2s of 1923, and going on to the 'U–2–a' 4–8–4 of 1927. From these large locomotives the design was developed to the 'U–2–g' of 1942, and the first of this class is shown in our picture. It was one of this series, No. 6218, that made the last runs with steam on the Canadian National Railways in 1971. These huge engines, of which there were thirty-five, had two cylinders 25½ in. diameter by 30 in. stroke; the coupled wheels were 6 ft. 1 in. in diameter, and the boiler pressure 250 lb. per sq. in. They were followed by a still later variety, the 'U–2–h' in 1943–4, which had the same basic dimensions, but were improved in certain details. Of this final batch there were thirty, and like the 'U–2–g' series they were built by the Montreal Locomotive Works. Their most spectacular performance was regularly made on the very heavy daytime expresses between Montreal and Toronto, on which they hauled loads of 1,000 tons at speeds of 80–85 m.p.h. on level track.

3 Engines of 'Dunkirk': (*a*) The S.E. & C.R. 'E' Class.

In the evacuation of the British Expeditionary Force from the Dunkirk beaches in 1940 the working of the troop trains on the Southern Railway was as vital a part of the operation as the ferrying of the men across the Channel, though it was fortunately not fraught with such incessant enemy attack. Every locomotive that could turn a wheel was pressed into service, and famous veterans took their places alongside more modern types. Many soldiers, not normally railway enthusiasts, were cheered by the sight of the clean, smartly turned out engines, as a sign that whatever chaos might reign across the Channel things were still in order at home. As previous volumes in this series have shown, the engines of the S.E. & C.R. were amongst the most ornate of any in Great Britain, and in Southern Railway days the famous Wainwright 'E' class, though not sporting the former array of polished brass and copper-work, were smart enough when they hauled some of the troop trains of Dunkirk. They were then over thirty years old, but continued in service throughout the War, and the majority for about ten years afterwards, reaching more than forty-five years of excellent work. Our picture shows one of them as running at the time of Dunkirk.

4 Engines of 'Dunkirk': (*b*) The 'King Arthur' Class.

Despite the success of other Southern Railway express locomotives of the inter-war period, and the production subsequently of the range of Bulleid air-smoothed 'Pacifics', the 'King Arthurs' will always remain one of the most popular classes ever to have run the rails in Southern England, and it is appropriate that locomotives with names taken from the chivalry of the Arthurian legend should have assisted in such an operation as Dunkirk. Engines working the trains from Dover and Folkestone ran to Redhill, where fresh engines took over for the further journeys of the trains. Such was the urgency of the operation that no time could be spared for turning the engines. Many of them returned from Dover tender first, after their fires had been cleaned and they had re-watered. It was usual to make two return trips on one tenderful of coal, and many were the runs on which the fireman was using the last remaining shovelfuls on his approach to Redhill! So much ash from fires was dumped in the engine yard at Redhill that it became a major problem to remove it. Never before had so many engines been serviced there in so short a time. Our picture shows a 'King Arthur' class engine in the malachite-green livery that had not long previously been adopted for the largest Southern express locomotives.

5 War Department: G.W.R. 'Dean Goods' 0–6–0 Fitted for Military Service, 1940.

At the beginning of World War II equipment was prepared for use with the British Expeditionary Force drafted for service on the continent of Europe. While the 2–8–0 was considered ideal for generally heavy service, on troop trains and such like there was a need for lighter units, and for this the ever-popular Great Western 'Dean Goods' was chosen. Although the design dated from as early as 1883 it had been successively modernised, notably by the addition of a superheater, and in 1939 it was one of the handiest and most efficient mixed traffic types in Great Britain. For service on the Continent the engines selected had to be fitted with the Westinghouse air-brake. Our picture shows one of these, with the familiar air-pump mounted on the side of the smokebox and the main reservoir on the running plate. A further batch of these engines was equipped for running in areas where water was not readily available. They were equipped with condensing tanks, and steam pipes for obtaining water from wayside streams and small rivers, when necessary.

6 **The First British War Department:** 2–8–0 of 1940.

In the early days of World War II a long campaign over a battlefront on the frontiers of France and Germany was foreseen and, based on the experience of 1914–18, preparations were made for equipment for military service behind what was expected to be the British sector of the battle line. The Stanier 2–8–0 of the L.M.S.R. was chosen as a general-purpose locomotive, equally successful in the haulage of heavy freight and in working passenger trains at moderate speeds. Various modifications to the design were made to render it suitable for Continental use, such as the fitting of standard French coupling and buffing gear, and the Westinghouse brake. But the first locomotives were only just completed by the North British Locomotive Company when the dramatic success of the German attacks on the western front led to the retreat and evacuation from Dunkirk. These special 'W.D.' 2–8–0s were afterwards sent to the Middle East, working in Egypt, Palestine and elsewhere. When the time came for the re-entry of Allied forces into Europe, a different type of 2–8–0 was specially designed, as referred to later in this book, under ref. 29.

7 **Pennsylvania Railroad:** 4–4–4–4 Express Passenger Locomotive of 1942.

The Pennsylvania had a very distinguished record of steam locomotive development. It was one of the very few American railways to build in its own shops and to form an individual practice, as distinct from that of the great locomotive manufacturers. Earlier volumes of this series have described and illustrated famous designs, such as the 'K4' 'Pacific' and 'M–1–a' 'Mountain'. The locomotive now illustrated was the culmination of this development, and followed the construction in 1939 of a still larger non-articulated experimental locomotive of the 6–4–4–6 type. The engines of 1942 had four cylinders and, to keep them all outside, the drive was divided between two pairs of four-coupled wheels. The boiler was necessarily very large and carried a pressure of 300 lb. per sq. in. The grate, which was of course mechanically fired, had an area of 92 sq. ft., while the four cylinders were each of 19¾ in. diameter by 26 in. stroke. The coupled wheels were 6 ft. 8 in. diameter and the tractive effort, 65,000 lb. The engine alone weighed 222 tons, and the huge tender another 193 tons. These locomotives were capable of hauling trains of 1,000 tons at 100 m.p.h. on level track.

8 **Pennsylvania Railroad:** 6-8-6 Non-condensing Geared-turbine Express Passenger Locomotive of 1944.

In 1935 Sir William Stanier, when Chief Mechanical Engineer of the L.M.S.R., interposed in the celebrated series of 'Pacific' engines of the 'Princess Royal' class one that was turbine-driven, and this engine was illustrated in a previous volume of this series, *Railways at the Zenith of Steam* 1920–40. It was very successful, but its economy in working over the ordinary 'Pacific' engines was not such as to justify the building of any more. The Pennsylvania Railroad made a closely similar experiment in 1944, and the remarkable engine now illustrated, No. 6200, was operated in regular traffic on the same duties as the 4-4-4-4 engines of the '5511' class (ref. 7). It was an even larger and heavier locomotive than these latter, weighing 259 tons (engine) and 189 tons (tender). The tractive effort was 70,500 lb. This tremendous engine, like its forerunner in England, did some magnificent work; but it was introduced when steam was definitely 'on the way out' in the U.S.A., and it unfortunately made no lasting impact on future practice.

9 **Union Pacific Railroad:** The 4-8-8-4 Express Freight Locomotive of 1941 – 'Big Boy'.

To the Union Pacific Railroad belongs the distinction of having the largest and heaviest locomotives ever built. The '4000' class, built by ALCO, were designed for the express freight traffic over the historic first trans-continental main line of the U.S.A. Their tractive effort of 135,400 lb. was exceeded by several other large American classes, notably by the Northern Pacific '5000' class of 1928; but as a modern design, of maximum efficiency, the 'Big Boys' were unsurpassed in their particular field. Their cylinders were 23¾ in. by 32 in. stroke; they had coupled wheels 5 ft. 8 in. in diameter; and the boiler pressure was 300 lb. per sq. in. The grate area was no less than 150·3 sq. ft. The overall length was 117 ft. 7 in. The total weight of engine only in working order was no less than 354 tons, and the tender, carried on fourteen wheels, weighed another 194 tons – 'Big Boys' indeed!

10 **Nashville, Chattanooga and St. Louis Railway:** The 'Yellow Jacket' Class 'J3' 4-8-4.

The line is one of the oldest in the southern states of the U.S.A., the first section having been opened in 1849. It is now closely associated with the great Louisville and Nashville Railroad, and it is by this association that the N.C. & St.L. actually makes contact with the city of St. Louis. Its own main line runs roughly east and west from Atlanta north-westwards to Chattanooga and Nashville, where it intersects the main line of the Louisville and Nashville. After that the N.C. & St.L. proceeds almost due west to Memphis, on the Mississippi some 250 miles south of St. Louis. It was in 1930 that the N.C. & St.L. took delivery of four large locomotives of the 4-8-4 type. They rode so smoothly that they earned the nickname of the 'Gliders'. They did excellent work, but it was not until war conditions demanded extra power that additional 4–8–4s were added. Ten new engines of an improved design were purchased in 1942, and they had a decorative touch in the broad yellow band running the length of the engine and tender. Our picture shows the first of these fine engines that received the nickname of the 'Yellow Jackets'. A further ten were added in 1943. One of these engines has been preserved and is on permanent display in Nashville's Centennial Park.

11 **St. Louis – San Francisco Railway (Frisco Lines):** Diesel-electric Locomotive.

This illustration has been chosen as typical of what are now termed the 'first-generation' diesels of the U.S.A. The Electro-Motive Division of General Motors began its remarkably successful production run of standard main-line diesel-electric locomotives in 1938, using the mass-produced '567' engine. The company had a considerable start on its competitors and, to rationalise production and use each plant to its optimum capacity during the War, the U.S. Government ordered that all main-line diesels were to be built by General Motors. In 1940 it built no less than 218 units, almost one every working day. In contrast to the universal black of work-a-day steam locomotives in the U.S.A., the new diesels were decked in gay colours. The two-unit locomotive illustrated has a total of four engines each of 1,000 horsepower, each of which has twelve cylinders, 8½ in. diameter by 10 in. stroke, arranged in V-type formation. There are two six-wheeled trucks under each section, with the motors supplying power to the front and rear axles of each truck, with the centre axle unpowered. The wheel arrangement of each unit is thus A–1–A + A–1–A.

12 **Western Pacific Railroad: A** Modern Luxury Coach.

The beautiful stainless-steel cars introduced by the Budd Manufacturing Company have become familiar sights on railways in many parts of the world, either by direct supply or through the activities of associated companies. The car we illustrate is one used on the 'California Zephyr' service of the Western Pacific Railroad, a line that runs westward from Salt Lake City across the states of Utah and Nevada to enter California near Herlong and then make a southward course to Sacramento and San Francisco. This car includes what was originally termed a 'Vista-Dome', that proved so popular with sightseers that in later cars greater accommodation was provided in 'domes', in combined buffet, lounge and observation cars. As is so vividly shown in our picture, the opportunity given by the materials and form of construction of the car was taken to make it truly a thing of beauty.

13 **Chesapeake and Ohio Railroad:** A Typical United States 'Roundhouse'.

In the early days of railways in all parts of the world the most generally favoured type of 'house' for keeping locomotives not in immediate use was the roundhouse, consisting of a series of tracks extending like the spokes of a wheel from a central turntable. In Great Britain however, about the turn of the century, the 'straight' type of shed began to come into vogue, and this was much developed in later years, to fit in with 'through' servicing facilities in which locomotives entered at one end, and were 'progressed' through to the other end in readiness for their next turn of duty. On the continent of Europe however, and in North America, the roundhouse remained the standard form of shed, and some very fine new buildings were constructed in later years to provide for the giant locomotives being introduced in the late 1930s, and during the time of World War II. Our picture shows a very striking example on the Chesapeake & Ohio Railway, with one of the tremendous 2-6-6-6 articulated freight locomotives in the roundhouse. The *scale* of the building will be appreciated from the overall length of these locomotives – 116 ft. 6 in., and their total weight in working order – 527 tons!

14 **Spanish National Railways (RENFE):** Tank Car.

At a time when the highways of so many countries in the world are being congested with automobiles of all shapes, sizes, and carrying capacities, there is a growing realisation that railways have a unique capacity for conveying merchandise in bulk. Furthermore, the larger the load carried in a single vehicle, the more convenient it is for handling in depots, while the vehicles themselves built on lengthy bogie-supported frames can be marshalled into trains of their own, and run at passenger-train speed. This in turn simplifies the working of the line, by minimising the number of different train schedules that have to be provided. Our picture shows a very elegant design of tank car for carrying liquid fuel. It has a capacity of 105,000 litres (23,100 gallons), and a loaded weight of about 45 imperial tons.

15 **St. Louis–San Francisco Railway:** A Triple-deck Car Carrier.

To those familiar with the limitations of the British loading gauge the possibility of carrying three tiers of cars on one railway vehicle may seem remote. Indeed, it has needed some ingenuity in vehicle design to make it possible to accommodate two tiers, taking full advantage of lowering the bottom deck to the lowest possible level between the bogies of the vehicle. No such artifices are needed with the liberal American and Canadian loading gauge and, as will be seen from our picture, the lowest deck is level throughout. On the other hand very careful attention has to be paid to the design of the buffing gear of these huge vehicles. It is not only in ordinary transit, but in passing them through fully-mechanised hump marshalling yards with electronic computerised control of the braking, that this has to be taken into consideration. The design of these car carriers was prepared in consultation with the motor car manufacturers.

16 **Norfolk & Western Railway:** High-capacity Coke Car.

This railway is one of the great coal carriers of the eastern states of the

U.S.A. and for a time was resolutely opposed to the use of any but coal-burning locomotives. Although introducing a few diesels for shunting, its own departure from traditional steam was in the acquisition of a very powerful coal-fired gas-turbine locomotive. Its freight-carrying equipment was comprehensive and specialised, and the special box-car for carrying coke is a typical example. The car is loaded from the top, and is unloaded through the side doors, which are slid sideways to permit the contents to be delivered.

17 **Norfolk & Western Railway:** A Modern Caboose.

As a complement to the freight train equipment is the modern caboose, fitted with every convenience for the conductor (guard) and the brakemen who have to travel on the train. These cabooses include sleeping and cooking facilities, and the characteristic lookout from the 'crows-nest' in the roof.

18 **Southern Railway:** The 'Q1 Austerity 0-6-0 of 1942.

By the year 1942 'austerity' was a catchword in wartime Britain. Everything was being done to save metal. Iron railings were being cut down for scrap, ordinary people were giving old pots and pans to be melted down, and at that time new 0-6-0 locomotives were needed on the Southern Railway for general service. O. V. S. Bulleid, then Chief Mechanical Engineer, was one of the most original and imaginative of designers and, faced with the problem of producing a more powerful engine than the existing 'Q' class, without increasing the weight, he jettisoned every piece of metal that was not functionally necessary. There were no running plates, no wheel splashers, no castings where a fabricated welded assembly would do. By all the older standards of locomotive lineament the result looked horrible; but the locomotives themselves were excellent in service, and fairly caught the eye of wartime publicists, who praised to the skies the way in which the Southern Railway was 'with it' in conforming to the austerity standards of the day. So what would, in other years, have been ostracised as a locomotive atrocity became a model of patriotic railway engineering. It is however somewhat significant that none of the other British railways followed in the same style!

19 **German Federal Railway (D.B.):** 'Austerity' 2-10-0 General Service Locomotive, Series '52'.

Shortly before the outbreak of war in 1939 the German State Railway, as it was then, introduced a lightweight version of its powerful 2-10-0 freight engine of Series '44'. This was the Series '50', which was illustrated in a previous volume in this series, *Railways at the Zenith of Steam* 1920-40. Under war conditions, and particularly to meet the extreme severity of winter conditions on the Russian front, an austerity version of the Series '50' was produced in 1942. It was designed with great skill to effect a maximum saving in materials, and in production time; and whereas the Series '50' was a very powerful engine for its weight (85 tons, engine only), having a tractive effort of 50,000 lb, no less than 26 metric tons was saved on the total weight of engine and tender on the Series '52'. This total was 117 tons, against 144 on the Series '50'. The savings in weight were made by dispensing with everything not essential in a purely wartime locomotive, such as smoke deflecting plates, continuous running plates, feed-water heater and other refinements. Eventually more than 10,000 of these locomotives were built, many in Austria. Our picture shows one of them smartly turned out in the peacetime style of the German Federal Railway, though one can be sure none of them looked so attractive in their early days!

20 **German Federal Railway (D.B.):** The Class '10' Three-cylinder 4–6–2.

These handsome locomotives are among the very last steam to have been designed anywhere in the world. They were intended to reduce maintenance and repair costs, and to incorporate all the features that had been found necessary in the long history of steam locomotive development. What is remarkable however, is the strikingly handsome outline and absence of gadgets hung on the outside, which were in some quarters regarded as the hallmark of 'modern' efficiency. The three cylinders are 18·9 in. diameter by 28·35 in. stroke; the coupled wheels are 6 ft. 7¾ in. diameter, and the boiler pressure 256 lb. per sq. in. The boiler is large with an evaporative heating surface of 2,221 sq. ft., but the superheater is exceptionally so, with a heating surface of no less than 1,137 sq. ft. The grate area is 42·6 sq. ft. The tractive effort of 37,037 lb. is roughly equivalent to that of the largest British 'Pacific' locomotives, and the locomotive has a normal maximum speed of 87 m.p.h. One can only regret that these fine engines arrived on the scene so late in steam locomotive history. The first of them was built by Krupp, in 1956.

21 **American-built 'Austerity' 2–8–0:** For Service in Great Britain and European War Zones.

To assist in war transport on British railways and in readiness for the re-entry of Allied troops on to the European Continent a special design of 2–8–0 general service locomotive was built in large quantities by various American manufacturers. They were an interesting blend of British and American practice, having British buffing and drawgear, both Westinghouse and vacuum brake, but such American specialities as bar frames, and smokebox with removable front plate. The first of these locomotives arrived in England in 1942 and were put to work on the Great Western Railway. They had cylinders 19 in. diameter by 26 in. stroke; and coupled wheels 4 ft. 9 in. diameter, and carried a boiler pressure of 225 lb. per sq. in. The boiler itself was large, with a grate of 41 sq. ft. designed for burning low-grade coal, if necessary. The weight of the engine in working order was 72 tons, and 130 tons with tender. The tractive effort was 34,000 lb. These locomotives became familiar objects on the Great Western Railway during 1943 and 1944, where they did much useful work.

22 **Spanish National Railways (RENFE):** 4–8–2 Four-cylinder Compound Passenger Locomotive.

These highly impressive locomotives were a development of a design brought out by the former Northern Railway of Spain, for working over the heavily graded main line from Madrid to the Biscay Coast. In view of the arduous, work they were called upon to perform, one could hardly describe them as 'express' locomotives. One of these engines was rebuilt by the Norte Company with the Dabeg type of valves, and this formed the prototype of the class illustrated, built by Babcock & Wilcox in 1946–8. They were originally used on the most mountainous part of the northern main line between Avila and Irun, but have now been largely displaced from that area, by successive extensions of the electrified system. The cylinder diameters are 18 in. high-pressure, and 27½ in low-pressure, with a common stroke of 26¾ in. The coupled wheel diameter is 5 ft. 9 in. and the total weight of engine and tender in working order is 182 tons (imperial). A number of them are now stationed at Zaragoza. Out of a total of twenty-nine engines in the class, including the rebuilt Norte engine of 1930, six were at one time equipped for burning oil fuel.

23 **Swedish State Railways:** The 'S1' Class 2–6–4 Tank Locomotive of 1952.

The availability of large quantities of hydro-electric power in Sweden led to extensive schemes of railway electrification; there remained however areas where steam could still be profitably used, even into the 1950s, and the famous firm of Nydqvist & Holm A. B., of Trollhättan – NOHAB – did not receive its last order for steam locomotives for the Swedish State Railways until 1952. This was for a batch of the smart little 2–6–4 tank engines shown in our picture. The last of this batch of thirty was completed in 1954. This class has what might be termed the characteristic Scandinavian 'look' about it, to be seen on many steam locomotives at one time operating in Norway as well as in Sweden. One detects the style of the builders themselves in the strong 'family likeness' between these ultimate Swedish 2–6–4s, and some 2–6–2 tanks built for the Oslo suburban services in 1919, and illustrated in our previous volume *Railways in the Years of Pre-eminence 1905–19*. Other NOHAB features are the plain stove-pipe chimney, the combined casing for dome and sandbox on the top of the boiler, and the sloping down of the side tanks at the front to give an uninterrupted view of that part of the track immediately ahead.

24 **Chesapeake & Ohio Railway:** Streamlined 4–6–4 Locomotive for High Speed.

The Chesapeake & Ohio was essentially one of the great coal-hauling railways of the U.S.A., and with supplies readily to hand it was naturally not one of the first American railways to change over to diesel traction. In 1941 it introduced a new class of express passenger locomotive of the 4–6–4 type, the 'L2' class, and a further batch of these engines was built new by Baldwins, after the War in 1948. At the same time the administration was anxious to introduce new high-speed trains, and for these the unusual step was taken, not of buying special new locomotives, nor adapting the existing 4-6-4s, but of rebuilding five 'Pacifics' that had been in service on the railway since 1926. It was certainly a true rebuild, for part of the old boiler was utilised, in conjunction with a new firebox and smokebox. In changing from the 4-6-2 to the 4-6-4 wheel arrangement a booster was added, and the front end was thoroughly modernised by the use of poppet valves for steam distribution. The old tenders were used, though streamlined as necessary. Taken all round this was a most interesting happening, so late in the history of the steam locomotive as the year 1947, and illustrates the reliance that continued to be placed on it by railways in the eastern states of the U.S.A. at that time. (See also reference to the Norfolk and Western, ref. 149.)

25 **Southern Railway (England):** 'West Country' Class 4-6-2.

In 1941 O. V. S. Bulleid, the spectacularly minded Chief Mechanical Engineer of the Southern Railway, had produced the 'air-smoothed' 'Merchant Navy' class of 'Pacific' locomotive. Although specified for mixed traffic, and immediately put to work on certain very heavy wartime freight services, it included many novel features intended to form the basis of post-war passenger locomotive practice. The boiler was designed to burn low-grade fuel; the valve gear was totally enclosed in an oil bath, and many accessories were fitted to facilitate the working of these locomotives in traffic. After the War authority was given for the construction of a smaller, lightweight version, for general service throughout the Southern main-line network. The first series of these, introduced in 1945, were named after towns and holiday resorts in the West Country; but later engines were named after wartime leaders and famous air squadrons, and became known as the 'Battle of Britain' class. Like the 'Merchant Navy' class they were very fast and powerful locomotives, but suffered from troubles connected with the more novel features of their design, notably the oil bath encasing the special Bulleid radial valve gear. Many of them were subsequently rebuilt with three sets of orthodox Walschaerts valve gear, and had the air-smoothed casing removed. (See ref. 47.) As originally built their basic dimensions were cylinders (three) 16⅜ in. diameter by 24 in. stroke; coupled wheels 6 ft. 2 in. diameter; boiler pressure 280 lb. sq. in.; tractive diameter 31,000 lb.

26 **General Roca Railway (Argentine):** 4-8-0 Mixed Traffic Locomotive.

Until the end of World War II, and the profound changes in world politics that followed its conclusion, the majority of the railways in the Argentine Republic were British-owned. But when they were taken into national ownership the old names were discarded and those of military personalities substituted. In this metamorphosis the well-known Buenos Aires Great Southern, the largest and busiest of all the Argentine railways, became the 'General Roca', and its old and familiar nickname of 'the BAGS' ceased to be appropriate. In 1949 the Vulcan foundry received a repeat order for mixed traffic locomotives of the 4-8-0 type. Prior to the War this firm had supplied 4-6-2 and 4-8-0 locomotives of otherwise similar proportions, for express and mixed traffic duties respectively. The 4-8-0s in particular were very successful, hauling very heavy express fruit trains. The new engines of 1949 were of similar dimensions, having cylinders 19½ in. diameter by 28 in. stroke; coupled wheels 5 ft. 8 in. diameter; a boiler pressure of 225 lb. per sq. in.; and a tractive effort of 30,000 lb. The rail gauge of the General Roca Railway is the Argentine broad gauge standard of 5 ft. 6 in.

27 **Great Northern Railway (Ireland):** Light Branch 4-4-0 Locomotive.

In the years following the end of World War II railway administrations all over the world were anxious to make good the arrears of locomotive replacement occasioned by the War, and the British locomotive building industry was called upon for a great variety of new designs, both large and small. Among the neatest and most conventional by previous British practice were these light 4-4-0s for branch line service built by Beyer, Peacock & Co. in 1948. The only external features that distinguished them from earlier G.N.R. (Ireland) locomotives were the partially closed-in cabs and the high-sided tenders. Like the three-cylinder main-line express locomotives of the same vintage (ref. 32), they were finished in the gay blue livery originally adopted for the compound 4-4-0s in 1935. The basic dimensions of the new 'branch' 4-4-0s were: cylinders, 18 in. diameter by 24 in. stroke; coupled wheel diameter 5 ft. 9 in.; and tractive effort 16,800 lb. There were five of them in the class, designated 'U', and they were named after counties served by the Great Northern Railway, namely *Meath, Louth, Armagh, Antrim, Down.*

28 **New South Wales Government Railways:** The 'C38' Class 'Pacific' Express Passenger Locomotive.

By the end of the 1930s it was evident that the loads and speeds of the Inter-state and other express trains were getting beyond the maximum capacity of the efficient and reliable 'C36' class 4-6-0s, and a design of 'Pacifics' was prepared having a much greater steam-raising capacity. They were built as very simple, robust two-cylinder machines with an absolute minimum in the way of 'gadgets', though in the prevailing fashion of the day the first five of them were streamlined. These five engines were built by the Clyde Engineering Company of Sydney, whereas the remaining twenty-five engines of the class were built in the railway shops. They had cylinders 21½ in. diameter by 26 in. stroke; coupled wheels of 5 ft. 9 in. diameter; boiler pressure 245 lb. per sq. in.; and a tractive effort of 36,200 lb. Like all 'Pacifics' they were inclined to slip on starting, and the drivers who were used to sure-footed 4-6-0s found some difficulty with this at first. But with more generous provision of sand and increased experience, this was largely overcome, and for more than twenty-five years they ran the principal express trains with complete success. Despite their relatively small coupled wheels, designed for hard work on severe gradients, they ran very freely on the favourable stretches of line – attaining speeds of more than 70 m.p.h. with ease. They were built at intervals between 1943 and 1949 and the last of them were still in regular passenger service until 1969.

29 **British War Department:** 2–10–0 'Austerity' Mixed Traffic Locomotive.

Elsewhere in this book reference is made to several locomotive classes designed specially for, or adapted to, wartime service by various of the belligerents in World War II. After the adaptation of the L.M.S. '8F' 2–8–0 (ref. 6) an austerity 2–8–0 was needed for service with the British forces in the re-entry to Europe, so long previously planned, and eventually accomplished in 1944. The British 'Austerity' 2–8–0 was of generally similar capacity to the American (ref. 21), but designed to normal British standards, maintaining the strictest economy in materials. But having produced an excellent 2–8–0, R. A. Riddles, then Deputy Director of Royal Engineer Equipment, considered that a larger version would also be desirable for long continuous hauls, and the 2–10–0 illustrated was produced. It had the same cylinders and motion as the 2–8–0 but a much larger boiler, with wide firebox, and proved considerably more efficient in continuous steaming. The cylinders are 19 in. diameter by 26 in. stroke; coupled wheels are 4 ft. 8½ in. diameter, boiler pressure 225 lb. per sq. in. and tractive effort 34,215 lb. The production engines were all finished in grey; but one of them was allocated to the Longmoor Military Railway, near Liss, Hampshire, named *Gordon*, and painted in the gay colours shown in our picture.

30 **London & North Eastern Railway:** The 'K1' Class 2–6–0.

When Edward Thompson became Chief Mechanical Engineer of the L.N.E.R. on the death of Sir Nigel Gresley in 1941, he formulated a policy for post-war development of the locomotive stock, using a very simple two-cylinder engine layout, that could be applied, with the same sized standard cylinders, to 4–6–0, 2–6–0, 2–8–0 and 2–6–4 tank locomotives. He utilised existing standard boilers, all of which were of proved reliability. The 2–6–0 of class 'K1', which forms the subject of our picture, was derived from the Gresley 'K4', which was similar, but had three cylinders and the Gresley conjugated valve gear for operating the valve spindle of the middle cylinder. The 'K1' proved a very strong and reliable design, and a large number was under construction when the British railways were nationalised in 1948. Our picture shows one of the later engines of the class in the livery of the mixed freight locomotives of the nationalised system. Their basic dimensions were cylinders, 20 in. diameter by 26 in. stroke; coupled wheels 5 ft. 2 in. diameter; total heating surface 1,708 sq. ft.; grate area 27·9 sq. ft.; boiler pressure 225 lb.

per sq. in.; tractive effort 32,081 lb. They did a great deal of hard, useful work, on British Railways.

31 **First British Main-line Diesel-electric Locomotive:** L.M.S.R. No. 10000.

The very rapid introduction of diesel-electric traction in the U.S.A., which had begun before the War and continued with ever-increasing momentum afterwards, was noted with considerable interest by British engineers, but with some doubts as to its economic justification in Great Britain, at a time of severe post-war austerity. On the L.M.S. H. G. Ivatt, Chief Mechanical Engineer, determined upon an exhaustive series of trials between diesel and steam traction and built at the same time two diesel-electric express locomotives and some new steam 'Pacifics' of the well-tried Stanier 'Duchess' class, but including many additional features. The diesel electric locomotives were designed in collaboration with the English Electric Company, which was actively developing an export trade in diesel locomotives, and had already gained considerable experience in this field. The first L.M.S. locomotive was completed in 1947, just before nationalisation; and this latter event rather forestalled the comparative trials that were originally intended. No. 10000 was of no more than moderate power, and was used in conjunction with No. 10001, coupled in multiple, on duties where the maximum capacity of the 'Duchess' class 'Pacifics' was required. The two locomotives were of great importance, as forerunners of the very successful Type '4' diesel of British Railways, introduced in 1958. (See ref. 72.)

32 **Great Northern Railway (Ireland):** Three-cylinder Simple 4-4-0 Express Locomotive.

In 1932 this international railway, with its principal main line connecting Dublin and Belfast, introduced some large new 4-4-0 locomotives of the three-cylinder compound type, with their layout of machinery based directly upon the famous three-cylinder compounds of the Midland Railway. These Irish compounds did good work, proving very strong on the banks, and swift runners on the favourable stretches of line. When further new locomotives were required after World War II however, Mr. H. R. McIntosh, the locomotive engineer, designed instead some 4-4-0s of similar capacity but as three-cylinder simples. They differed from the pre-war compounds in having Belpaire instead of round-topped fireboxes. Five of the new engines were built, as previously by Beyer, Peacock & Co. They had cylinders 15¼ in. diameter by 26 in. stroke; coupled wheels 6 ft. 7 in. diameter; a boiler pressure of 220 lb. per sq. in.; and a tractive effort of 21,469 lb. The engine alone weighed 66¼ tons, in working order. They were named after Irish rivers: *Liffey*, *Boyne*, *Lagan*, *Foyle* and *Erne*.

33 **Canadian Pacific Railway:** The 'G5' Class Mixed Traffic 'Pacific' of 1946.

Earlier volumes in this series have described how the Canadian Pacific

Railway developed its motive power to meet the numerous severe conditions of service, of varying kinds, on its immensely long main line 'From Sea to Sea', as the advertisement went. From the 'Pacifics' of more than sixty years ago came the 'Hudsons' of gradually increasing power and efficiency, with special locomotives of gigantic proportions and the 2-10-4 wheel arrangement, for working through the Rocky Mountains. Canada was hit as severely as any country by the prolonged depression of the 1930s, and the C.P.R. made few additions to its general motive power stud. The older locomotives of smaller proportions had to carry on. After the War replacements were urgently needed and the new, thoroughly modern design of small 'Pacific' was introduced. It was small by Canadian standards, but nevertheless having the tractive power of one of the English Gresley non-streamlined 'Pacifics' of the 'A3' class. These very handsome Canadian engines had two cylinders, 20 in. diameter by 28 in. stroke; coupled wheels 5 ft. 10 in. diameter; a high boiler pressure of 250 lb. per sq. in.; and a tractive effort of 34,000 lb. They proved as fast and efficient as they were handsome, and 'saw steam out' on many secondary lines of the C.P.R.

34–37 **Insignia of Australian Railways.**

In the days of the old railway companies of Great Britain one of the most distinctive and decorative features of locomotives and carriages, on the majority of them, was the display of their coats of arms. This practice was not followed by many other railways anywhere in the world, even on those with strong British affinity or ownership, though some, at any rate, used very attractive devices on their letter headings, reports and other documents. In Australia the railways in the different states are administered and operated quite independently from each other, though cooperating closely for interstate traffic and having a degree of coordination in policy through the Australian and New Zealand Railway Conference. The insignia of the state railways in Australia incorporate portions, or the whole, of the crests of the states, as they are embodied to a greater or lesser extent in the state flags. The New South Wales Government Railway crest, (ref. 34), is the same as that of the state itself, and has as the centrepiece of the shield the St. George's Cross, of England, with quarterings representing wool and wheat. It is supported by a lion and a kangaroo. The motto *Orta Recens Quam Pura Nites* can be translated 'though of recent origin with what pure radiance you shine'. The State of Victoria used the stars of the Southern Cross as its emblem, and this is embodied in the insignia of the Victorian Railways, (ref. 36).

For centuries before white men discovered the distant lands of Western Australia not only poets, but also some naturalists, had believed in, but never confirmed, the existence of black swans; and when the earliest explorers actually beheld them it was no more than natural that they became the living symbol of Western Australia, used on the postage stamps of the State for more than fifty years. The Western

Australia Government Railway uses the black swan prominently in its coat of arms, (ref. 35), while at the same time using the heraldic shield of the United Kingdom, within a garter carrying the motto of the Order of the Garter, and surmounted by the Imperial Crown.

The South Australian Railways use a simple circular badge depicting, heraldically, another indigenous bird, the white-backed piping shrike, (ref. 37).

38 **South African Railways:** The 'GMAM' Class Beyer-Garratt 4–8–2 + 2–8–4 Locomotive.

These fine locomotives not only formed a very important addition to the steam power stock of the South African Railways, but represent one of the most remarkable feats of production on the part of the British locomotive building industry. At the end of 1955, Beyer, Peacock & Co. accepted an order for thirty-five of these large locomotives on condition that delivery should be commenced in seven months – on the face of it an impossible task. Yet by a magnificent cooperative effort on the part of all concerned the first locomotive was steamed one month before the contract date. They have cylinders 20½ in. diameter by 26 in. stroke; coupled wheels 4 ft. 6 in. diameter; boiler pressure 200 lb. per sq. in.; and a tractive effort of 68,800 lb. The total weight in working order is 190 tons. On the long runs through near-desert country an auxiliary water tank of 6,750 gallons capacity is coupled. The water capacity of the tank on the hind unit of the locomotive is 2,100 gallons. Their principal duties have been in the Western Transvaal working on the lines from Johannesburg and Pretoria to Mafeking.

39 **South African Railways:** The '25' Class 4–8–4 Locomotive with Condensing Tender.

The main line of the South African Railways when it passes south from the Transvaal runs through country where good water is increasingly scarce. With a few exceptions all trains south of Kimberley, and as far south as Beaufort West, are steam-hauled. The freights are extremely heavy, and locomotives were needed that not only had great tractive power but also used a minimum of water. The '25' class of 4–8–4 was the outcome. They could be described as a 4–8–4 development of the very successful '15F' 4–8–2 with the same sized cylinders and coupled wheels, 24 in. by 28 in. cylinders and 5 ft. 0 in. coupled wheels, but with a larger boiler and much larger firebox, and a higher boiler pressure of 225 lb. per sq. in. The tractive effort is 53,750 lb. To economise in water consumption ninety of these engines were built with special tenders, as shown in our picture, in which the exhaust was condensed. The exhaust steam from the cylinders is passed into a turbine driving a blower fan in the smokebox, which replaces the normal draught from the blastpipe. From the blower turbine the exhaust steam passes along the side of the engine, then through an oil separator to another turbine in the tender which drives the air intake fans, and thence to the condensing radiators. Finally the steam passes to the condensate elements mounted on both sides of the tank. The condensate is collected in a tank fitted underneath the tender frame and is fed back into the boiler by a live-steam turbine centrifugal pump.

40 **New South Wales Government Railways:** The 'AD 60' Class 4–8–4 + 4–8–4 Beyer-Garratt Locomotive.

The New South Wales railways include some very arduous tasks of haulage in their normal freight workings. On the main line west there is the spectacular ascent over the Blue Mountains, while on the north main line the very severe Cowan bank has to be ascended from the crossing of Hawkesbury River. In 1952 Messrs. Beyer, Peacock & Co. delivered some Garratt locomotives of exceptional size and power, having a total weight in working order of 255 tons. The four cylinders were 19¼ in. diameter by 26 in. stroke; the coupled wheels were 4 ft. 7 in. diameter; and the boiler pressure was 200 lb. per sq. in. These basic dimensions provided a nominal tractive effort of 59,560 lb. Many important details of equipment were included, such as a mechanical stoker – for the grate of 63·4 sq. ft., self-cleaning smokebox and ashpan, and a rocker grate. A particularly notable feature was the provision of a one-piece cast-steel bed frame for each of the two engine units. These great engines have only recently been taken out of traffic. They were among the last steam locomotives in regular service in New South Wales.

41 **Western Australian Government Railways:** The 'V' Class 2–8–2 Freight Locomotive of 1955.

Although Western Australia was earlier in the field with the use of diesel locomotives, the state has large resources of coal, in the Collie area, and it was a matter of policy to retain a considerable *bloc* of steam locomotive workings. Two entirely new designs incorporating the latest practice in construction were therefore introduced as recently as 1955. The heavy main-line freight engines of the 'V' class have a maximum axle load of 15 tons, on the 3 ft. 6 in. gauge. The cylinders are 19 in. diameter by 26 in. stroke; coupled wheels are 4 ft. 3 in. in diameter, and boiler pressure is 215 lb. per sq. in. They are fitted with spark-arresting apparatus as a precaution against fire throwing with the soft Collie coal. In the long dry spells experienced in Australia bush fires are one of the greatest hazards. These engines were used on what is termed the Great Southern main line, between Albany and York, and also on that portion of the trans-continental main line between Midland and York. With their tractive effort of 33,630 lb. they were the most powerful non-articulated locomotives to run on the 3 ft. 6 in. gauge in Australia.

42 **Queensland Government Railways:** 4–8–2 + 2–8–4 Beyer-Garratt Locomotive.

The 3 ft. 6 in. gauge lines in Queensland were restricted to a maximum axle load of 9¾ tons at one time, and during the period of reconstruction after World War II this severely limited the types of motive power that could be used. The Beyer-Garratt was chosen, not only for heavy freight haulage, but also as a prestige passenger job for hauling the 'Sunshine Express' throughout the 1,043 miles between

Brisbane and Cairns. By use of the Garratt type a locomotive having a tractive effort of 32,770 lb. was produced without exceeding the stipulated maximum axle load. So urgently were they needed that of the thirty engines ordered, nineteen were built at Beyer, Peacock's works in Manchester, while the remaining eleven were subcontracted to the Société Franco-Belge de Matériel de Chemin de Fer, and built in France. They were magnificently finished in 'Midland Red', an innovation for the Queensland Railways, and for some years were very much the 'flagships' of the motive power stud. One engine of the class has been retained for special workings, and a further one is in the Queensland Railway Museum.

43 **Western Australian Government Railways:** The 'W' Class Lightweight 4–8–2 Locomotive.

At the same time as the new heavy main-line locomotives were being projected, power was equally needed for the many branch lines and subsidiary lines where the axle loading was limited to 10 tons. In addition to this the new locomotives were required to steam freely on the low-grade Collie coal, and operate in districts where water is scarce and of high salinity. The W.A.G.R. had the vast experience of Beyer, Peacock & Co. in the design of these engines, and they included many ultra-modern features that have proved highly successful in service. The initial order was for twenty, but this was subsequently increased to sixty. A pleasing feature of these engines was their notably 'clean' outline, free from 'gadgets' hung in every conceivable place, which are sometimes hailed as the necessary accompaniments of a 'modern' engine. They had cylinders 16 in. diameter by 24 in. stroke; coupled wheels 4 ft. in diameter; and a boiler pressure of 200 lb. per sq. in. The tractive effort was 21,670 lb. – no more than a moderate-powered engine, but a most versatile one.

44 **London & North Eastern Railway:** The 'Peppercorn' 'A2' Class 'Pacific' of 1947.

During World War II when locomotive maintenance standard became somewhat diluted, the Gresley 'Pacific engines which had established so splendid a record of performance in normal conditions suffered from inattention to their running gear, and there were failures of the conjugated valve motion. Gresley's successors, first E. Thompson and then A. H. Peppercorn, sought to eliminate these troubles by building new 'Pacific' engines with three separate sets of valve gear. The Peppercorn 'A2' class, with 6 ft. 2 in. coupled wheels, were powerful and hard-worked engines; but while filling an important role in main-line traffic neither they, nor the 'A1' class, with 6 ft. 8 in. coupled wheels, superseded the Gresley 'A3' and 'A4' classes. For one thing they were heavier coal burners, and this counted against them on the long non-stops. As noted under (refs. 126 and 127), the Gresley 'Pacifics', with greatly improved maintenance work in post-war years, remained the principal express passenger locomotives on the East Coast Route until the end of steam traction.

45 British Railways, London Midland Region: The Stanier 'Duchess' Class 4–6–2.

Under (ref. 31), mention is made of the important comparative trials between steam and diesel-electric locomotives that H. G. Ivatt intended to carry out on the L.M.S. railway. The onset of nationalisation in 1948 postponed these trials – indefinitely as it proved, and the first phase of locomotive development in the new era was entirely concerned with steam. No new locomotives of a standard type were produced for the heaviest express passenger traffic, and the 'regional' types were left to carry on. The London Midland Region was fortunate in having such powerful and efficient engines as the Stanier 'Duchess' class 'Pacifics', of which we illustrate the *City of London* in the 'red' livery adopted for the L.M.S. 'Pacifics' in the 1950s. In years just before the change to diesel traction began, these engines were doing some of the fastest and heaviest work ever recorded between Euston and Glasgow, and although this may be a controversial claim they came to be regarded by many as the finest British express passenger class of the entire steam era.

46 Great Western Railway: 'County' Class 4–6–0 of 1945.

Towards the end of World War II F. W. Hawksworth, Chief Mechanical Engineer of the G.W.R., prepared in outline, designs for a large 'Pacific' engine for post-war passenger traffic. At the time circumstances were not favourable to the construction of such a locomotive; but with authorisation for further batches of 4–6–0 mixed traffic engines, opportunity was taken to try out one of the most important features of the proposed 'Pacific', namely the high boiler pressure of 280 lb. per sq. in. The boiler was based on that of the Stanier '8F' L.M.S. 2–8–0 design of which Swindon had built eighty engines to the order of the Ministry of War Transport. This high-pressure boiler in conjunction with the standard G.W.R. two-cylinder engine layout produced a very powerful mixed traffic locomotive, and in some areas it was used in express passenger traffic, turn and turn about with the celebrated 'Castle' class 4–6–0. The 'Counties' did particularly well on heavily graded routes, such as the north main line between Wolverhampton and Chester, and in Cornwall. At first only the pioneer engine No. 1000 *County of Middlesex* had a double chimney, but in later years all thirty of the class were so fitted, though with a slightly modified design.

47 British Railways, Southern Region: Modified 'Merchant Navy' Class 'Pacific' Locomotive.

The Bulleid 'Pacifics' introduced by the Southern Railway, just after World War II (ref. 25), incorporated a great many novel features – too many to be embodied in a large production batch of a new locomotive design. Although, at their best, these engines did some truly remarkable work the incidence of failures was too high to be tolerated in regular service. After nationalisation careful study of the records of both 'Merchant Navy' and 'West Country' made it clear that nothing short of major rebuilding would meet the case. The enclosed valve gear, inside an oil bath, was an ingenious proposal, but it gave endless trouble, and it was removed and replaced with three sets of conventional Walschaerts valve gear. The 'air-smoothed' outer casing was more of a liability than an asset. It did little or nothing to reduce air resistance and it made many of the working parts inaccessible. This was removed. Lastly the high boiler pressure of 280 lb. per sq. in. was not utilised to increase the range of expansion of the steam, and in the rebuilt engines this was reduced to 250 lb. per sq. in. In their modified form the Bulleid 'Pacifics' did much hard and reliable work. One of them attained the record speed, for the Southern Region, of 104 m.p.h., near Axminster, Devon.

48 **Canadian National Railways:** Colour Light Signal Aspects.

For more than fifty years it has been a point of debate among signal engineers and operating men as to whether the signals at the approach to a junction should indicate the route that a train is about to take, or the speed at which the driver should proceed. In the first case reliance needs to be placed on the driver's knowledge of the route for the speed to be approximately regulated. He should know that diversion to a branch, or to a subsidiary line, requires a certain reduction of speed. On the other hand, what are termed 'speed aspects' call for a reduction in speed to a figure implied by the aspect displayed, and the train would then be travelling at a speed safe for the negotiation of the junction ahead. Both systems have their critics, though both are well established and have given many years of entirely reliable service in heavy and fast traffic. The British system is to indicate the route, while North American practice is to indicate the speed. The signal aspects that are standard in Canada, and are in general use on the railways of the U.S.A., are shown in the diagrams, together with the instructions to drivers that they convey. Generally speaking it is the uppermost light in the combination of three lights vertically that gives the principal message. For example, the full speed signal is given by a green above two reds. Although many of the indications include one or more reds, the interposition of greens and yellows indicates varying degrees of caution or medium speed. Note should be taken of the distinction between the 'medium' speed and 'limited' speed through areas, signified by the addition of an illuminated 'L' sign, for limited, where limited speed is required. It is only when no colours other than red are displayed that a train is required to come to a dead stop. In comparison with the simple British colour light indications and geographical signs for diverging routes the North American system may seem complicated; but it is used with complete reliability and success, including some routes on which high-speed running at 90 m.p.h. is regularly performed.

49 **British Railways, Southern Region:** Bo-Bo 675-volt D.C. Electric Locomotive.

Although the Southern Region electrified lines are operated almost entirely by multiple-unit train sets, in Kent there are a number of services that have to be worked by locomotives, including both passenger and goods in connection with the Continental train ferry service. For these duties a special type of electric locomotive was designed, having a one-hour rating of 2,500 horsepower. This class is capable of a maximum speed of 90 m.p.h. with passenger trains, and also of hauling 900-ton freight trains. The use of the third-rail system of traction on Southern Region presented certain problems where there are gaps in the conductor rails over level crossings. There are two current pick-up shoes, and the motor and generator armature shaft each carry a heavy fly-wheel to provide the necessary kinetic energy to maintain the speed of the 'set' over the breaks in supply caused by these gaps in the conductor rails. This arrangement is very effective in service. In the normal way it is impossible to detect the passage over these gaps, and it is only when the locomotive is pulling hard on a heavy ascending gradient that one can detect a slight 'surge' in the speed of the train.

50 **Berne – Lötschberg – Simplon Railway:** The 'Ae 4/4 II' Class Bo – Bo Electric Locomotive.

The forerunner of this celebrated class of locomotive, the 'Ae 4/4 I' introduced in 1944, can be regarded as one of the pioneers of modern European railway motive power. It was a novelty in Swiss practice, in that special attention was given to weight reduction. The bogies and superstructures were of all-welded construction, and light alloys were used in the fabrication of the body. No 'carrying wheels' were used. It was an 'all-adhesion' locomotive, and although weighing no more than 78 tons had a rated horsepower of 4,000. It was designed to haul a 390-ton train at 47 m.p.h. up the steepest gradients on the line, 1 in 37. The later development of this remarkable class of locomotive, the 'Ae 4/4 II' which we illustrate, has a rated horsepower of 6,240, and yet the 'all-up' weight is no more than 80 tons. On the mountain section of the Lötschberg line, between Spiez and Brigue, the maximum speed permitted is 47 m.p.h., both uphill and down, and these locomotives are capable of hauling the heaviest of loads uphill at the maximum line speed. It is only in the Lötschberg Tunnel itself that higher speeds are allowed. There the line is easily graded, and mostly straight, and speeds up to 62 m.p.h. are attained.

51 **Swiss Federal Railways:** The 'Ae 6/6' Co – Co Electric Locomotive.

The remarkable success of the new 'all-adhesion' Bo – Bo locomotives on the Lötschberg line no doubt influenced the Swiss Federal Railways towards the introduction of a powerful new class of the Co – Co wheel arrangement for the heavily graded Gotthard line. Experience had shown that a locomotive of the 'Ae 4/4' classification would not have the requisite tractive power for hauling the maximum-load trains. The gradients are equally severe and the rated maximum speeds are the same. The 'Ae 6/6' class was the result, first introduced in 1954. These handsomely styled locomotives have a continuous horsepower rating of 5,400, and a one-hour rating of 6,000. They are designed to haul a train of 600 metric tonnes (588 imperial tons) up a gradient of 1 in 38½ at 47 m.p.h. and attain a maximum speed on suitable sections of line of 78 m.p.h. Like the Lötschberg locomotives they operate on 15,000 volts A.C., 16⅔ cycles. They are all named, after cities and districts served by the Swiss Federal Railways, and carry the appropriate coats of arms, in full colour, as well as the names.

52 **French National Railways (S.N.C.F.):** The Co–Co '7000' Class High-speed Electric Locomotive.

Although the idea of having electric locomotives with no bogies or pony-trucks undoubtedly came from the successful Swiss locomotives (refs. 50 and 51) the French 'CC 7000' class was the first 'total adhesion' locomotive manufactured for speeds higher than 78 m.p.h., and the first of these was put into regular service, after extensive tests, in 1949. The preliminary trials were conducted in both passenger and freight service, in the course of which a maximum speed of 112 m.p.h. was attained. These tests indicated that the locomotive could be safely run at speeds far in excess of anything that was then demanded in ordinary service. The S.N.C.F. consequently decided to standardise the type for service on lines equipped with 1,500 volts D.C. traction. These were the former Paris–Orleans main line, and the P.L.M. main line as far south as Lyons. As a result of the success of these locomotives the manufacturers, Alsthom, have received orders for many locomotives of the same design from other railways. In a series of special high-speed tests in March 1955, locomotive No. 7107 of this class attained a maximum speed of 206 m.p.h.

53 **French National Railways:** The '241. P' Class 4–8–2 Express Passenger Locomotive.

This magnificent class, built by Schneider between 1947 and 1949, was developed from the '241.CI' class of the Paris, Lyons and Mediterranean Railway and, although a French national standard, included several distinctive P.L.M. features. One of these lay in arranging the outside (low-pressure) cylinders to drive the second pair of coupled wheels and the inside (high-pressure) to drive the third pair. Another P.L.M. characteristic can be seen in the wedge-shaped front to the cab. These great locomotives worked south of Lyons, and then from Avignon until the electrification of the P.L.M. main line was extended in stages to Marseilles. After that they were transferred to the Etat system on the main line to Brest. They were extremely powerful machines. Their basic dimensions were, cylinders, high-pressure, 17·56 in. diameter by 25·6 in. stroke; low-pressure, 26·5 in. diameter by 27·56 in. stroke; coupled wheels 6 ft. 7½ in. diameter; boiler pressure 290 lb. per sq. in. The weights in working order were, engine 129 tons, tender 81¼ tons. The tractive effort was 45,084 lb., and the maximum speed in normal service 75 m.p.h.

54 **French National Railways:** Prototype 4–8–4 Three-cylinder Compound Express Locomotive.

After the end of World War II the great French locomotive designer

André Chapelon prepared designs for a new range of high-power steam locomotives based on the principles he had postulated, and proved in the rebuilding of certain locomotives of the former Paris, Orleans Railway in the 1930s. The huge 4–8–4 locomotive illustrated was the only one of its kind, because although it proved extremely successful the S.N.C.F. had by then decided to add no more steam locomotives to its stock, and to extend the already electrified areas. Chapelon's '242.A' was a three-cylinder compound, and like the English Midland compounds started with live steam admitted only to the low-pressure cylinders. The starting tractive effort was 47,000 lb. and when working full compound, 47,077 lb. The basic dimensions were cylinders, high-pressure (one) 23·6 in. by 28·35 in.; low-pressure (two) 26·8 in. by 29·9 in.; coupled wheels 6 ft. 4¾ in.; boiler pressure 290 lb. per sq. in. Weights were engine 145½ tons, tender 74½ tons. The normal maximum speed was 87 m.p.h., but 100 m.p.h. was attained on special tests. One can only regret that the development of this magnificent locomotive was halted by the decision to electrify.

55 **French National Railways:** The '232.U1' Four-cylinder Compound 4–6–4.

The Northern Railway of France was always noted for the quality of its locomotive performance, and the success of the various four-cylinder compounds on the de Glehn principle had influences far beyond the Nord railway, or indeed France. But for the imminence of war, from 1912 onwards the 4–6–4 type of locomotive might have become a main line standard some thirty-five years earlier than it actually did so; because du Bousquet's giant four-cylinder compound 4–6–4s of 1911 were not developed beyond the two prototype engines. The national circumstances did not then favour the extensive testing that would have been necessary. The Class '232.U' of 1949 was however a fitting climax to the individual locomotive development on the Nord, although produced under S.N.C.F. auspices. Many modern features were incorporated, such as bar frames and roller bearing axle-boxes, and these engines did splendid work on the Paris–Lille expresses prior to electrification. The basic dimensions were: cylinders, high-pressure (two) 17·56 in. by 27·56 in.; low-pressure (two) 26·77 in. by 27·56 in.; coupled wheels 6 ft. 6¾ in. diameter; boiler pressure 290 lb. per sq. in.; tractive effort 46,958 lb. The engine weight was 126¾ tons, and the tender 82½ tons.

56 **French National Railways:** The '141.R' Mixed Traffic 2–8–2 Locomotive.

While in post-war years French locomotive engineers with their traditional skill were applying themselves to the design of new types on the most modern lines, as exemplified by the '241.P.', '242.A.', and '232.U.', classes, immediate aid to the much-devastated French railways was urgently needed, and with the ex-P.L.M. '141.P' as a basis, the 2–8–2 type was chosen for mass-production by American and Canadian firms. Baldwins, Lima and ALCO all participated, together with the Montreal Locomotive Works. In all more than 1,000 of these useful engines were supplied. They were two-cylinder 'simples' of rugged construction, designed for hard and lengthy service; and although so different from the traditional French designs they were immediately welcomed by all concerned for their reliability, free steaming, and general freedom from troubles in running. Along the Mediterranean coast, between Marseilles and the Italian frontier, they worked the principal express trains including the 'Mistral' and the 'Blue Train'. Their basic dimensions are: cylinders 23½ in. diameter by 28 in. stroke; coupled wheels 5 ft. 5 in. diameter; boiler pressure 220 lb. per sq. in.; tractive effort 44,500 lb. The weights are engine 114 tons, tender 71½ tons. Those working along the Mediterranean coast were oil-fired.

57 **British Railways:** The 'Britannia' Class '7' Standard 'Pacific' Locomotive.

R. A. Riddles, the member of the Railway Executive responsible for mechanical and electrical engineering, directed the design of a new range of standard steam locomotives that should embody the best features of the practice of the 'Big Four' of pre-nationalisation days. The class '7' 'Pacific', for mixed traffic service, was the first of these new designs to appear, and the pioneer engine, No. 70000 *Britannia*, was completed at Crewe Works in 1951 in time to be exhibited at the Festival of Britain display in the summer of that year. The basis of the design, and indeed of all the British standard range of steam locomotives, was a rugged, extremely simple, two-cylinder engine layout, with everything outside and get-at-able. The details included features of Southern and L.N.E.R. practice, while the large boiler was a direct development of Stanier's practice on the L.M.S., which had been derived, in its turn, from the long-established principles of boiler design on the G.W.R. The 'Britannia' class, of which more than fifty were eventually built, were hard working and free-running engines, and although designated 'mixed traffic' were used almost entirely in express passenger service. Except on the Great Eastern line of the Eastern Region, where they worked all the principal express trains, they were 'second line' units, not superseding the most powerful express locomotives of the former G.W.R., Southern, L.M.S. and L.N.E. Railways.

58 **British Railways:** The Standard Class 'BR4' 2-6-0 Mixed Traffic Locomotive.

The range of British standard locomotives developed after nationalisation had some diverse origins, although on actual production they all had a strong family likeness. The 'BR4' 2-6-0 can be said to have originated from the L.M.S. '3000' class 2-6-0 designed by H. G. Ivatt and produced shortly after the end of World War II. These latter engines incorporated many new features and, after initial trouble with the draughting had been overcome, did much good work. The 'BR4' which succeeded them was a truly excellent medium-power unit, having a fine turn of speed, and useful on passenger as well as goods trains. The two cylinders were 17½ in. diameter by 26 in.

stroke; the coupled wheel diameter was 5 ft. 3 in.; and with a boiler pressure of 225 lb. per sq. in., the tractive effort was 24,170 lb. This latter was a high figure for a locomotive weighing no more than 59¾ tons. They were, of course, intended for no more than intermediate duty, and the relatively small grate of 23 sq. ft. was conducive to low coal consumption in this class of service. Engine No. 76114 was the last steam locomotive to be built at the historic Doncaster Plant works, established by the former Great Northern Railway and the birthplace of so many famous steam locomotives.

59 **British Railways:** The Standard 'BR9' Express Goods 2–10–0.

The 2–8–0 had been a standard type for heavy freight service on many of the individual railways of Great Britain for many years before nationalisation, and there had been one attempt to develop it into the 2–8–2 for still heavier duty. The 2–8–2, like the 'Pacific' in passenger service, gave the possibility of using a wide firebox spreading its grate outwards over the small pair of trailing wheels. When consideration came to be given to a high-power freight engine for the nationalised system a 2–8–2 version of the 'Britannia' 'Pacific' (ref. 57) was proposed; but experience with the wartime 2–10–0 built for overseas military service in liberated Europe (ref. 29) showed the advantages of this wheel arrangement, and the 2–10–0 was selected for the 'BR9'. It proved to be the most outstanding design of all the British standard range and, although having coupled wheels no larger than 5 ft. 2 in. in diameter, ran express passenger trains at speeds up to 90 m.p.h. The basic dimensions were: cylinders 20 in. diameter by 28 in. stroke; boiler pressure 250 lb. per sq. in.; and tractive effort 39,667 lb. A total of 221 was built; the last one, No. 92220, was completed at Swindon works in 1960.

60 **British Railways, London Midland Region:** 'Black Five' Mixed Traffic 4–6–0, with Caprotti Valve Gear.

For many years, in many countries, locomotive engineers have sought to improve thermal efficiency and general performance by departing from the well-proved, conventional valve gears of the Stephenson and Walschaerts types. Poppet valves have the attraction that they can provide a 'snappier' opening and closing of the valves, and elimination of some throttling of the steam in the process. They can, also, be lifted completely from their seats when the locomotive is coasting, and thus give freer running. Of the various types of poppet valve used from time to time in this country the 'British Caprotti' – an adaptation of the original Italian form of the gear – has achieved a certain popularity, and it was included among various alternative front-end designs that H. G. Ivatt intended to experiment with on the L.M.S. railway in 1947–8. The 'Caprotti-Fives', as they were frequently called, were very fast engines, but they never seemed to develop the tractive power of the standard 'Black Fives' with Walschaerts gear, when it came to starting a heavy load, or working hard up a severe gradient.

61 **Turkish State Railways:** The '56,001' Class 2–10–0 Mixed Traffic Locomotives.

At the beginning of the period covered by this book the Turkish State Railways were taking delivery from Germany of two classes of very powerful modern locomotives, a 2–8–2 express type and a 2–10–0 mixed traffic. The latter was in most respects the more generally useful, because the heavy loads and steep gradients that abound did not give scope for express running in the generally accepted sense of the term. Apparently, on account of the War, the German builders could not supply them fast enough, and orders for more of the class were placed in Great Britain. It was not until after the War that these could be delivered, and they were built by the Vulcan Foundry and Beyer, Peacock & Co. These British-built engines were exported in 1948 and bore the Turkish running numbers of 56080 to 56116. Their basic dimensions were: cylinders, 25·6 in. diameter by 26 in. stroke; coupled wheels 4 ft. 9½ in. diameter; boiler pressure 250 lb. per sq. in. The tractive effort was 63,300 lb. The weight of engine alone in working order was 106 tons. In 1949 a further batch of fifty was built in Czechoslovakia by the Skoda Company. These latter had a slightly larger tender than the original German, and the British-built, engines of the class.

62 **German Federal Railways (D.B.):** The Class '23' 2–6–2 of 1953.

Before World War II the medium-powered mixed traffic locomotives in Germany were the survivors of a once very numerous class of Prussian 4–6–0s, the 'P8' class. At one time there were no less than 3,850 of these engines, and 2,975 were taken into Reichsbahn stock in 1924. By the end of World War II these veterans had reached the end of their useful lives, and a new class of 2–6–2 was designed as a replacement – the very striking '23' class. A most noticeable feature of these engines is the extraordinarily high pitch of the boiler. When working international express trains between Venlo and Cologne, for example, the locomotive seemed to tower over the coaches – large as these latter are nowadays. The basic dimensions are: cylinders 21·6 in. diameter by 26 in. stroke; coupled wheels 5 ft. 9 in. diameter; boiler pressure 227½ lb. per sq. in.; tractive effort 33,870 lb. The weight of engine alone in working order is 82¼ tons, and the tender 61 tons. These engines are still familiar objects on the railways of West Germany.

63 **Czechoslovak State Railways:** The Class '498·1' 4–8–2 Express Locomotive.

These remarkably impressive locomotives were built by the Skoda Company in 1950, and are typical of the elegance of mechanical design shown in recent Czechoslovak locomotives. The constructional features include bar frames, roller bearings on all axles, mechanical stoker, a thermic siphon in the firebox, and the Kylchap twin-orifice blastpipe and chimney. The locomotives have three cylinders with a separate set of valve gear for each. While the cab and the small smoke-deflecting plates are

'Central European' in character, the general proportions are truly beautiful in their effect. The three cylinders are 19·7 in. diameter by 26·8 in. stroke; coupled wheels are 6 ft. 0 in. diameter; boiler pressure 227½ lb. per sq. in. and tractive effort 41,670 lb. The boiler is very large, with an evaporative heating surface of 2,459 sq. ft. and a superheating surface of 794 sq. ft. The grate area is 52·2 sq. ft. The total weight of engine alone in working order is 112 tons and the tender 79½ tons. The normal maximum speed in service is 75 m.p.h.

64 **East German State Railways:** A Rebuilt '01' Class 'Pacific'.

After the end of World War II the former German Empire was divided into three, and that part at first under Russian military occupation, and now officially known as the German Democratic Republic, has a railway system with the same name as that of the former Empire – the Deutsche Reichbahn (D.R.). The original locomotive stock working in this territory included large numbers of former Prussian and older Reichbahn standard classes, and in due course there were interesting developments. One of these is shown in our picture, which illustrates one of the familiar '01' 'Pacifics' that has been extensively rebuilt and modernised. They have been fitted with larger boilers, 'Boxpok' driving wheel centres, and an appearance of streamlining produced by the painting on the deep valence, which is continued across the cab and tender. Some of these rebuilds were fitted with the Giesl ejector. As rebuilt these engines have cylinders 23⅝ in. diameter by 26 in. stroke; a coupled wheel diameter of 6 ft. 6¾ in.; and a boiler pressure of 227½ lb. per sq. in.

65 **British Railways:** The English Electric Type '4' Diesel-electric Locomotive B.R. Class '40'.

When the British Railways Modernisation Plan was launched one of the first new express passenger locomotives to be introduced was a direct development of the original L.M.S. No. 10000, having the 1–Co – Co1 wheel arrangement and an improved version of the same excellent English Electric diesel engines and traction motors. Some of the first deliveries of the new class were drafted to the Great Eastern line of the Eastern Region, and immediately began to do excellent work on the fast trains between Liverpool Street and Norwich. With an engine horsepower of 2,000, and a tractive power at the drawbar of about 1,700, they were easily master of any Great Eastern duties, and on the L.M. Region could handle many of the heavy express trains running north from Euston. They were not equal to the maximum capacity of the Stanier steam 'Pacifics' of the 'Duchess' class, but they could take anything else and proved a most valuable and reliable acquisition. Later locomotives were sent to Scotland and worked on the East Coast route north of Edinburgh. A total of 200 of these locomotives was acquired. By later standards they would be considered rather heavy in relation to their tractive power – 133 tons for 2,000 horsepower; but they proved most dependable units, and capable of high speeds when the need arose.

66 **British Railways, Western Region:** The 'Western' Class Diesel-hydraulic Locomotive, B.R. Class '52'.

In the early stages of the British Railways Modernisation Plan, a certain latitude was given to the Regions to choose the kind of motive power they considered most suitable to their particular needs and, while the Regions responsible for the East Coast Anglo-Scottish service specified the 'Deltic' (ref. 67), the Western Region after much investigation decided to adopt the hydraulic system of transmission that was currently being adopted on a considerable scale on the Federal Railway of West Germany. Following the earlier introduction of the 'Warship' series, of 2,200 engine horsepower, the larger and more powerful 'Westerns' were introduced in 1961. Some of these powerful locomotives, of 2,700 horsepower, were built at Swindon Works, and others at Crewe. They use the Maybach MD 655 V-type engine, and the well-tried Voith system of hydraulic transmission. They have all been named, each name being prefixed by the word 'Western' – *Western Enterprise, Western King, Western Explorer* and so on. After teething troubles inevitable with a new design they have given excellent service on the fast express trains of the Western Region. The first locomotives of the class to be introduced were painted in khaki colour as shown in our picture. At a later period a shade of reddish purple was used, to be followed by the now standard British Railways blue.

67 **British Railways:** The Prototype English Electric 'Deltic' Locomotive.

In all the earlier applications of the diesel engine to railway traction, in the famous '567' engine of General Motors in the U.S.A. and in the English Electric engines used in the L.M.S. prototype No. 10000 (ref. 31) and in its subsequent development (ref. 65), the slow-running marine type of engine was employed, with cylinders banked in the shape of a 'V'. The English Electric Company broke new ground in 1955 by building an experimental locomotive based on the lightweight high-speed 'Deltic' engine developed by D. Napier & Son Ltd. This enabled a unit of greatly increased power to be provided of *reduced* weight. The engine horsepower was no less than 3,300, and the total weight only 106 tons. The experimental locomotive was loaned to British Railways, and did some extremely fine work; but because of structural limits could not be used generally. An order was subsequently placed for twenty-two similar locomotives, which have since maintained the fastest and heaviest express service on the East Coast main line between Kings Cross and Edinburgh. The prototype, in its gay colours, was donated by the English Electric Company to the Science Museum, London.

68 **Great Western Railway (England):** 2,500-Horsepower Experimental Gas-turbine Locomotive.

In the period just after World War II, when the fuel situation in Great Britain was extremely difficult, the Great Western Railway began experiments with gas-turbine electric locomotives, at the same time that a number of steam locomotives were being converted to oil firing. Investigations in conjunction with the famous Swiss firm of Brown-Boveri suggested that the fuel cost might be halved by the use of gas-turbine locomotives. A design of locomotive was worked out that would have an equivalent performance to that of the 'King' class 4-6-0 steam locomotives. The gas-turbine was used to generate electricity so that the final drive was electric. It was designed to have a drawbar pull of about 5 tons at 60 m.p.h. and about 3 tons at 90 m.p.h. – both considerably in advance of 'King' performance. The locomotive was put into service in 1948 and did much excellent work. But there were many incidental difficulties, and with the nationalisation of the British railways in 1948 the decision to abandon, temporarily, all forms of main-line traction other than steam, this interesting and promising experiment came to an end.

69 **Rhodesia Railways:** Coat of Arms.

Under refs. 34 to 37 the insignia of four of the State Railways of Australia are illustrated and described, with the comment that they are not used on the locomotives and carriage stock, as used to be the practice in Great Britain. By way of contrast the crest of the Rhodesia Railways is carried on all the passenger carriages of the administration. It consists of the arms of Rhodesia encircled, not by the traditional 'garter' of English heraldry, but by a plain ring; the shield displays the emblems which appeared on the former British colonial ensign. The supporters are sable antelopes, and the crest, in gold, is one of the Zimbabwe birds – soapstone figurines discovered in the ruined city of Zimbabwe.

70 **South African Railways:** Coat of Arms.

This is one of the most elaborate of present-day railway coats of arms. It consists of the shield of the Union of South Africa supported by typical African animals of the antelope species, and surmounted by a heraldic lion. The four quarters of the shield include the figure of Hope, grasping an anchor, the insignia of the Cape of Good Hope; two wild oxen, for Natal; an orange tree, for the Orange Free State; and a trek-cart for the Transvaal – the four countries embraced in the Union of 1910. This coat of arms, handsome and comprehensive as it is, does not normally appear on any of the rolling stock of the South African Railways.

71 **Malayan Railways:** The Crest, Granted in 1957.

The crest of the Malayan Administration was granted in May 1957 by His Highness the Sultan of Selangor, in whose domain the headquarters of the Malayan Administration lies.

The crest consists of a pall reversed vert, charged with a crescent, and within the horns thereof an estoile of eleven points. On a wreath of the colours is a tiger salient proper.

The tiger has been the traditional emblem of the former Federated Malay States Railways and the Malayan Railway Administration. The reverse cross pall represents the Singapore crest painted in green, the Islamic colour, instead of red as in the Singapore crest. The estoile of the eleven points represents the eleven states comprising the Federation of Malaya.

72 **British Railways:** The First Insignia.

After the nationalisation of the British railways, a form of badge or insignia was designed for display in a variety of circumstances. Compared to some of the devices used by the old companies in pre-grouping days it was extremely simple, consisting of nothing more than the 'British Lion' embracing a flanged wheel, symbolical of railway transport.

73 **Rhodesia Railways:** The '20th' Class Beyer-Garratt 4–8–2 + 2–8–4 Locomotive.

The Rhodesia Railways is one of the most extensive users of the Beyer-Garratt type of articulated locomotive in the world. In addition to the celebrated 15th class (4–6–4 + 4–6–4) used on the mail trains between Bulawayo and Mafeking, and in general main-line service elsewhere, various smaller classes have been purchased for work on branches where engineering restrictions impose a strict limitation in axle loading. But for the very heaviest duties, particularly in freight haulage on the north main-line to the Victoria Falls, a huge 4–8–2 + 2–8–4 class is employed. These are the most powerful locomotives on the Rhodesia Railways, and have four cylinders 20 in. diameter by 26 in. stroke; coupled wheels 4 ft. 3 in. diameter; a boiler pressure of 200 lb. per sq. in. and a tractive effort of 69,330 lb. The grate area is 63 sq. ft. and to ensure continuous steaming in the heaviest conditions a mechanical stoker is fitted. These enormous engines weigh 225 tons, and are regularly employed on freight trains of 1,500 to 1,700 tons. Despite their small coupled wheels they are free running, and exceptionally smooth in riding at speeds of around 45 m.p.h. on the 3 ft. 6 in. gauge track.

74 **New Zealand Government Railways:** The 'Da' Class Diesel-electric Locomotives of 1955.

When the New Zealand Railways first introduced diesel traction for main-line service they followed the tradition that had become general in many countries in having the nose-cab type introduced in the U.S.A. just before World War II, and the first units of this type were purchased from the English Electric Company in 1954. Following this however a number of 'second-generation' diesels were acquired in 1955–6 from General Motors of the standard 'G.12' model of the so-called 'hood-cab' type. Fifteen of this first order were built in Canada, at London, Ontario, and the remainder in the U.S.A. As N.Z.G.R. class 'Da' these locomotives proved an outstanding success, giving a much accelerated service on the North Island main-line. Their nominal horsepower is 1,425, for a dead weight, in working order, of 76 tons. The great advantage of these locomotives over the previous steam units was the additional power that could be attained by coupling two in multiple, for operation by a single crew. Many additional locomotives have since been ordered, some from the Clyde Engineering Company in Australia, and more from General Motors in Canada.

75 **Rhodesia Railways:** Fourth Class Main-line Carriage.

The passenger coaching stock of the Rhodesia Railways is mostly of very fine up-to-date designs, and the fourth class vehicle illustrated is typical of carriages used on the mail and other long-distance trains. The colours, as will be seen from our picture, are those of the English Great Western Railway, in chocolate and cream, with the coat of arms (ref. 69) carried in the centre of the body panel. This coach is one of a batch built by Metropolitan Cammell Ltd. in England, in 1965. The overall length over the headstocks is 63 ft. 5 in., and the width over the side panels 9 ft. 3 in. The generous loading gauge makes possible a very wide vehicle despite the narrow rail gauge of 3 ft. 6 in. The total height from the rail is much the same as for British coaching stock and is 12 ft. 8 in. The tare weight is 30½ tons. These coaches ride very comfortably on the finely maintained tracks, at speeds up to about 55 m.p.h., which is about the maximum normally attained on the principal express trains between north and south of Bulawayo.

76 **Benguela Railway (Portuguese-West Africa):** 4-8-2 Wood-burning Locomotive.

The Benguela Railway runs almost due east and west from the west coast of Africa at Lobito Bay, and from its inception it had a problem over locomotive fuel. Fortunately the native eucalyptus wood provided a reasonable, though rapidly burnt, fuel and with steam locomotives the operation of the railways was organised to use it on a large scale. Trees are grown by the railway administration in belts extending for many hundreds of miles on both sides of the line, and are cropped in rotation. The locomotives are accordingly designed for wood burning, and extra men are carried on the footplate to assist in getting the sized logs forward for the fireman to stoke them into the firebox. Although very large locomotives of the Beyer-Garratt type are used on the line there are many smaller units of modern design at work, and the locomotive shown in our picture is one of a batch built by the North British Locomotive Company in 1951. They have cylinders 21 in. diameter by 26 in. stroke; coupled wheels 4 ft. 6 in. diameter; a boiler pressure of 200 lb. per sq. in. and a tractive effort of 36,200 lb. The grate area is large, and the boiler barrel longer than that of similar locomotives working in Equatorial Africa that are fired on coal or oil.

77 **British Railways, London Midland Region:** The 'AL6' Bo – Bo Electric Locomotive.

When the electrification of the main-line between Euston, Liverpool and Manchester was authorised an invitation was given to British locomotive manufacturers to submit designs for new locomotives within a general specification for a unit with an output of 3,300 horsepower of the Bo – Bo wheel arrangement and not exceeding 80 tons in weight. This broad parameter was based upon the success of the 'all-adhesion' types of locomotive introduced in Switzerland and France – particularly in the latter development, as the locomotives working on the Paris–Lille electrification were performing work very similar to that required on the London Midland Region. In England locomotives were built by five different firms, and from the experience gained the standard L.M. type, the 'AL6', was evolved. They have proved very successful, maintaining the very fast new electric services with regularity and reliability. The basic requirement has been the maintenance of schedules a few minutes under the level two hours over the 158 miles between Euston and Crewe with trains of twelve coaches, though they have proved capable of regaining up to ten minutes, even on these fast timings when incidental delays have supervened. By the time this book is completed the electrification will have been extended to Glasgow, and for this an improved type of locomotive, the 'AL7' has been designed. This is of the same approximate tractive power as the 'AL6', but includes a number of major design developments. These locomotives will maintain a five-hour service over the 400 miles between Euston and Glasgow.

78 **German Federal Railways:** The Class 'E.10' Bo – Bo Electric Locomotive.

It was fully in keeping with the general trend of electric locomotive development in Europe that the German Federal Railways should adopt the Bo – Bo 'all-adhesion' type for new, high-power units introduced in 1952. Five prototypes were then put to work, and the successful experience with these led to the standardisation of the design from 1957 onwards. The prototypes were limited to a maximum speed of 80 m.p.h., but the production units that followed were rated up to 93 m.p.h. A few specially geared locomotives of the same general design were allocated to the high-speed 'Rheingold' express, and painted in keeping with the coaches used on that train. These had a maximum service speed of 100 m.p.h. The ordinary 'E 10' class, designated 'E.10[1]' to distinguish them from the five prototypes of 1952, have a one-hour rating of 4,400 horsepower. They operate on the standard German traction system of 15,000 volts A.C., 16⅔ cycles. They have the high starting tractive effort of 25 tons. The total weight is 82 tons, making them of very similar physical proportions to the British 'AL6' on the London Midland Region (ref. 77) and the French '9200' class, both of which owed their inspiration – as the German 'E.10' also did – to the success of the B.L.S. 'Ae 4/4' (ref. 50).

79 **Rhaetian Railway (Switzerland):** Electric Locomotive of Class 'Ge 6/6'.

The Rhaetian Railway is one of the most fascinating in all Switzerland. On the narrow gauge of 1 metre, it provides the principal means of communication in the canton of Grisons, with access to the Engadine and to the Bernina Pass, and operating the famous 'Glacier Express' that conveys through carriages from St. Moritz and Chur to Zermatt. The route includes the steepest gradients in Europe that are worked with adhesion; and although there is one stretch of 1 in 14 over a distance of 17 miles, there are no sections of rack-and-pinion working. It will be appreciated that very powerful and efficient electric locomotives are needed for such a route and our picture shows one of the latest, introduced first in 1958. It is one of seven having the Bo - Bo - Bo wheel arrangement. They operate on the standard Swiss overhead traction system of 15,000 volts at 16⅔ cycles. They have a maximum speed of 47 m.p.h., while at a speed of 29 m.p.h. they develop 2,400 horsepower. Earlier locomotives of the Rhaetian Railways of the 'Ge 4/4' class were finished in a bright red livery, not unlike that of the Lötschberg; but green has now been adopted for both locomotives and carriages.

80 **South African Railways:** The '5E1' Mixed Traffic Main-line Electric Locomotive.

While the South African Railways have been in the forefront of steam locomotive practice from the beginning of the period covered by this book, it has always been the policy gradually to extend the electrified area, southward from the Transvaal and northwards from the Cape. The development of electric motive power has been remarkable. Following the trend of practice in Europe the Bo - Bo wheel arrangement has been favoured and in 1955 an order for a large batch of new locomotives of 2,000 horsepower (one-hour rating) was placed with the English Electric Company. The design was developed into the very successful '5E1' which we illustrate. From the '5E', the one-hour rating has now been increased in the '5E1' to no less than 2,600. This has enhanced the one-hour horsepower rating per ton of locomotive weight from 24·1 to 31·3 – a remarkable feat in design. There are 158 of the '5E' class in service, and no fewer than 500 of the '5E1' class. This does not represent the limit of South African development of electric motive power, for the '5E1' has been followed by the '6E' with a one-hour power rating of no less than 3,320.

81 **East African Railways:** The '59th' Class Beyer-Garratt 4–8–2 + 2–8–4 Locomotives.

The main line of the former Kenya and Uganda Railway is, in every sense of the word, a mountain railway. On its busiest section, the 332 miles between the Indian Ocean port of Mombasa and the capital city of Nairobi, it climbs 5,500 ft. and includes long stretches of uncompensated 1 in 60 gradients. The line is single throughout, and the passing loops are up to 8 miles apart; and because of the slow speeds on such a route the situation was being reached of the line being worked to maximum train operating capacity. The only way to increase the tonnage was to increase loads. Fortunately the track had been improved to the extent that axle loads in excess of 20 tons could be accepted by the civil engineer and the enormous 59th class Garratts, introduced in 1955, enabled the loads of the freight trains to be increased to 1,200 tons. These engines, the largest anywhere in the world operating on the metre gauge, have four cylinders 20½ in. diameter by 28 in. stroke; coupled wheels 4 ft. 6 in. diameter; a boiler pressure of 225 lb. per sq. in.;

and a tractive effort of no less than 83,350 lb. They are oil fired, and have a grate area of 72 sq. ft. The weight in working order is 251 tons.

82 **South African Railways:** The '23' Class 4-8-2 Express Passenger Locomotive.

In the previous volume in this series, *Railways at the Zenity of Steam* 1920-40, the very powerful '15F' class 4-8-2 mixed traffic locomotive was described and illustrated. The success of those engines, and their freedom in running, determined the S.A.R. to standardise on eight-coupled locomotives even for express passenger service, and a new design of 4-8-2 was introduced, generally similar to the '15F', except that the coupled wheel diameter was increased from 5 ft. to 5 ft. 3 in. and, although using the same boiler, the pressure was increased to 225 lb. per sq. in. The '23' class can be readily distinguished from the '15F's by their huge twelve-wheeled tenders. The respective coal and water capacities are 18 tons and 9,500 gallons, against 12 and 5,940 on the '15F'. The '23' class are also fitted with mechanical stokers. Coal is conveyed from the tender by a revolving screw in the bunker conveyor unit, to a telescopic intermediate unit located between the tender and the cab. From this the coal passes up the fixed elevator pipe and is then fed to the distribution table. Thence it is blown by steam jets to the desired points in the firebed. There are 136 locomotives of the '23' class and all of them were built in Germany. Most of them are stationed at Bloemfontein for working south and west.

83 **South African Railways:** The '24' Class Lightweight Branch 2-8-4 Locomotive.

While the South African Railways was continuing to develop locomotives of great power for the heavy main-line duties, the older types, on branch-line working, were reaching the end of their useful lives, and shortly after the War an entirely new type was designed specially for lines where the maximum axle load could not exceed 11 tons. These locomotives were interesting as being the first ever built in Great Britain with one-piece cast-steel frames, in which cylinders were incorporated. This was a notable method of reducing weight. These locomotives were built by the North British Locomotive Company in Glasgow, and proved a great success in service. They had the Vanderbilt type of tender, with a cylindrical tank for the water; a large firebox for burning low-grade fuel; and an excellent free-steaming boiler. The nominal tractive effort of these fine engines is 27,600 lb. and so far 100 of them are in service on many diverse parts of the South African Railways.

84 **South African Railways:** Cape Town, New Signal Box.

This striking example of modern functional railway architecture houses one of the latest phases in a chain of development in railway traffic control methods. While it cannot be said that Cape Town was the point of origin of the present South African railway network it was very nearly so. Railways in what was then the Cape of Good Hope began at Durban in 1860, but this first step was followed at Cape Town only a few months later. In a very short time Cape Town became an important railhead. The mail service from England was all conducted through the port, and luxurious express trains ran to the growing cities of the Transvaal and Rhodesia. Although an interesting installation of the hydraulic system of interlocking was made nearby, at Salt River Junction, Cape Town itself had a major mechanical interlocking, until replaced in 1928 by colour light signals, electrically operated points, and a miniature-lever type of interlocking machine. It was notable as being the first instance, anywhere in the world, of the position-light type of signal for shunting. This type is now standard on British Railways. The present signal box represents the third generation of signalling control with miniature thumb-switches instead of levers, arranged in a way devised by the engineers of the South African Railways to meet their own particular needs. It was put into service in 1967.

85 **French National Railways:** The New Locomotive Roundhouse at Avignon.

In the wholesale destruction suffered by the French Railways in the concluding stages of the War, when aerial bombardment was carried out on a massive scale to delay and disrupt communications, and prevent the rapid movement of Nazi troops to areas being attacked by the invading British and American armies, locomotive depots and marshalling yards were targets of the first priority. When the time came for reconstruction it is interesting to find that the French Railways retained the 'roundhouse' type of layout for their modernised depots. In this they followed the practice consistently used throughout the steam era in North America, in contrast to the British rectangular form of 'shed'. Our picture, showing the new roundhouse at Avignon, is typical of many fine new buildings erected on the French Railways after the War. Until electrification extended southwards from Lyons in the 1960s Avignon was a very important steam depot, and housed some of the huge '241.P' 4-8-2 locomotives (ref. 53) that were used in hauling the principal expresses from Paris to the Côte d'Azur resorts. Avignon, however, is no longer a staging point on this route, for the electric locomotives work through from Paris to Marseilles.

86 **Canadian National Railway:** Toronto Yard; The 'Hump' Control Tower.

'Toronto Yard' is the all-embracing name given to a huge operating complex at the centre of the entire network of the Canadian National Railways in the Toronto area. The 'yard' has been aptly described as nine yards in one, covering an area of 1,000 acres, with 158 miles of track and standing space for 11,000 of the huge bogie cars commonly used in North American freight transport. There is a very large centralised control tower, which is the nerve-centre of the whole area, but there are in addition the subsidiary control towers for watching over the progress of trains being propelled over the individual humps. Our picture shows one of these, specially designed with a high-level 'lookout' in every direction from the rooms wherein are situated the control machines for regulating the speed of wagons as they descend from the hump. A British observer cannot fail to be impressed – if not overawed – by the colossal size of some of the cars that are constantly under such efficient control. Some of these 'cars' are 90 ft. long and so tall that a portion of their ends is painted white to show the extent to which they are 'out of gauge' and thus prohibited from running over certain routes. The normal through-put of cars in the Toronto Yard complex is about 6,000 daily.

87 **Canadian Pacific Railways:** St. Luc Marshalling Yard, Near Montreal.

This great yard was the first to have fully mechanised shunting control in Canada, and it was brought into service in 1962. It was designed to handle an average of 120 trains arriving and departing daily and, as the majority of these trains have around 100 bogie cars, the high capacity of the yard can be well appreciated. Traffic arrives and departs from three directions. One main flow is towards Toronto and south-western Canada and into the U.S.A.; a second flow passes across the St. Lawrence River and then forks – one branch going to the Maritime Provinces and the other making immediate connection with the Penn–Central Railroad of the U.S.A., which penetrates to within a few miles of Montreal; the third main flow leads north to Quebec. The establishment at St. Luc includes a very large locomotive roundhouse, and diesel and car repair shops. At the time the St. Luc marshalling yard was brought into service most trains were still steam-hauled, and the roundhouse was built to accommodate the largest freight locomotives. No passenger engines were ever stationed at this depot.

88 **Royal State Railways of Thailand:** Diesel-hydraulic Express Passenger Locomotive.

Among railways that have adopted diesel traction in a big way there has been, in some cases, considerable debate as to whether electric or hydraulic transmission gave the more advantageous results. In Western Germany the hydraulic system has been favoured to the exclusion of others, and the famous firm of Henschel, in addition to building for the Deutsche Bundesbahn, has successfully exported models specially designed for tropical conditions. The Royal State Railways of Thailand, dependent almost entirely on wood for steam locomotive fuel, is gradually turning over to diesel traction, and among a diversity of different designs from different parts of the world the Henschel diesel-hydraulic has proved very successful. It has a high coefficient of adhesion due to low-positioned bogie pivots, and is driven by a Maybach Mercedes-Benz engine of 1,500 horsepower. The normal maximum speed is 56 m.p.h., and from personal experience on the footplate it can be said that these locomotives ride very comfortably at maximum speed.

89 **Royal State Railway of Thailand:** 4–6–2 Wood-burning Express Passenger 'Pacific'.

The geography of Thailand inevitably dictates the extent of the railway system of the country, and the long single-tracked line to the south that links up with the Malayan Railways at Padang Besar runs for the most part through a sparsely populated countryside given over largely to the cultivation of rice. In the period covered by this book, following the upheaval of the War and the occupation of Thailand by enemy troops, the south main line was worked by steam locomotives fired with wood. Our picture shows one of the very handsome metre-gauge 'Pacifics' obtained from Japan, which include a number of characteristic Japanese features. The wood used is mostly quite local, brought to the stations by the peasants and bought on the spot. It burns rapidly, and a tender stacked to the very maximum permissible by the loading gauge would not provide fuel for more than about 150 miles. The locomotive workings have to be arranged so that the out-and-home mileage does not exceed this, and in consequence engine changes were frequent on the run to the south. A very similar-looking 2–8–2 type of locomotive was also obtained from Japan for freight working. The diesel locomotives that are working north and east of Bangkok are being multiplied, so as to take over operation completely on the south main line.

90 **Malayan Railways:** Diesel-electric 1,500-Horsepower Main-line Locomotive.

In readiness for converting the entire main line of this interesting railway to diesel traction an order was placed with the English Electric Company for twenty locomotives embodying the well-proved 12 SVT diesel engine, and carried on a locomotive chassis and body of the familiar 'first-generation' nose-cab type, but carefully adapted to the particular climatic and other running conditions of this railway of the tropics. The characteristics of diesel-electric were very closely studied, so that workshop and servicing facilities could be prepared well in advance of the arrival of the locomotives from England, and staff adequately trained. As a result, the introduction of these locomotives into service was extremely successful from the very outset, without any of the teething troubles commonly expected to occur in such a transition of power. The new locomotives were designed to work throughout the 488 miles from Singapore, via Kuala Lumpur to Prai, and haul train loads of 450 tons without assistance on the heavy section through the Taiping Pass, where there are very long gradients of 1 in 80, and severe curves. The maximum tractive effort is 54,000 lb. and the continuous rating 31,050 lb. at 13 m.p.h. The maximum service speed on this metre-gauge railway is 60 m.p.h. After being put into service the locomotives were named after wild flowers of the Malayan countryside.

91 **Burma Railways:** Diesel-hydraulic General Service Locomotive.

The Burma Railways operate in a variety of extreme climatic and physical conditions. The tropical jungle through which most of the railway runs, with its extreme heat and humidity, is one thing; the exceptionally severe gradients of the Lashio line, with lengthy stretches of 1 in 25 gradient and continuous curvature, provide further arduous circumstances. In steam days the Mallet type of articulated steam locomotive found one of its first applications outside the U.S.A. on the Lashio line, and in later years the Beyer-Garratt type was used. In changing over to diesel traction the basic Henschel diesel-hydraulic locomotive, adapted for severe tropical climates, had further specialised equipment added to meet the conditions of the long *downhill* rides of the Lashio line, where all the problems of braking were present in an accentuated form. To avoid overheating of brake blocks, heavy consequent wear, and the danger of 'brake fade', the new locomotives were fitted with dynamic braking, which is a form of regenerative braking that can be applied to non-electric locomotives, and which provides most of the brake power by putting the engine 'on compression', as it were, and minimising the braking effort required from the brake shoes on each vehicle of the train. In other technical aspects the locomotives are similar to those supplied by Henschels to Thailand (ref. 88).

92 **French National Railways:** The ex-P.L.M. 'K' Class Rebuilt 'Pacific'.

As described in earlier volumes of this series the Paris, Lyons and Mediterranean Railway was an extensive user of 'Pacific' locomotives and towards the end of the 1930s many of these were thoroughly modernised, with improved superheaters, twin-orifice blastpipes, and improved exhaust arrangements from the cylinders. Unlike the contemporary 'Pacifics' of the Northern Railway of France, not all the P.L.M. engines had the independent valve gears for the high- and low-pressure cylinders. The 'K' class of rebuilds, which we illustrate, was one of the most successful conversions having all the detailed modifications mentioned above, and the independent valve gears. This latter in the hands of a highly skilled driver could provide an outstanding performance. As electrification was extended to the P.L.M. lines a number of these ex-P.L.M. 'Pacifics' were transferred to the Nord and worked on the English boat trains between Paris and Calais. Before transference, one of these 'K' class engines working north from Dijon with a very heavy train of 650 tons, climbed the mountainous 16½ miles to Blaisy Bas, mostly on 1 in 125, in 26¾ minutes, and then ran the ensuing 82¾ miles to the stop at Laroche in 73 minutes.

93 **Italian State Railways:** 2–8–0 Locomotive with Crosti Boiler.

This unusual locomotive, without the conventional chimney, was the result of a series of scientific experiments that began as early as 1937 to try and obtain more economical working of steam locomotives. The development shown in our picture dates from 1954, and was the result of work carried out in the early years of the War by Dott. Ing. Piero Crosti. He used a pair of subsidiary boilers, or pre-heaters, on either side of the main boiler, and the unusual arrangement requires that there shall be a chimney towards the rear end of the boiler instead of in the normal place. A total of eighty-three locomotives of the '743' class of 2–8–0s was modified in this manner, and showed savings in fuel of more than 10 per cent as compared to unmodified engines of the same class. The basic dimensions of these engines were: cylinders 21¼ in. diameter by 27½ in. stroke; coupled wheel diameter 4 ft. 6 in.; working pressure 171 lb. per sq. in.; total weight of engine only in working order, 70·4 tons. It was reported that not only were the locomotives so modified more economical, but they steamed more freely. Of course, the boiler with its preheaters, was more expensive to construct than a conventional boiler, and coming towards the end of the steam era there was insufficient time to ascertain whether the extra cost was finally justified by the savings in fuel while running.

94 **German Federal Railway (D.B.):** The Post-war Standard 2-8-4 Tank Locomotive.

Among the range of new standard steam locomotives introduced by the German Federal Railway of which the 2-6-2 (ref. 62) is a further example, the 2-8-4 tank engine is ideally suited to much of the relatively short-distance workings in the heavily industrialised districts of the Ruhr and the Lower Rhineland. In describing this neat and powerful locomotive, however, reference must be made to the German description, which can be confusing if it is not understood. What in British and American areas of influence is called a 'tank engine' is called by the Germans a 'tenderlok', thus logically suggesting that the locomotive has its tender as an integral part. These new German 2-8-4 tanks, like the 2-6-2 'tender' engines – to use the latter term in its English sense – are very tall, and tower over the most modern coaching stock. They have cylinders 22·4 in. diameter by 26 in. stroke; coupled wheels 4 ft. 11 in. diameter; a boiler pressure of 199 lb. per sq. in.; and a tractive effort of 37,400 lb. The total weight in working order is 112 tons.

95 **Spanish National Railways (RENFE):** 4-8-4 Express Passenger Locomotive.

On the continent of Europe, after the end of World War II, there was, for a time, a vogue for very large new steam passenger locomotives. In the 1930s the 4-8-4 type had become common in the U.S.A. and in Canada for the heaviest passenger and fast freight duties on lines where steep gradients had to be climbed in the course of an otherwise fast run. These runs, like those of the 'Chief' on the Santa Fe, and the intercity expresses of the Canadian National between Montreal and Toronto, were *really* fast, and involved continuous running at over 80 m.p.h. In Europe, except in the case of the giant Chapelon '242.A1' (ref. 54), such high speeds were not involved, and it was as hill-climbers that the big 4-8-4s were primarily intended. The RENFE engines are magnificent to behold, and distinguished as the only class on the nationally owned stud to carry the green livery. They have cylinders 25¼ in. diameter by 28 in. stroke; coupled wheels 6 ft. 2¾ in. diameter; a boiler pressure of 227½ lb. per sq. in.; and a tractive effort of 46,865 lb. They have twin-orifice blastpipes and double chimneys, and are oil-fired. The engine alone in working order weighs 140 tons, and the tender 67 tons.

96 Indian Government Railways: The 'W.G.' Class Standard 2–8–2 Heavy Freight Locomotive.

Since the War extensive standardisation of steam locomotive power has taken place in India, and the 'W.G.' class, introduced in 1950 and first built by the North British Locomotive Company, has become the broad-gauge (5 ft. 6 in.) standard for heavy freight work. The design was to a large extent based upon previous 2–8–2 designs, but incorporated many improvements. Bar frames are used instead of plate; larger fireboxes are fitted, with provision for mechanical stokers if required, and opportunity to make many parts interchangeable with the new 'W.P.' class 'Pacifics' (ref. 98). The 2–8–2s which are capable of hauling trains of 1,800 tons on the level, or 1,300 tons on a gradient of 1 in 150, have two cylinders 21·9 in. diameter by 28 in. stroke; coupled wheels 5 ft. 1½ in. diameter; a boiler pressure of 210 lb. per sq. in.; and a tractive effort of 38,890 lb. The first 100 locomotives of this class were built in Great Britain, but since then many have been built in India at the Chittaranjan Works. But great though the capacity of this fine new establishment was, it was insufficient to meet the need for new standard locomotives, and additional engines of this most successful class have been built in Austria, Belgium, Germany, Italy, and Japan, in addition to further orders placed with 'North British' and in the U.S.A. The class now numbers over 2,000 locomotives, the largest for any railway in the British Commonwealth.

97 Indian Government Railways: The 'Y.P.' Class Metre-gauge Standard 'Pacific'.

India has a lengthy mileage of important railways laid to the metre gauge, and in the period of post-war recovery the same attention was given to provision of new modern motive power, as to the broad-gauge lines. In 1952 the first of a large order for 'Pacific' engines for the metre gauge was delivered by the North British Locomotive Company. The design was worked out at the office of the Ministry of Railways at Chittaranjan Works, and orders for the locomotives, in large production batches, were placed simultaneously in both Great Britain and Germany. Many more engines of the class have since been built at the railway works at Chittaranjan. These neat and compact little engines, which weigh no more than 57 tons in working order, have cylinders 15¼ in. diameter by 24 in. stroke; the coupled wheels are 4 ft. 6 in. diameter, and the boiler pressure is 210 lb. per sq. in. This provides a tractive effort of 18,450 lb. In accordance with post-war Indian practice, bar frames are used and, to keep the weight to a minimum, the running plates and cabs are built up of aluminium plates and sections. Our picture shows one of them as gaily turned out and working on the Southern Railway, of the Indian national network.

98 Indian Government Railways: The 'W.P.' Standard 4–6–2 Express Passenger Locomotive.

Indian experience with the 4–6–2 type of locomotive in pre-war years had not been of the happiest, and when consideration was given to the production of new designs much re-thinking was done, and an outstanding product eventuated. A pilot order for sixteen engines was placed with the Baldwin Locomotive Company (U.S.A.) in 1947, and these engines, built strictly to the Indian specifications, soon proved excellent machines in every way. Then, under the Colombo Plan Aid Programme, a further 120 were ordered from the Canadian Locomotive Company of Kingston, Ontario, and further units came from Austria and Poland. With many further additions the class is now more than 500 strong. They have cylinders 20¼ in. diameter by 28 in. stroke; coupled wheels 5 ft. 7 in. diameter; boiler pressure 210 lb. per sq. in.; and tractive effort 30,600 lb. In accordance with Indian practice the piston valves were made of very large diameter, to promote free running and, as in the metre-gauge 'Y.P.' class, numerous measures were taken to keep down the weight. The boiler and firebox was made very large to facilitate burning lower-grade non-coking coals, and the result was a locomotive weighing 101½ tons, with a maximum axle load of only 18½ tons. These fine engines are likely to remain in service for many years to come.

99 **Indian Government Railways:** 3,600-Horsepower Electric Main-line Locomotive.

At the same time as the standardisation and large-scale production of new steam power was in progress on the railways of India, measures were being taken to improve working on lines already electrified. The main lines of the former Great Indian Peninsula Railway, from Bombay to Poona and from Bombay to Igatpuri, both include the notoriously difficult sections over the Western Ghats, with lengthy gradients of 1 in 40 and severe curvature. Earlier volumes in this series have illustrated the special steam tank engines designed to provide banking assistance on these inclines. The electrification of these lines on the 1,400 volt D.C. overhead system, between the Wars, greatly eased the situation, and the fine new locomotives illustrated, built by the English Electric Company, in collaboration with the Vulcan Foundry, enabled greatly increased train loads to be handled. They have a maximum starting tractive effort of 69,000 lb.; a one-hour rating, at 28½ m.p.h., of 48,000 lb.; and a continuous rating of 39,000 lb. at 30 m.p.h. They are, however, not merely very powerful hill-climbers. They are essentially express passenger locomotives, and have a maximum service speed of 75 m.p.h., and are also used in fast freight service.

100 **Union Pacific Railroad:** The 'GP.20' 2,000-Horsepower Diesel-electric Locomotive.

Union Pacific is a great name in world railroading! In earlier volumes of this series many developments in its history have been depicted and described, from the grandly historic 'Golden Spike' ceremony at Promontory, Utah, in 1868, when the first trans-continental line across North America was completed. In the diesel age the Union Pacific has gone from strength to strength, and although the type of motive power we have chosen to illustrate here, the robust, well-tried workhorse of North America, the General Motors 'GP.20' of no more than 2,000 horsepower, the railroad has since taken delivery of locomotives having an engine horsepower of 5,000, and still later of 6,600 horsepower in the tremendous Centennial engine, introduced at the time the railroad was celebrating its own centenary of operation, 1869 to 1969. Of course, the 'GP.20' type was designed to be coupled in multiple, and if 6,000 horsepower was required for a specific job, one just coupled three of them together. The Centennial, the world's most powerful single diesel locomotive belongs to a period later than that of this book; but so far as 'largest ever' we can only ask readers to turn to ref. 9 in this book – the largest steam locomotive ever built in the world, also Union Pacific, the 'Big Boy' 4-8-8-4.

101 **Central Railway of Brazil:** U.S.-built 'SD.18' Diesel-electric Locomotive.

At first glance this Brazilian locomotive looks very similar to the Union Pacific 'GP.20' (ref. 100). It was, in fact, no more than a slight variety of the General Motors standard type of what is frequently termed the 'second-generation' diesels. The 'first-generation' in the U.S.A. is very well represented by the Frisco lines locomotive (ref. 11) with its nose-cab and body built out to the maximum extent of the loading gauge. But while still using the standard '567' diesel engine General Motors in their 'second-generation' model produced a locomotive that, if not so handsomely styled, was a much better utility job. Only the 'hood-cab' was built out to the full width of the frames. The machinery was enclosed, but access to it was obtained from open galleries on either side, which made maintenance work very much easier. This feature is shown in the Union Pacific 'GP.20' and in the Brazilian 'SD. 18'. The latter is a standard model except that its power bogies are arranged to run on the 5 ft. 3 in. gauge tracks of the Central Railway. This is a machine of 1,800 engine horsepower, and it can be coupled in multiple to make a two-, three- or even four-unit locomotive according to the tractive power required.

102 **Illinois Central Railroad:** The 'GP.40' General-Purpose Diesel-electric Locomotive, 3,000-Horsepower.

The Illinois Central was one of the first American railways to introduce diesel locomotives for other than shunting purposes when, in 1936, it put on to the road a streamlined lightweight articulated passenger train, diesel-powered. In 1939 the first cab-nosed diesel-electric locomotives of the then-standard type were purchased from General Motors, and by 1954 the passenger services of the railway were completely dieselised. In the meantime however General Motors had produced their new standard workhorse, varieties of which have been illustrated under refs. 100 and 101. The general purpose type (GP), universally known as 'geeps', proved as great a success on the Illinois Central as elsewhere, and the first purchases, of the GP.7 category, 1,500 horsepower, in 1950 were used in the

Chicago district, for shunting and transfer freight trains between the various terminals. By the year 1963 the Illinois Central had 643 diesel locomotives in service, consisting of 42 cab-nosed passenger type, 414 'geeps' and 173 shunters. Then, to deal with the heaviest freight work, in the mid-1960s the very powerful 'GP.40' units were purchased, as in the case of all previous Illinois Central diesels, from General Motors. These large locomotives have an engine horsepower of 3,000 and, with the reliability built in from the nigh forty years experience of the manufacturers, they were soon doing a great job on the line.

103 **Atchison, Topeka & Santa Fe:** The ALCO 'Pa.1' Diesel-electric Locomotive of 1946.

Throughout the twentieth-century history of American railways, the Santa Fe has been in the forefront of locomotive development and had an exceptionally high standard of road performance. During World War II government orders confined the production of main-line locomotives to General Motors, in a process of rationalisation of manufacturing resources; but very soon after the end of the War the American Locomotive Company (ALCO), in collaboration with General Electric, brought out its 'PA.1' passenger diesel. The styling was different to those of General Motors, already familiar in the U.S.A., but ALCO installed inside that streamlined body only a single-diesel engine, in contrast to the two '567' engines of General Motors. This was known as the 'Model 244', with sixteen cylinders and producing 2,000 horsepower. ALCO produced both 'cab' units, as shown in our picture, and 'booster' units without driving cab, for coupling in multiple; and on the immense freight trains worked over the severe gradients on the line through the southerly mountain ranges of the middle-west, *en route* to Los Angeles, it was not unusual to see a four-unit 'locomotive' made up of 'cab', 'booster', 'booster' and 'cab' units, in that order – 8,000 engine horsepower under the control of one crew.

104 **Victorian Railways:** The 'R' Class 4-6-4 Express Passenger Locomotive.

In the rehabilitation programme embarked upon by the Victorian Railways after World War II, known as 'Operation Phoenix', these large new locomotives were designed for high-grade express work. They were massively constructed and intended for heavy work and long mileages without servicing. They had bar frames, 5 in. thick, liberal use of cast-steel assemblies, and a boiler designed for hard continuous steaming, with mechanical stoking. Self-aligning roller bearings were fitted to all axles, and particular attention was given to details of the steam circuit, to ensure there were no hindrances to the free flow of steam. The cylinders were 21½ in. diameter by 28 in. stroke, and the piston valves 11 in. diameter – a large size for such cylinders. The coupled wheels were 6 ft. 0 in. diameter, and with a boiler pressure of 210 lb. per sq. in. the tractive effort was 32,800 lb. With their running plate valences and smoke deflectors painted scarlet they certainly had an air of colour and distinction to add to their massive appearance. Seventy of them were built in Scotland by the North British Locomotive Company and, although originally intended for the Victorian 5 ft. 3 in. gauge, they were so designed that they could be converted to 4 ft. 8½ in. when through running on the standard gauge from New South Wales was affected. When this change did take place however, steam had been superseded by diesel traction on the principal express trains.

105 **South Australian Railways:** The Rebuilt 4-6-2 Locomotive *Duke of Edinburgh.*

In the 1930s an interesting class of lightweight 'Pacific' engine was built at the Islington workshops of the South Australian Railways to the designs of F. J. Shea. They were intended for passenger service on sections of line that could not accommodate the heavy 4-8-4 locomotives used on the Interstate expresses. They had two cylinders 18½ in. diameter by 28 in. stroke; coupled wheels 5 ft. 6 in. diameter; and a boiler pressure of 200 lb. per sq. in. The tractive effort was 25,000 lb. The ten locomotives of this class did good work, but with the onset of dieselisation their days were coming to an end, and in September 1969 engine No. 621, the second of the class, was condemned. But Dean Harvey, Tours Manager of the South Australian Division of the Australian Railway Historical Society, organised the raising of sufficient funds to have engine No. 621 completely overhauled. Harvey found the money; the S.A.R. did the work in their Islington shops. The result is that many steam-hauled tours continue to be run in South Australia. The seal was set on this most enterprising project when the renewed engine was named *Duke of Edinburgh* in April 1971, with the enthusiastic approval of His Royal Highness.

106 **Tasmanian Government Railways:** The 'M' Class 4-6-2 Locomotive of 1951; 3 ft. 6 in. Gauge.

In Tasmania the railways are handicapped by severe gradients and incessant curvature over lines built at minimum capital expenditure to open up the country in early colonising days. The maximum axle load permitted is 10¼ tons. Yet a powerful locomotive was required to operate an improved passenger train service between Hobart and Launceston. The 'M' class 'Pacifics' were built by Robert Stephenson and Hawthorns Ltd. at Darlington, and embody numerous excellent features of construction. Welded members are used wherever possible, to reduce weight, including the inner steel fire box, hopper-type ashpan, and partial fabrication of the tender tank. The engine is designed to negotiate curves of 330 ft. radius, without any gauge widening, and personal observation on the footplate has confirmed that they do ride these severe curves both smoothly and comfortably. The two cylinders are 16 in. diameter by 24 in. stroke; coupled wheels are 4 ft. 7 in. diameter; and boiler pressure is 180 lb. per sq. in. The total weight of engine alone in working order is only 54·2 tons, and the tender weighs 41·2 tons. The tractive effort is 15,500 lb. One of these locomotives has been preserved in full working order, and is frequently used for steam-hauled special trains. Finished in cherry red and maintained in immaculate condition, it is a popular subject for railway photographers in Tasmania.

107 **New Zealand Government Railways:** The 'JA' Class 4–8–2 Passenger and Mixed Traffic Locomotives.

In a previous volume in this series, *Railways at the Zenith of Steam* 1920–40, the semi-streamlined 'J' class 4–8–2 of 1939 was illustrated and described. These locomotives proved a most valuable addition to the motive power stud of the N.Z.G.R., so much so that after the War a modified version, the 'JA' class, was introduced. These were of two distinct batches. There were thirty-five built at the Hillside workshops especially for South Island service; and on this they proved the mainstay of the system until the time came for dieselisation. They were rated to haul 400-ton passenger and 1,000-ton freight trains. They were built between 1946 and 1956. At the same time a further sixteen – in this latter case, oil-fired – were ordered from the North British Locomotive Company, and went into service in 1952 on the North Island system. These engines were mostly used in the Auckland district. The two batches were the same, except for the fuel used, and had cylinders 18 in. diameter by 26 in. stroke; coupled wheels 4 ft. 6 in. diameter; and a boiler pressure of 200 lb. per sq. in. Despite their small wheels and the 3 ft. 6 in. gauge, they had a splendid turn of speed, occasionally topping 70 m.p.h.

108 **German Federal Railways:** The Krauss-Maffei 'V.200' Diesel-hydraulic Locomotive.

Under refs. 88 and 91 mention has been made of the German predilection for the hydraulic system of drive for diesel locomotives, and the success that industry has achieved in exporting locomotives of this type. It is therefore interesting to study the 'home' product. Krauss-Maffei is one of the most famous names in the world for construction of locomotives, and earlier books in this series have described and illustrated some of the celebrated steam locomotives of the past, and their influence outside Germany. The strikingly styled locomotive we now illustrate is one of a series standardised by the German Federal Railways on routes not being electrified, and is developed from a design of 1952. It was the prowess of this design that influenced the Western Region of British Railways towards the adopting of the diesel-hydraulic locomotive, and externally one can detect a faint 'family likeness' between the 'V. 200' and the W.R. 'Warships'. The 'V.200' has an engine horsepower of 2,000/2,300, a weight in working order of 80 tons, and a maximum service speed of 87 m.p.h. The equipment includes two twelve-cylinder, four-stroke diesel engines, some locomotives having the Voith, and others the Mekydro, system of transmission.

109 **French National Railways:** The '68,000' Class Diesel-electric Locomotive.

One cannot complain of any monotony of styling or finish with the diesel and electric locomotives of today. One has only to compare the German 'V.200' and the Danish and the Finnish units pictured adjacent to each other in this book with the French '68,000' to appreciate how diverse the railway scene is becoming in Europe, as it had become in the first flush of the diesel age in the U.S.A. These French locomotives are taking the place of steam, on routes not yet electrified. They were first introduced in 1963, and within five years more than 100 were in service. In tractive power they correspond approximately to the British Type '4' or class '47' (ref. 152), having an engine horsepower of 2,670. The weight in working order is 104 tons, and maximum service speed 81 m.p.h. They are designed for coupling in multiple, and also for coupling with the slightly less powerful '67,000' class. These latter have an overall weight of 79 tons, an engine horsepower of 2,000, and are similarly styled. Both the '67,000' and '68,000' classes are essentially express passenger units, though the '67,000' class is also used in fast freight workings. Until the construction of the still larger '72,000' class, beyond the period of this book, the two classes together represented the standard main-line diesel power of the S.N.C.F.

110 **Finnish State Railways:** Main-line 1,900-Horsepower Diesel-electric Locomotive.

The Finnish State Railways have a route-mileage of around 3,000, roughly equal to one of the largest British systems in pre-grouping days. Until 1950 practically all the motive power was steam, most of it manufactured in Finland; but from that time onward the changeover to diesel traction has been continuous, again all of indigenous manufacture. Some locomotives are of local national design; others are of foreign design manufactured under licence. The locomotive illustrated is a stylish example of a diesel for main-line express work, and rated to run at a maximum speed of 75 m.p.h. It is one of a series built in Finland from 1959 onwards and has a total weight of 122 tons, on six axles. Since the introduction of this class a remarkable lightweight design of enhanced capacity has been put into service. Although weighing no more than 98 tons, it has a rated horsepower of 2,800, and is capable of a maximum speed of 87 m.p.h.

111 **Danish State Railways:** 1,750-Horsepower Diesel-electric Main-line Locomotive.

Denmark has a long record of successful locomotive construction and the firm of A/S Frichs built many excellent steam units. When the Danish State Railways began the change to diesel traction, advantage was taken of the lengthy and world-wide experience of General Motors, and the famous '567' engine, to form the centrepiece of the new locomotives. The Swedish firm of Nydgvist & Holm A B had formed a business association with General Motors and the outcome was the NOHAB-GM range of diesel-electric locomotives. In those supplied to the Danish State Railways the mechanical parts were sub-contracted to A/S Frichs, including the bogies, the underframes, and certain other parts, thus continuing the association of Frichs with locomotives for the railway. These locomotives are of the 'AIA–AIA' type. The generator set powered by the diesel engines supplies current to four motors, each of which is connected to one of the outer axles of the six-wheeled bogie. The centre axle of each bogie is not powered. The handsome styling of these locomotives, with the wings and crown on the 'nose' of the cab, adds a touch of distinction to the express trains that are operated.

112 **Canadian Pacific Railway:** 1,500-Horsepower Diesel-electric Locomotive.

Under ref. 11 in this book the creation of the 'first-generation' diesel-electric locomotives in North America was mentioned. In 1949 General Motors loaned two standard locomotives, each of three 1,500-horsepower units, one to the Canadian Pacific and one to the Canadian National Railways. There was much interest as one of them made its way west over the C.P.R. in the depths of winter. In three weeks the temperature never went above zero, and at times it was 50 degrees below! But the diesel continued to work efficiently, and the C.P.R. bought a number of them, first of all for the very severe section through the Rockies, where the high tractive effort of the diesel engine at low speed gave them a considerable advantage over the largest of the existing steam power. Gradually their use spread over the entire trans-continental main line. They have certainly stood the test of time, and those 'first-generation' General Motors locomotives, built at the newly established Canadian plant at London, Ontario, are still engaged in first-class service today – more than twenty years after their first construction. Today they are painted in the new scarlet livery, striped in white, and carry the name 'C.P. Rail', instead of 'Canadian Pacific'. They are often coupled in multiple with the 'hood-cab' second-generation mixed traffic diesels.

113 **Canadian Pacific Railway:** The 'Dome-Observation-Lounge' Car.

It was in 1954 that the C.P.R. took delivery, from the Budd Company of Philadelphia, of the new stainless steel cars for the trans-continental expresses. They are of various types, including de-luxe coaches for passengers sitting up through the night; a scenic dome coach, including buffet, snack lounge, and a sky-line coffee shop – all available to non-sleeping car passengers, dining car, and the fine sleepers, some having private bedrooms and others 'roomette' berths. But the tail-end 'dome-observation-lounge' is indeed something special. It has a beautiful 'stern-walk' lounge buffet, and the magnificent elevated 'dome', which is just that much higher than the ordinary coaches so that one can see ahead above the top of the rest of the train. It is an enthralling experience to travel in the 'dome' at 70 to 75 m.p.h. across the Prairies, watching the long train winding ahead through the awe-inspiring canyons of British Columbia. The dining and sleeping cars, together with the rear-end dome cars, are all named, after parks and chateaux – not actual locations, but the suffix or prefix added to names of eminent persons in Canadian history, such as *Chateau Radisson*, *Dufferin Manor*, and so on.

114 **Pacific Great Eastern Railway:** 'MLW'-type 3,000-Horsepower Diesel-electric Locomotive.

The development of the Pacific Great Eastern Railway is one of the phenomena of modern Canadian railroading. From an impecunious steam-worked railway in the backwoods of British Columbia it has become an important freight carrier extending from Vancouver to within measurable distance of the provincial boundary with the Yukon. In 1949 it was no more than 345 miles long; now its route-mileage is 1,550, and in 1972 its name was changed to the British Columbia Railway. It is primarily a freight carrier, and it includes on its main line one of the longest and steepest gradients on a railway to be found anywhere in the world. From Lillooet northwards, climbing high above the canyon of the River Fraser, the line climbs at an average gradient of 1 in 53 for *twenty-four miles.* The freight traffic is heavy and now worked entirely by diesel power. The locomotives are all of Montreal Locomotive Works type, using the design originally prepared by the American Locomotive Company (ALCO). Most of them are of 1,600 and 1,800 horsepower, all of the 'hood-cab' type; but just after the end of the period of this book some 3,000 horsepower units were added, and it is one of these that is shown in our picture.

115 **Algoma Central Railway:** 'GP7' 1,500-Horsepower Diesel-electric Locomotive.

The story of the Algoma Central is one of the great, though perhaps one of the least-known, railway romances of the world. How a railway was conceived as an integral part of the vast industrial empire generated at Sault Ste. Marie, Ontario, by Francis H. Clergue, from 1899; how it became involved in the financial 'crash' of 1903; how construction was continued nevertheless with Provincial Government Aid, until in 1914 it went completely bankrupt are only preliminaries to the main story. By then the Algoma Central had a main line 296 miles long, intersecting no fewer than three trans-continental routes, and no more than thirty-five steam locomotives to work it! For nearly forty years the railway was managed by a committee of bond holders; but in the early 1950s an astonishing metamorphosis took place, and under very able private company management it was lifted out of its long-time precarious position to one of resounding prosperity. The change to diesel traction began in 1951, and was completed by the end of 1952; it was, in fact, the first Canadian railway to dispense entirely with steam. All the new power was of General Motors standard models, and our picture shows one of the earliest and least powerful.

116 **Japanese National Railways:** The 'C51' Class 4-6-2 Express Passenger Locomotive.

While this book is primarily connected with developments in railways from 1941 onwards, so far as Japan is concerned information was not available regarding earlier periods when the books relating to them were prepared. Opportunity has therefore been taken to include in this volume certain locomotives that were still in regular mainline service from 1941 onwards but which were first introduced earlier. Of these there is no more celebrated example than the 'C51' class 4–6–2, a very handsome design, shown here in its original form. At a later period smoke deflectors were added on each side of the smokebox, and an upward extension to the top of the chimney was added – neither improving the appearance. Note will doubtless be taken of the shapely chimney, strongly reminiscent of the English Great Central practice of J. G. Robinson. At one time there were nearly 300 of these locomotives in traffic. Their basic dimensions were: cylinders 21 in. diameter by 26 in. stroke; coupled wheels 5 ft. 9 in. diameter; boiler pressure 180 lb. per sq. in.; and nominal tractive effort 25,400 lb. Their rated maximum speed, on 3 ft. 6 in. gauge, was 60 m.p.h., though there were times when they were driven much faster.

117 **Japanese National Railways:** The 'C53' Class Three-cylinder 4–6–2 Express Locomotive.

In 1928, when the need was felt for more powerful locomotives than the 'C51' class, an extremely interesting new design of 'Pacific' was introduced. Although the twentieth century had witnessed the development of a wholly indigenous locomotive practice in Japan, as distinct from the British and American imports of earlier days, a close study continued to be made of overseas practice, and the fame of Sir Nigel Gresley's three-cylinder locomotives in England resulted in the adoption, not only of three-cylinder propulsion, but also of the Gresley conjugated valve gear for actuation of the valve spindle of the inside-cylinder valves. The 'C53' class, of which nearly a hundred were constructed, were notable in the abandonment of the handsome 'G.C.R.' type of chimney for a plain stovepipe, and the removal of the sandbox from the boiler top. The 'C53' class were fast and powerful engines, and one of them has been preserved in working condition. The basic dimensions are: cylinders (three) 17¾ in. diameter by 26 in. stroke; coupled wheels 5 ft. 9 in. diameter; boiler pressure 199 lb. per sq. in.; nominal tractive effort 30,000 lb.

118 **Japanese National Railways:** The 'C11' Class 2–6–4 Branch Passenger Tank Engine.

In the country districts the J.N.R. has a number of branch lines carrying a light, though important, traffic and the 2–6–4 type was standardised for this class of work. A number of them are still at work today, although the tendency is nowadays to use diesel railcar sets. The 'C11' is a smart little unit of thoroughly modern design with coupled wheels 5 ft. 0 in. diameter and cylinders 17¾ in. diameter by 24 in. stroke, and having a boiler pressure of 214 lb. per sq. in. Engines of this class are working in the northernmost island of Japan, Hokkaido, in branch line service, and elsewhere engaged in shunting. The nominal tractive effort is 23,108 lb. Like all the more recent steam locomotive designs of the Japanese National Railways, it was built in large quantities, and totalled at one time 381 engines. The smaller 'C12' with the

2–6–2 wheel arrangement was also very numerous at one time, mustering nearly 300 in all. A few of these latter are also still in service.

119 **Japanese National Railways:** The 'C57' 'Light' 4–6–2 Passenger Locomotive.

The prefix 'C' in the class designations of J.N.R. refers only to the number of coupled axles. Thus all six-coupled engines are prefixed 'C'; eight-coupled are 'D', and so on. The 'C57' 'Pacific', of which over 200 were constructed, is a powerful unit, with a maximum axle load of only 14 tons. There are a number of these locomotives still in regular service in the islands of Hokkaido and Kyushu, and our picture shows one of them specially finished and decorated for working the Imperial Royal Train, which the author was fortunate enough to see during a visit to Japan in 1973. The coupled wheels are of the standard diameter of 5 ft. 9 in. and the cylinders 19⅝ in. diameter by 26 in. stroke. With a relatively high boiler pressure of 227 lb. per sq. in. the nominal tractive effort is 28,268 lb. Despite the use of coal of a standard far below the worst customary in Great Britain the 'C57' class steam freely, albeit to the accompaniment of dense clouds of black smoke. They are limited to a nominal maximum of 60 m.p.h.

120 **Netherlands State Railways:** Bo – Bo Electric Locomotive.

In the complete reconstruction of the Dutch Railways that was necessary after the wholesale devastation caused in the concluding stages of World War II it was possible to plan the national network anew, as a fully integrated whole. At the same time the reconstruction could not take place more than gradually, and use had to be made of a considerable number of steam locomotives that were still serviceable. So, while the ultimate object was the provision of a rapid, multiple-unit series of trains, for all internal services many new locomotives were needed in the interim period, and to provide for the haulage of freight and the international through express trains. For general service on the electrified lines, equipped with 1,500 volt D.C. overhead lines, an Alsthom design of electric locomotive was chosen. This had been adopted by the French Railways and was doing good service, and the locomotive shown in our picture differs only in small detail from the French. It is capable of a continuous output of 2,400 horsepower, and this can be realised in the haulage of a 1,250-ton freight train at 50 m.p.h., or a 630-ton passenger train at 71 m.p.h. – both on level track. This is generally well in advance of everyday requirements.

121 **French National Railways:** Quadri-current High-speed Electric Locomotive.

The development of international express train services in Europe has always been complicated because of the systems of electric traction standardised in different countries. There are four systems in current use, as follows:

1,500 volt D.C. in Holland, and certain lines in France.

3,000 volt D.C. in Belgium, Italy and Spain.

15,000 volt A.C., 16⅔ cycles, in Germany, Austria and Switzerland.

25,000 volt A.C., 50 cycles, on all newly equipped lines in France.

The locomotive illustrated is designed to operate on any of the above four systems. There are four separate pantographs, and at an international frontier it is possible to change from one system to another without stopping. Locomotives of this type are used on certain luxury express trains running non-stop between Paris and Brussels, and at the Franco-Belgian frontier when the traction system changes from 25,000 volts A.C. to 3,000 volts D.C. the pantograph hitherto in use is lowered, and then while coasting through a neutral section the 3,000 volt D.C. pantograph is raised, but power cannot yet be applied. Only when it is proved electrically that the pantograph raised is in correspondence with the voltage on the line can power be re-applied. Actually however the change-over period is scarcely discernible, even to an experienced observer in the train.

122 **French National Railways:** 'Grand-Confort' Rolling Stock for TEE Services.

The gradually increasing network of Trans-European Express trains is a much-appreciated feature of modern travel between major centres of population and industry. They combine exceptionally high speed with maximum comfort, and provide a very acceptable alternative to air travel. The Paris–Brussels service mentioned under ref. 121 involved a journey time of little more than two hours from one city centre to the other, which could not be equalled using air transport, with the inevitable journeys from each city centre to the outlying airports. The coach illustrated is one of a type recently introduced on such very fast French services as the 'Mistral', running between Paris, Lyons, Marseilles, and Nice. The stainless steel construction follows the Budd principle (ref. 12), but unlike many recent coach designs these French vehicles are of the individual compartment rather than the open saloon type. They ride most luxuriously, even on curving stretches of the line when the speed is sustained continuously at around 100 m.p.h.

123 **Italian State Railways:** The 'Settebello' De Luxe High-speed Electric Train.

The Italian State Railways was one of the first in Europe after World War II to introduce extra high-speed luxury trains, and it was in 1953 that the *treno-lusso* was put on, running thrice weekly on the route Milan–Bologna–Rome–Naples. The seven-car train, named the 'Settebello', or 'lucky seven', is powered by twelve traction motors working on the standard Italian system of 3,000 volts D.C. and runs at a maximum speed of 112 m.p.h. The accommodation is exceedingly luxurious with seating for no more than 160 passengers, in the seven cars. A most unusual provision is that of observation lounges at both the rear and the front of the train. Our picture shows how the driver's compartment is arranged at high level, so that the 'ground floor', as it were, can be made available for passengers. There are seats for eleven passengers at each end of the train, and these can be occupied free of any supplementary charge. When the 'Settebello' was first put on there was only one train set in commission, and it ran thrice weekly. Now it runs daily. Its fastest 'laps' are Milan to Bologna, 136 miles in 108 minutes, 75·7 m.p.h.; and Florence to Rome, 197 miles in 178 minutes, 66·5 m.p.h.

124 **London Midland & Scottish Railway:** The 'Converted' 'Royal Scot' Class 4–6–0 Locomotive.

The 'Royal Scot' class of locomotive when first introduced in 1927 developed a high standard of performance on the Anglo-Scottish train services between London and Glasgow; but after the introduction of the range of locomotive with taper boilers by Sir William Stanier it was found that maintenance costs with the latter type were considerably lower than with the more conventional type used in earlier engine classes. A decision was taken therefore to renew the engines of the 'Royal Scot' class with large boilers having a tapered barrel and the Great Western shape of Belpaire firebox. Opportunity was taken also to improve the cylinder design and valve events. The first engine to be so treated was No. 6103 *Royal Scots Fusilier* in 1942, and the results were so satisfactory that in due course the entire class of seventy locomotives was so treated. In maximum performance the 'converted' engines did not greatly exceed the work of the original variety; but their reliability and freedom from casualties was greatly increased.

125 **British Railways, Western Region:** The 'King' Class 4–6–0.

When the four-cylinder 4–6–0 locomotives of the 'King' class were first introduced on the Great Western Railway in 1927 they were, by a considerable margin, the most powerful express engines in Great Britain. For twenty years they rendered an exceptionally high standard of performance; but in the years after World War II the deterioration in quality of fuel available made necessary some modifications to the design to keep them abreast of requirements. A higher degree of superheat was introduced. The drafting in the smokebox was modified to enable pre-war rates of steam production to be maintained with the inferior post-war coal. With these changes some remarkable performances were put up, including the haulage of a twenty-five-coach train of 795 tons at a start-to-stop average speed of 57 m.p.h. The final change is that shown in our picture, whereby the locomotives of this class were fitted with twin-orifice blastpipes and double chimneys. This further increased their speed and efficiency, and one engine of the class, No. 6015 *King Richard III*, attained a maximum speed of 108 m.p.h. while hauling the 'Cornish Riviera Express'.

126 **British Railways, Eastern Region:** The 'A4' Streamlined 'Pacific'.

This famous class of high-speed express passenger locomotive achieved many notable records soon after its first introduction in 1935; but in the years covered by the period of this book it continued to play so important a part in the working of first-class traffic on the East Coast Route as to establish itself as one of the most outstanding engine classes of the day. Some significant detail modifications to the machinery made no small contribution to its continuing high efficiency. Improved machinery and techniques in Doncaster Works, from where the class was maintained, made possible greater accuracy in repair work, and longer periods of duty between successive overhauls. It also gave greater reliability in traffic. The greatest tribute to the working of these engines came in each summer season, when for several months the morning Anglo-Scottish expresses were run non-stop over the 393 miles between Kings Cross and Edinburgh. The booked time was 6½ hours; but time was frequently made up to the extent of 25 minutes, in recovering from engineering and other incidental hindrances *en route*. The net average speed in such instances was thus well over 60 m.p.h. on this long run.

127 **British Railways, Eastern Region:** The 'A3' 'Pacific' Express Passenger Locomotive.

The 'A4' streamlined engines (ref. 126) were developed from the 'A3' which in turn represented an advance, dating from 1928, of the original Gresley 'Pacifics' of the Great Northern Railway, built in 1922. But like the 'A4', the 'A3' was also substantially improved in the years following World War II and, except on the Edinburgh non-stop expresses, worked turn and turn about with the 'A4's on the principal express services from London, Kings Cross. The 'A3's had the same important treatment so far as accuracy of repair was concerned. They were equipped with twin-orifice blastpipes and double chimneys and, because of the soft blast resulting from the improved draughting, they had to be fitted with smoke-deflecting plates at the side of the smokebox. This did not improve their appearance, but it was an attachment that was very necessary to eliminate the risk of exhaust steam beating down and obscuring the driver's view of the line ahead.

128 **New Zealand Government Railways:** The 'EW' Class 1,800-Horsepower Bo-Bo-Bo Electric Locomotive.

When the decision was made to electrify the Hutt Valley line out of Wellington, although electric traction had been in use in New Zealand for many years there were no locomotives having the necessary tractive power for the severe gradients, yet conforming to the maximum axle loads that could be permitted. The inspiration of the triple-bogie locomotive may well have come from Italy, where locomotives of that type had been in service since 1942, with very good results. So, for the Paekakariki section, with the 1 in 57 gradient of Pukerua bank to be surmounted, the N.Z.G.R. placed an order with English Electric for seven powerful locomotives, yet weighing no more than 75 tons, and coming within the stipulated maximum axle load of 12½ tons on the 3 ft. 6 in. gauge track. They were put into service in 1951 and have proved an outstanding success. They are geared for a maximum speed of 60 m.p.h., but do not normally exceed 50 m.p.h. It is however in climbing the steep gradients that their main value lies. They mount the Pukerua bank at 40 m.p.h. with a 300-ton passenger train, and take a 600-ton freight up the same incline at 20 m.p.h. It is interesting to note also that the same wheel arrangement was subsequently adopted by the metre-gauge Rhaetain Railway in Switzerland (ref. 79), in 1958, for its very heavily graded Alpine route.

129 **New South Wales Government Railways:** The '46' Class Main-line Electric Locomotive.

The N.S.W.G.R. has two sections of exceptional grading relatively near to Sydney, so near that an extension of the electrified suburban area was a logical development, to reap the rewards of electric traction in hauling heavy passenger and freight trains. The two sections concerned were the crossing of the Blue Mountains between Penrith and Lithgow on the main west line, and on the north line to Gosford, including the severe gradients in approaching the Hawkesbury River. The specification laid down for main-line electric locomotives ordered from the Metropolitan Vickers Company, in England, required a sustained speed of 35 m.p.h. on a 1 in 33 gradient with a load of 400 tons. The difference between electric and diesel-electric locomotives of approximately the same size and weight is strikingly shown in New South Wales by comparison of these new 'electrics' with the '44' class diesels. The latter have an all-up weight of 106 tons compared to 108 for the 'electric', and their engine horsepower is 1,800. The electrics have a continuous horse-rating of 3,500, and for short periods the output can be considerably greater. In making this comparison however the high capital cost of installing electric traction must be borne in mind.

130 **Commonwealth Railways (Australia):** 1,500-Horsepower G.M. Diesel-electric Locomotive.

In travelling on railways in many parts of the world nowadays one recognises the familiar profiles of English Electric, Alsthom, General Motors, and M.L.W. products in many far places, often in the most exotic colours; but there is perhaps no more striking application of a completely standard locomotive design than that of the 'first-generation' G.M. 1,500-horsepower units on the Commonwealth Railways, in Australia. These excellent locomotives, usually working in pairs, operate the amazing Trans-Australian line across the Nullabor Plain, making a single journey of 1,108 miles between Port Pirie, South Australia, and Kalgoorlie, Western Australia. On this run they are manned by four different crews, two from each end. The men work a four-day cycle, two days working out and two working home, lodging on three successive nights in the course of this roster. The route includes the record-making stretch of 297 miles of absolutely straight track, across the utter 'nothingness' of the Nullabor Plain. The normal passenger train speed is 60 m.p.h., and the landscape is so completely devoid of features that when a crossing station is approached its buildings first appear as specks on the horizon, sighted over the curve of the earth, like the first appearance of islands or ships at sea.

131 **Queensland Railways:** 90-ton Co - Co Diesel-electric Main-line Locomotive.

The change-over to diesel traction on the Queensland Government Railways began in 1952 but, unlike some other railways one can recall, they adopted a policy of complete standardisation from the outset. There was no question of testing the merits of various designs and then choosing that which was considered most suitable. The choice was made before ordering began, and the new fleet now consists of no more than *three* types. Furthermore, it was arranged that all these locomotives would be built in Queensland, using imported power units. The three types are a 90-ton Co - Co of 1,500 to 2,000 horsepower for general purpose passenger and freight main-line haulage; a 60-ton Co - Co of around 900 horsepower, for branch line passenger work, and a 40-ton diesel-hydraulic, for shunting and light branch work. There are some very heavy coal hauls now on the Queensland Railways requiring the use of three 1,980-horsepower Co - Co locomotives, but the main-line passenger trains are taken by a single locomotive, usually of 1,650 horsepower. The attractive livery shown in our picture is applied to all the 'road' locomotives, whether on coal trains or passenger, and all are kept most beautifully clean. The diesel-hydraulic shunting locomotives are finished in a livery of bright green and grey.

132 **The Alaska Railroad:** 2-8-0 General Service Locomotive of 1943.

The remote northern state of Alaska assumed major strategic importance as a base for the United States Air Force during World War II. In more recent times it has become familiar to world travellers as a staging point on the jet-liner civil air service on the Polar Route from Europe to the Far East. In 1943 additional motive power was needed for war service on the Alaska Railroad, and a number of 2-8-0s were purchased from the Baldwin Locomotive Company. These locomotives, of which No. 557 illustrated was the last steam unit to remain in service in Alaska, were generally similar to the 2-8-0s built by Baldwin and other American manufacturers for service with the United States armies in Europe (ref. 21). The special features, such as vacuum brake and British type of buffing and drawgear were naturally not included, and it will be seen that No. 557 has the usual American headlight, cow-catcher, and bell. As originally it was a coal-burner, but in 1955 it was converted to oil firing, as shown in our picture. Its basic dimensions were exactly the same as those shipped to Europe from 1942 onwards.

133 **Deutschen Reichsbahn (East Germany):** High-speed Diesel Railcar Train.

The high-speed semi-streamlined diesel 'railcar' train had its origin in Germany in the early 1930s, and it was indeed the spectacular performance of the 'Flying Hamburger' that led directly to the construction of the ever-memorable 'Silver Jubilee' steam-hauled streamlined express of the L.N.E.R. In the years before World War II other fast railcar services from Berlin were introduced, with rather more extensive passenger accommodation than the 'Flying Hamburger'; but since the War this particular type of train has not been revived in West Germany. In East Germany where the railway system retains the pre-war name applied to the whole country – Deutschen Reichsbahn – some new high-speed trains have been introduced. Our picture shows the leading unit of the strikingly styled Berlin–Schönefeld service. Each train consists of two driving motor cars, one at each end, and three trailer cars. Each motor car is powered by a twelve-cylinder 900 horsepower engine. The transmission is hydraulic. These trains run up to a maximum speed of 102 m.p.h.

134 **Swedish State Railways:** The 'Dm 3' 9,780-Horsepower Electric Locomotive.

The three-unit articulated electric locomotive has been developed for various types of heavy-duty service since the New Zealand Government Railways took the Italian innovation of 1942, and adapted it with such success to the Wellington Hutt Valley line in 1951 (ref. 128). So far however no other development has, for maximum power, approached the remarkable 'Dm 3' class built by NOHAB for the Swedish State Railways in 1960. These triple-articulated units are among the most powerful single locomotives in the world, having a shaft horsepower of 9,780. They operate on 15,000 volts, 16⅔ cycles, on the standard 4 ft. 8½ in. gauge. There are six traction motors, driving in pairs on to lay shafts between the three groups of driving wheels. Each of these groups is eight-coupled, and the entire weight of the locomotive, 267 tons, is available for adhesion. They are used for the haulage of very heavy iron-ore trains, of 5,100 tons, over steep mountain gradients between Kiruna and Narvik in the far north of Sweden. A total of nineteen of these extremely powerful locomotives was supplied; of these, sixteen have rheostatic braking which, in the working of such huge loads downhill, is a 'must'. Their maximum speed is only 37 m.p.h.; but it is, of course, haulage power and braking power that is of prime importance in such a service.

135 **Italian State Railways:** The 'D 341' Class Diesel-electric Locomotive.

The Italian Railways were among the first in the world to adopt electric traction, and in recent years there has been considerable extension of the 3,000 volts D.C. electrified network. But as in France and Germany there are considerable areas previously worked by steam that do not yet justify electrification and these are being changed over to diesel traction. The locomotive shown in our picture is an interesting example of a general-purpose medium-powered unit of which many have been put into service. It is of the Bo–Bo wheel arrangement with an all-up weight of only 64 tons. It is limited to a maximum speed of only 62 m.p.h. – essentially a unit for secondary lines. It is finished in the khaki livery that was at one time standard for all Italian electric locomotives, though more recently a smart turn-out of light grey and bright green has been adopted for the main-line passenger locomotives.

136 **Japanese National Railways:** A Diesel Multiple-unit Express Train. Steam traction is now being rapidly 'phased out' on the Japanese National Railways, and quite apart from the 'super' express trains on the Shin-Kansen lines, laid to the 4 ft. 8½ in. gauge (ref. 153), many very fine new train-sets have been introduced to the 3 ft. 6 in. gauge lines. These are of both diesel and electric traction. In the northern island of Hokkaido diesel traction is used, and our picture shows one of the type of limited express trains running between the capital city of Sapporo and the port of Hakodate, where contact is at present maintained with the main island of Honshu by means of a train ferry. These trains are finely appointed, with full air-conditioning, and both buffet and individual seat service. The speeds vary on different parts of the system, but the maximum is around 75 m.p.h., and the riding is very smooth and comfortable on excellently maintained track. Similar trains, electrically driven, are used on other parts of the system.

137 **Japanese National Railways:** The 'D51' Class 2–8–2 Mixed Traffic Locomotive.

This class, introduced shortly before World War II, became, in its almost universal usage, the Japanese equivalent of the British 'Black Five' of the L.M.S. It is a very powerful modern design, of essentially functional appearance, and including features introduced to deal efficiently with the soft, rather small coal in regular use. The exhaust from the valves is taken through a large reservoir before passing to the blastpipe, and this has the effect of evening out the blast and avoiding a fierce draught on the fire, which would life the small coal. As it is the exhausts from these locomotives is often very discoloured. They have two cylinders 21⅝ in. diameter by 26 in. stroke; the coupled wheel diameter is 4 ft. 7 in. and with a boiler pressure of 199 lb. per sq. in. the tractive effort is 37,419 lb. The weight of engine alone is 76½ tons. The effect of that 'softening' reservoir is to give a very quiet exhaust and, even when starting a heavy freight train, the beat is most deceptively soft. These engines were very successful in service and more than 1,100 of them were built. The extension of the electrified system has made many of them redundant today and the survivors are mostly to be found in the northern island of Hokkaido, and in the southern island of Kyushu.

138 **Japanese National Railways:** The 'C62' Class 4–6–4 Express Passenger Locomotive.

These very impressive locomotives were the ultimate development of Japanese main-line steam passenger motive power on the 3 ft. 6 in. gauge. In their latter days they were used on the island of Hokkaido hauling the express trains between the ferry port of Hakodate and the island capital, Sapporo. They were a development of the range of 'Pacific' locomotives and of an earlier 4-6-4 design, the 'C61'. The 'C62' class had two cylinders 20½ in. diameter by 26 in. stroke; coupled wheels 5 ft. 8⅞ in. diameter; and with a boiler pressure of 227½ lb. per sq. in. the tractive effort was 30,583 lb. – a high figure for an express passenger engine on the 3 ft. 6 in. gauge on a line that did not permit such huge locomotives as those in South Africa on account of structure gauge limitations. The 'C62' class had an all-up weight, engine only, of 87½ tons. One of these engines, No. C62-2, has been preserved and is maintained in full working order at the preserved steam roundhouse at Kyoto. On occasions it is steamed and driven along a short length of track outside the shed.

139 **Japanese National Railways:** One of the 'ED' Series of Electric Locomotives.

The electrification of Japanese Railways has proceeded rapidly in recent years, though there have been many incidental difficulties because of the different systems of electric power supply in the main island of Honshu, and in the smaller ones. In Honshu the 3 ft. 6 in. gauge lines have been electrified on the 1,500-volt D.C. system as used in Holland and parts of France. In the southern island of Kyushu electrification is at 20,000 volts A.C., 60 cycles, while the new Shin-Kansen lines (ref. 153) are electrified at 25,000 volts A.C., 50 cycles, as in Great Britain and in use for all new electrification works in France. Today most of the daytime express trains on the 3 ft. 6 in. gauge are of the multiple-unit type, either electric, or, in non-electrified areas, diesel (ref. 136); but there are a number of overnight sleeping car trains that have to be hauled by individual locomotives, and all the latest types are suited to either passenger or freight haulage.

140 **Victorian and South Australian Railway:** First-class Sleeping Car for the 'Overland'.

'The Overland', the very popular sleeping car express running nightly between Melbourne and Adelaide, is the oldest-established through intercity express in Australia. From their inception the Victorian and the South Australian Railways adopted the same gauge, 5 ft. 3 in., and when their systems were connected in 1887 at the border station of Serviceton, through running was commenced. The name 'Overland' has an historic origin. Until the linking up of the two state railways at Serviceton the only regular means of communication between the capital cities of Melbourne and Adelaide was by sea. From 1887 the connection was 'over land'. Today the 'Overland' is a very heavy, luxuriously appointed train, often loading to eighteen cars. It is diesel-hauled throughout. The sleeping cars are among the most elaborately equipped in the world, and, like those on other intercity expresses in Australia, such as the 'Southern Aurora', between Sydney and Melbourne, and the 'Indian Pacific', are fitted with private showers for each berth. The rolling stock used on the 'Overland' is jointly owned by the Victorian and South Australian Railways. Locomotives are changed at Serviceton.

141 **German Federal Railways:** An Intercity Double-decker Train.

The problem of dealing with accommodation for peak-hour passenger traffic is one that has concerned railways in all the developed countries of the world. Railways favoured with more generous loading gauges than those of Great Britain began experimenting with double-decker trains many years ago, but the question is not entirely one of just packing people in. On the Southern Railway in England some experimental trains were tried, but became unpopular with everyone concerned because of the time taken to load up at stations. The handsome German train that we illustrate is unusual in that it is not primarily a commuter service. It runs from the industrial Rhineland, starting at Dortmund, to Frankfurt and Fulda. It is of lightweight construction and provides seating for no less than 324 people in three coaches. The top floor of one coach includes some second-class accommodation, while on the top floor of the centre of the three coaches is a buffet. Otherwise all the seating is for third-class passengers. In contrast to many more recent trains the windows seem on the small side; but it must be remembered that this train was introduced as relatively long ago as 1951.

142 **The Gornergrat Railway, (Switzerland):** Electric Railcar Train.

The Matterhorn is perhaps the most spectacular mountain in the high Alps, and, since 1898, observation of its striking profile and approaches has been made easy by the construction of the Gornergrat Electric Railway, which takes tourists easily to an altitude of 10,270 ft. to a classic point of observation on the range. The railway makes the ascent from the world-famous tourist resort of Zermatt in no more than 45 minutes. The only hazards likely to be experienced by a visitor making the trip is the unpredictable nature of the weather. One can travel through the Rhone Valley to Brigue, the junction point for the narrow-gauge railway to Zermatt, in what appears to be hot, settled fine weather in the early summer, and awake next morning to find deep snow, and the entire prospect of the mountains obliterated. The Gornergrat Railway, with its massive 'rack' drive, operates in most conditions of weather, though on such occasions it is usual to send a pilot car up the mountain to make sure there are no blockages of the line before a passenger train makes its ascent. The ruling gradient is 1 in 5, and the powerful lightweight railcars introduced in the post-war period reduced the journey time from around 70 minutes to the present 45 minutes. The actual difference in altitude between Zermatt and the upper terminus is 4,872 ft., climbed in no more than 5¾ miles.

143 **Greek State Railways:** Bogie De Luxe Coach.

This bogie coach, which seats eighteen first-class and twenty-eight second-class passengers, is designed for extra travelling comfort. The first-class and second-class passenger compartments are provided with comfortably upholstered revolving and reclining seats with head-rest, armrests, ashtrays and fittings for detachable trays. On the luggage racks arranged over the windows, reading lamps are provided for each pair of seats. The walls and ceiling are panelled with plastics. All the side-wall windows are of the semi-drop type. Roller blinds are fitted to act as sunshades. The bar compartment is equipped with bar counter with bottle racks, cooker and sink unit with fume exhaust, built-in refrigerator, geyser, coffee-maker unit, drinking water cooler, wall-cabinet, glass showcase and bin.

144 **Argentine State Railways:** Suburban Service First-class Carriage.

At a time when commuter travel in many parts of the world is provided on a 'one-class' basis, it is interesting to see that rather lavish accommodation is set aside for first-class passengers in the teeming suburban areas of Buenos Aires. The lengthy coach illustrated, which has a tare weight of 40 tons, has seats for no less than ninety-six passengers, while the corresponding second class, of comparable dimensions and weight, seats 103. Curiously enough the first class, which one would not normally expect to be so heavily patronised, is provided with much more lavish exits. There is a single-width door at each end and two double-wdth entrances intermediately. The second class has only a single-width door at each end. The interior saloon in both classes is lofty and spacious, but it will be seen that the top level of the windows is very low, presumably to keep out the sunlight on hot summer days. The second-class car is the same in this respect, and both are provided with louvred sun-blinds. These cars are designed to run on any of the 5 ft. 6 in. gauge lines, and not specially on any one of the different railway systems, 'General San Martin', 'General Roca', and so on.

145 **Chilean State Railways:** Co-Co Express Passenger Electric Locomotive.

In no country has geography dictated the form of a railway network to a greater extent than in Chile. The lofty range of the Andes running parallel to, and at no great distance from, the shores of the South Pacific Ocean has led to a growth of population in a relatively narrow corridor, and the main line of railway naturally runs southward for several hundred miles from the capital city of Santiago. The proximity of the mountain ranges has facilitated the development of electric power supplies, and electrification of the railways is in process of installation. The Chilean Railways, perhaps from their racial origins in the Latin countries of Europe, chose the same traction system as that of Spain and Italy, namely 3,000 volts D.C., and the very powerful locomotive shown in our picture is one of thirty-six supplied in the early 1960s by Gruppo Azienda Italiene. It is of the Co-Co type, having a weight of 133 tons, and a maximum speed of 81 m.p.h. The Chilean Railways, like the main lines of the Argentine and Brazil, use the 5 ft. 3 in. gauge, and with electric traction it is intended to develop some relatively fast services southwards from Santiago. With a power output that can slightly exceed 4,000 horsepower these locomotives should be amply capable of fine performance.

146 **Southern Pacific Railroad:** Double-deck Car for San Francisco Suburban Service.

The area around the celebrated 'bay' of San Francisco has in recent years experienced a positive explosion of population, and all forms of transport have become extended practically to their limits. In recent years the widely publicised Bay Area Rapid Transit system (BART) has been brought into operation, but in the meantime the largest of the 'ordinary' railways serving the area has made notable strides towards easement of the commuter traffic problem. In particular, attention has been concentrated on the 47-mile run between San Francisco and San Jose, a route that serves no less than twenty-five major centres of population. The commuter trains on this route each consist of six cars of the type shown in our picture, hauled by a diesel-electric locomotive. The Southern Pacific runs twenty-two of these trains daily in each direction, and during the peak hours departures are at 3-minute intervals from San Francisco. Some of these peak-hour services are timed very fast, having regard to the number of intermediate stops. A typical train is the 5·14 p.m. which covers the 32 miles to Palo Alto's California Avenue station, in 38 minutes.

147 **Spanish National Railways (RENFE):** 3,000-Volt Electric Multiple-unit Train.

There have been several systems of electric traction in Spain, the earliest dating back to 1911, when the Southern Railway, having to work heavy iron ore trains over a steeply graded mountain section, electrified 15 miles of the Almeria line on the 5,500 volt three-phase A.C. system. This has remained an isolated installation, and what has since become the national standard, 3,000 volts D.C., dates from 1922 when part of the Northern line was so equipped. Then certain suburban lines around Barcelona, and other lines were equipped on 1,500 volts D.C. but further work, and further diversification, was stopped by the Civil War. After the War, with the formation of the national railway system, RENFE, the decision was taken to standardise on 3,000 volts D.C., and much progress has since been made. The smart car shown in our picture is one used in the make-up of the Barcelona suburban electric trains, some of which are all-passenger cars, while others have a luggage compartment as shown. These cars were of Swiss design, but built under licence in Spain.

148 **Louisville & Nashville Railroad:** The 'M1' Class 2–8–4 of 1942.

This important and far-stretching railroad was one of those hardest hit by the great industrial depression of the 1930s, and had no new main-line locomotives for a period of nearly ten years. But the War in Europe and the mobilisation for defence in the U.S.A. put a different complexion on affairs in 1941. The railroad purchased new General Motors diesels for passenger work, but retained steam for freight, and the very fine 'M1' class of 2–8–4 was then introduced, and Baldwin's delivered the first of the class in July 1942. They were by far the largest engines so far owned by the Louisville and Nashville, and were too big for the turntables and the roundhouses! But increased power was needed, and the L. & N. quickly adapted things to suit the new engines. They had cylinders 25 in. diameter by 32 in. stroke and coupled wheels 5 ft. 9 in. diameter; and carried a boiler pressure of 265 lb. per sq. in. The tractive effort was 65,290 lb. The engine weight was just 200 tons, and the tenders were loaded with 22,000 gallons of water and 24 tons of coal. With two-thirds of the maximum coal and water capacity the tenders weighed 135 tons. The first order was for fourteen locomotives, Nos. 1950 to 1963, and a further twenty-two were put into service from 1948 onwards. They were a very good investment for the L. & N.

149 **Norfolk and Western Railway:** 2–8–8–2 Compound 'Mallet' Freight Locomotive.

The 2–8–8–2, arranged as in all true Mallet articulated locomotives as a compound, was at one time the almost universal heavy freight locomotive on American railroads. But its subsequent development was pursued only on the Norfolk and Western. This railway, in maintaining its post-war policy of retaining steam as its basic form of motive power, developed three classes: the 4–8–4 for express passenger, the 2–6–6–4 simple articulated for fast freight, and the class illustrated for the heaviest freight work. They worked loads of about 13,000 tons at 25 m.p.h. on level track. It was a very successful design. The cylinders were 25 in. diameter high-pressure (rear engine) and 39 in. low-pressure, both with a stroke of 32 in.; the coupled wheels were 4 ft. 10 in. diameter, and the boiler pressure 300 lb. per sq. in. At 4 m.p.h. a 'simpling' valve admits live steam to the low-pressure cylinders at reduced pressure, and this provided additional tractive effort on starting. In ordinary compound working the tractive effort is 126,388 lb.; but when working 'simple' as previously described it is 152,206 lb. These huge engines weighed 273 tons, and the tender, fully loaded, added another 169 tons. They were the only fully modernised compound Mallet articulated locomotives to remain in first-class main-line traffic in the U.S.A.

150 **Denver & Rio Grande Western:** 4–8–4 Express Passenger Locomotive.

The Denver and Rio Grande Railroad cuts through the heart of the Colorado Rockies and, although the gradients are very long and severe, some remarkably fast trains were operated by steam. Notable among these was the 'Exposition Flyer' operated jointly by the Burlington, the Rio Grande, and the Western Pacific between Chicago and San Francisco. From Denver, after a fairly level start, the ascent to the Moffat Tunnel involved an average gradient of 1 in 57 for 43 miles. The huge 4–8–4s that we illustrate were used on this route, and used to take a load of 700 tons without assistance. Although required to do much hard climbing, they were essentially express locomotives and had coupled wheels as large as 6 ft. 1 in. diameter. The two cylinders were 26 in. diameter by 30 in. stroke, and the enormous boiler had an evaporative heating surface of 5,506 sq. ft. and a superheating surface of 2,336 sq. ft. The tractive effort was 67,200 lb. These engines were required to take the 700-ton load of the 'Exposition Flyer' up the 1 in 57 gradient to the Moffat Tunnel at a sustained 25 m.p.h.

151 **Atchison, Topeka & Santa Fe:** The '5011' Class 2–10–4 Heavy Freight Locomotive.

This type of locomotive, known in the U.S.A. as the 'Texas' from its first use on the Texas and Pacific in 1925, though of immense power for a rigid framed locomotive, suffered at first from the difficulty of balancing the heavy reciprocating parts in small driving wheels. The Santa Fe took delivery of its first 2–10–4 from Baldwins in 1930 and, although the balancing problem had been partly solved by increasing the driving wheel diameter from 5 ft. 3 in., on the original Texas engines, to 5 ft. 9 in., this first Santa Fe 2–10–4 was not wholly satisfactory. When the class came to be multiplied from 1928 onwards the wheel diameter on the '5011' illustrated was increased to no less than 6 ft. 2 in. – remarkable for a ten-coupled heavy freight locomotive. The '5011' class was a great success. They had cylinders 30 in. diameter by 34 in. stroke and, with a boiler pressure of no less than 310 lb. per sq. in., had a tractive effort of 93,000 lb. The weight of engine alone in working order was 240 tons, and of the tender, 202·5 tons. They provided a magnificent example of the ultimate in rigid-framed heavy and fast freight steam locomotives in the U.S.A.

152 **British Railways:** Standard Type '4' Diesel-electric Locomotive Class '47'.

In the first phase of the British Railways Modernisation Plan there was as much difference of opinion as to what was the best system of electric transmission and type of engine, as there was on the respective merits of electric and hydraulic transmission. While the English Electric engine was first in the field, the Swiss-designed Sulzer engine, based on long-established marine practice, also had strong claims to consideration. The Sulzer engine was first incorporated in a series of Type '4' locomotives built at the Derby works of British Railways and, as the earliest units of the class were named after mountains, they became known as the 'Peak' class. But the outstanding success of 'all-adhesion' designs of locomotives on the continent of Europe inspired a new British diesel-electric design using the Sulzer engine, and the first batches of these were built by the Brush Electrical Company of Loughborough. These locomotives of 2,750 horsepower with the Co–Co wheel arrangement were destined to become the most numerous of all British non-steam classes to date. The majority of the engines for the 520 locomotives of this class, although of Sulzer design, were built, under licence, at the Naval Construction Works of Vickers Ltd. at Barrow-in-Furness. These locomotives are in extensive use on the Western, Eastern and Scottish Regions of British

Railways, and have a maximum speed of 95 m.p.h.

153 Japanese National Railways: 'Hikari' Super Express Train.

The opening of the first section of the epoch-marking Shin-Kansen network of super high-speed lines on the Japanese National Railways closely coincided with the end of the period covered by this book. It is an appropriate and dramatic end because it ushers in an entirely new conception of high-speed intercity railway travel. The first section, which was to a large extent experimental, connected Tokyo with the second largest city in the country, Osaka, and roughly paralleled the original Tokaido line – the first main line in Japan. But the 'New Tokaido line was no mere upgrading of an old route. It was entirely new, designed for continuous running at 100 m.p.h. and over, and laid to the 4 ft. 8½ in. gauge. Japan is a mountainous country, and to provide such a line involved heavy engineering work. Today there is a 'Hikari' – a super express train – *every quarter of an hour* from Tokyo to Osaka from 6 a.m. till 9 p.m., each consisting of sixteen cars, and providing seating accommodation for 1,400 passengers. The average loading on this service is 67 per cent seven days a week throughout the year. The average speed, inclusive of two stops, is 101 m.p.h., over the distance of 320 miles, and the maximum speed is 131 m.p.h.

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